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SAMPLING AND ANALYSIS PLAN

Mohawk Tannery Site – Southern Parcel Study

Nashua, New Hampshire
NHDES Site No. 198404002
USEPA QA Tracking # 12121

Prepared for the New Hampshire Department of Environmental Services
File No. 2158.01
September 2012

SEMS Doc ID 627415

APPROVAL PAGE

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Prepared by
Sanborn, Head & Associates, Inc.

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1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared to provide site-specific information regarding ongoing activities at the Mohawk Tannery Site Southern Parcel (the "Site") located in Nashua, New Hampshire. The SAP has been prepared consistent with and references the current New Hampshire Department of Environmental Services (NHDES) Hazardous Waste Remediation Bureau (HWRB) Master Quality Assurance Project Plan (Master QAPP), U.S. Environmental Protection Agency (USEPA) Request for Assistance (RFA) #08036, available on the NHDES website.[1] The HWRB Master QAPP describes general data quality objectives (DQOs), analytical procedures and measurements, including laboratory quality-control protocols necessary to achieve DQOs, and data-assessment procedures for the evaluation and identification of data limitations. This SAP provides site-specific information to supplement the general DQOs and procedures in the HWRB Master QAPP. A copy of the HWRB Master QAPP shall be on site at all times while work is in progress.

The objective of this SAP is to outline the project plan for on-going Site activities including sampling and monitoring locations, procedures and protocols, DQOs, quality assurance sampling and documentation, and other project requirements.

Any deviations from the procedures contained within this SAP shall be approved by Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

1.1 Site Description and History

The Mohawk Tannery Site, located at 11 Warsaw Avenue in Nashua, consists of two contiguous 15-acre parcels of land: a developed "Northern Parcel" which was historically used for tannery manufacturing and waste disposal operations, and a "Southern Parcel," which is largely undeveloped and does not appear to have been heavily used by the tannery. The former Tannery is bordered to the east and southeast by residential properties, to the north by property owned by the Fimbel Door Company (which includes a closed lined landfill formerly used for disposal of wastewater treatment sludge generated by the former Mohawk Tannery), and to the west and south by the Nashua River. The tannery (Northern Parcel) produced tanned hides for leather between 1924 and 1984, and has been inactive since 1984.

Sludges generated from former tannery operations were historically disposed in seven unlined on-Site disposal areas (designated Areas 1 through 7), and generally remain in place at the present time. A study of the Site completed in 1985 by Goldberg-Zoino and Associates, Inc. (GZA) of Manchester, New Hampshire estimated that the total volume of sludges remaining on-Site in the seven disposal areas is approximately 60,000 cubic yards (cy).

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[1] *http://des.nh.gov/organization/divisions/waste/hwrb/documents/hwrb_master_qapp.pdf*

Based on the environmental information compiled at that time, the Site was proposed for the National Priorities List (NPL) in May 2000 (CERCLIS ID NHD981889629). Subsequently in 2001 - 2002, Tetra-Tech NUS (TtNUS), on behalf of the USEPA, completed an Engineering Evaluation/Cost Analysis (EE/CA) for the sludge disposal areas at the Site, that generally confirmed the locations and extent of the sludge, evaluated remedial options for the sludge, and provided preliminary cost estimates to implement the remedial options.

Between 2002 and 2005, Sanborn Head completed a Remedial Investigation (RI) of environmental conditions and an assessment of risk for the northern developed parcel only (as Operable Unit 1 “OU1”). Specifically excluded from this OU1 RI were: the sludge disposal areas addressed in the EE/CA; the undeveloped Southern Parcel (the focus of this SAP); and Nashua River and related environs, surface water and sediment. Further, based on discussions with NHDES and USEPA, the OU1 investigation of groundwater generally was limited to shallow (i.e., near water table) conditions.

Known or potential contamination on the Southern Parcel includes:

- Available data indicate contamination from the tannery operations is present in the northern portion of the Southern Parcel, consisting of: tannery sludge/associated impacted soil in the vicinity of Disposal Areas 2 and 7, and impacted groundwater flowing south-southwest from the Northern Parcel.
- A documented asbestos disposal site (NHDES No. 200410149) appears to extend onto the eastern-most portion of the Southern Parcel, and apparent asbestos containing debris was observed along footpaths in the northern portion of the Southern Parcel (which is itself identified as an Asbestos Disposal Site - NHDES No. 200410150).
- In addition, the potential exists that sediments originating from the tannery site, or other potentially contaminated sites upstream of the Southern Parcel, may have been deposited by flood waters on the Southern Parcel, which is largely in the floodplain.

We understand the goal of these sampling activities is intended to provide the analytical data adequate to support a screening level human health and ecological risk assessment of the Southern Parcel for potential delisting from the NPL. We understand that the screening level risk assessment will evaluate potential risks to human health and the environment, and if no unacceptable risk is identified, the Southern Parcel, or a portion of the Southern Parcel will be recommended for delisting. If the screening level risk assessment requires additional data beyond those to be compiled as part of this investigation, then a subsequent phase of work could be developed in collaboration with USEPA and NHDES that might include additional environmental media sampling and analysis, and quantitative (e.g., non-screening level) risk assessment(s).

1.2 Summary of Site Hydrogeology

The RI focused on the Northern Parcel, and as such, limited hydrogeologic data exist for the Southern Parcel. Hydrogeologic information from the RI is presented below, and is anticipated to be generally representative of Southern Parcel conditions.

Geology in the vicinity of the Northern Parcel consists of glacial and alluvial soil deposits overlying crystalline bedrock, and is illustrated on Figures 8 through 11 of the RI Report. Bedrock beneath the Northern Parcel is identified as the Berwick Formation, typically described as a quartz-biotite-feldspar granofels or schist; and/or a Devonian-aged two-mica granite that intrudes the Berwick. Depth to bedrock varies considerably across the Northern Parcel, from about 6 to 9 feet below ground surface (ft bgs) in the northwest, to greater than 80 feet in the southeast portion of the Site near the Main Building. A bedrock high extends from the northwest portion of the Northern Parcel to the south-southeast for approximately 500 feet, through much of Lagoon 1, to the eastern part of Lagoon 2.

Based on water level measurements made during Sanborn Head's July 10, 2012 site visit with NHDES, ambient groundwater levels at the Site are typically between approximately 6 to 8 ft bgs near the Nashua River and approximately 52 feet in monitoring well SH-13 located in the upland terraced area south of the former tannery building. These depths generally correspond to the sand or fine sand unit (based on observations from monitoring wells). Vertical gradient information for the Northern Parcel is limited; however the existing data indicate upward gradients in the vicinity of monitoring well couplet SH-16S/D, which are located approximately 50 feet from the Nashua River. Farther away from the river, particularly moving topographically upward into the higher terraced areas, downward vertical gradients are anticipated.

Groundwater beneath the Southern Parcel is inferred to flow in a general south-southwest direction toward the Nashua River, the inferred discharge point for groundwater.

1.3 Data Quality Objectives

The Data Quality Objectives (DQOs) for the current investigatory efforts at the Southern Parcel are to generate field and analytical data of adequate quality to:

- Support a screening level human health and ecological risk assessment (evaluating groundwater, surface water, soil, and sediment risks) of the Southern Parcel for potential de-listing from the NPL.

- Allow evaluation/comparison between sediment sample results collected at locations from the Nashua River adjacent to the Southern Parcel and sediment samples collected at locations from the Nashua River upstream (i.e., background) of the Southern Parcel.

Performance acceptance criteria for all new data generated for this project will be based on principal Data Quality Indicators including: precision, bias, representativeness, completeness, comparability, and sensitivity. Consistent with the HWRB Master QAPP, Section 1.4, for data generated by the New Hampshire Department of Health and Human Services (DHHS), Division of Public Health Services (DPHS) Laboratory (NHDPHS Lab), the method detection limits (MDLs) and reporting limits (RLs) established by the laboratory have been accepted for use on this project. The NHDPHS Lab RLs, as well as RLs established by the USEPA New England Regional Laboratory (NERL), Alpha Analytical, Inc. (Alpha), and Eastern Analytical, Inc. (EAI), for select analyses described in Section 3 below, are summarized in Table 1. The MDLs, RLs, and acceptance limits for accuracy and precision have been accepted for use on this project.

Precision, bias, and sensitivity are Data Quality Indicators that will be evaluated as part of data validation. Representativeness, comparability and completeness are three parameters potentially affected by the quality of field sampling. Representativeness describes the extent to which sampling design and implementation (including sample collection and analysis) adequately reflects the environmental conditions of the Southern Parcel. Representativeness has been considered as part of selection of sampling locations and parameters. Refer to Figure 2 for sampling locations and Tables 2a through 2e for a summary of analytical parameters for each location.

Comparability is the extent to which data from one data set can be compared directly to similar or related data sets and/or decision-making standards. Data comparability will be achieved by continuity of acceptable laboratory practices, method analysis, sample collection procedures and sample handling. Any deviations from the procedures contained within this SAP must be approved by Sanborn Head's Project Manager or Principal-in-Charge (PIC) and documented.

Completeness is a measure of the amount of valid/usable data collected using a measurement system. Completeness will be calculated as a percentage of the number of valid/usable results obtained compared to the total number of results (usable and rejected) obtained during the field program. Theoretically, the completeness target is reached through adherence to the methods and QC requirements as defined throughout the SAP. However, it is not uncommon for a limited amount of data to be lost (i.e., rejected) due to human error or the nature of environmental matrices, especially in consideration of the low PALs established for the Site. The goal for the project is to achieve a minimum of 90 percent (%) data completeness for analyzed samples.

A combination of Tier II and Tier III data validation will be performed on the data generated as part of our field sampling, to support the human health and ecological screening level risk assessment. The NHDES will perform data validation on the data generated by the NHDPHS Lab; the USEPA will perform data validation on the data generated by the USEPA Lab, the USEPA Contract Lab, and Alpha. For samples analyzed by EPA and/or its contractor(s) for dioxins/furans and PCB congeners, EPA NERL will conduct Tier III data validation on the first data package, and Tier II data validation on the remaining data packages. If significant quality issues are observed in the Tier III data packages, then all of the data packages for dioxins/furans and/or PCB congeners will be subjected to Tier III validation. Tier II data validation will be performed on the remaining data, except total organic carbon data which will not be validated.

1.4 Project Action Limits

Project action limits (PALs) were established for the Site by USEPA and NHDES in accordance with project DQOs. Refer to Table 1 for a summary of test methods including respective laboratory RLs relative to the PALs.

Project Action Limits for Chemicals of Concern
Mohawk Tannery Superfund Site Southern Parcel

Chemical of Concern	Human Health Risk						
	Soil		Surface Water		Groundwater		
	Residential RSL	NHDES Soil Standards	NRWQC Water & Organism	NHDES SWQC	MCL	NHDES AGQS	Tapwater RSL
	(mg/kg)	(mg/kg)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)
1,2-Dichlorobenzene	19000	88	420	2700	600	600	280
1,4-Dichlorobenzene	2.4	7	63	400	75	75	0.42
Chlorobenzene	290	6	130	20	100	100	72
4-Methylphenol	310	0.7	NA	NA	NA	40	72
Benzo(a)Pyrene	0.015	0.7	0.0038	0.0044	0.2	0.2	0.0029
2-Methylnaphthalene	310	96	NA	NA	NA	280	27
Naphthalene	3.6	5	NA	NA	NA	20	0.14
Pentachlorophenol	0.89	3	0.27	0.28	1	1	0.17
Total PCBs	0.22	1	0.000064	0.00017	0.5	0.5	0.034
Dioxin (2,3,7,8-TCDD)	0.0000045	0.00007 †	0.000000005	0.00001	0.00003	0.00003	0.00000052
Antimony	31	9	NA	14	6	6	6
Arsenic	0.39	11	0.018	0.018	10	10	0.045
Barium	15000	1000	1000	1000	2000	2000	2900
Cadmium	70	33	NA	NA	5	5	6.9
Chromium	0.29 (VI)	1,000 (III) 130 (VI)	NA	1 (VI)	100 (Total)	100 (Total)	0.031 (VI)
Lead	400	400	NA	NA	15	15	NA
Manganese	1800	5200	NA	50	NA	840	320
Mercury	23	6	0.3	0.05	2	2	4.3
Thallium	0.78	10	0.24	1.7	2	2	0.16
Vanadium	390	NA	NA	NA	NA	NA	78

Chemical of Concern	Ecological Risk						
	Soil		Sediment		Surface Water		
	Lowest EcoSSL	Other Benchmark[1]	EPA R3	TEC	NRWQC	NHDES SWQC	EPA R3
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(µg/L)	(µg/L)	(µg/L)
1,2-Dichlorobenzene	NA	2.96	0.0165	NA	NA	763 [2]	0.7
1,4-Dichlorobenzene	NA	0.546	0.599	NA	NA	763 [2]	26
Chlorobenzene	NA	13.1	0.00842	NA	NA	50 [2]	1.3
4-Methylphenol	NA	163	0.67	NA	NA	NA	543
Benzo(a)Pyrene	NA	1.52	0.15	0.15	NA	NA	0.015
2-Methylnaphthalene	NA	3.24	0.0202	NA	NA	NA	4.7
Naphthalene	NA	0.0994	0.176	NA	NA	620	1.1
Pentachlorophenol	2.1	0.119	0.504	NA	15	4.05	0.5
Total PCBs	NA	0.000332	0.0598	59.8	0.014	0.014	0.000074
Dioxin (2,3,7,8-TCDD)	NA	0.000000199	0.00000085	NA	NA	0.00001	0.0000000031
Antimony	0.27	0.142	2	NA	NA	1600	30
Arsenic	18	5.7	9.8	9.79	150	150	5
Barium	330	1.04	NA	NA	NA	NA	4
Cadmium	0.36	0.00222	0.99	0.99	0.25	0.8	0.25
Chromium	34	34	43.4	43.4	11 (VI)	24 (III) 11 (VI)	11
Lead	11	0.0537	35.8	35.8	2.5	0.54	2.5
Manganese	220	220	460	NA	NA	NA	120
Mercury	NA	0.1	0.18	0.18	0.77	0.77	0.026
Thallium	NA	0.0569	NA	NA	NA	40	0.8
Vanadium	7.8	1.59	NA	NA	NA	NA	20

[1] Buchman, M. F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA, Office of Response and Restoration Div., NOAA, 34pp.

[2] The values listed are for totals where there is more than one isomer.

"†" Robin Mongeon at the NHDES indicated that the on-line version of Env-Or 600 (July 2008) has a typographical error. The published Soil Standard for dioxin (2,3,7,8-TCDD) is 0.001 mg/kg, but it should be 0.00007 mg/kg.

NA = not applicable

RSL = Regional Screening Level

MCL = Maximum Contaminant Level
NRWQC = National Recommended Water Quality Criteria
(http://water.epa.gov/scitech/swguidance/standards/current/index.cfm)
EPA R3 = EPA Region 3 (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm)
EcoSSL = EPA Ecological Soil Screening Level (http://www.epa.gov/ecotox/ecossl/)
TEC = Threshold Effect Concentration, from Macdonald et al
(2000; http://ptc.mtech.edu/pmunday/CFRevival/MacDonald%202000%20Sediment%20Quality%20Guidelines.pdf)
Macdonald, D. , Ingersoll, C. and Berger, T. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Arch. Environ. Contam. Tox. 39: 20-31.
For surface water PALs, select metals (e.g., cadmium, hexavalent chromium, and lead) have hardness dependent PALs. The PAL values for these analytes indicated above are subject to change depending upon site-specific hardness values to be obtained as part of these sampling activities.
Refer to Tables 1A through 1D for additional discussion.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

NHDES and USEPA have entered into a Cooperative Agreement to implement the Southern Parcel study at the Mohawk Tannery Site. NHDES is currently the lead regulatory agency for the Site, with assistance from USEPA and their contractors in performance of the study. Sanborn Head has been retained by the NHDES to provide environmental investigatory consulting services for the project.

For this phase of the project, project organization and general roles for Sanborn Head personnel are outlined below.

- The Sanborn Head Principal-in-Charge (PIC) for this project will be Charles A. Crocetti, PhD, P.G. Mr. Crocetti will oversee all aspects of the work performed by Sanborn Head. Mr. Crocetti will participate in the review of field data, and in field decisions such as the selection of samples for further chemical characterization in a fixed laboratory. Mr. Crocetti is a professional geologist licensed under New Hampshire Revised Statutes Annotated (RSA) 310-A and was the PIC on Sanborn Head's RI phase of investigation for the Mohawk Tannery (Northern Parcel).
- The Sanborn Head Project Reviewer will be Bradley A. Green, P.G. The Project Reviewer will review the draft report and other significant documents prior to submittal to NHDES and USEPA. In the PIC's absence, Project Reviewer acts as the PIC. The Project Reviewer will not be involved in day-to-day aspects of the project, to provide a "fresh," objective review. Mr. Green has coordinated previous sampling efforts on the Mohawk site and is familiar with loss prevention and risk management issues. Mr. Green was the project manager for the RI and FS completed by Sanborn Head at the Blackburn & Union Privileges Superfund Site in Walpole, MA. Mr. Green is a professional geologist licensed under New Hampshire RSA 310-A.
- The Sanborn Head Project Manager (PM) will be Timothy M. White, P.G. Mr. White has primary responsibility for the technical aspects of the project and field tasks. Mr. White will be the primary office contact during the fieldwork. Mr. White will review field data as they are generated/performed, and oversees preparation of the draft report prior to review by the PIC and Project Reviewer. Mr. White is a professional geologist licensed under New Hampshire RSA 310-A.
- The Sanborn Head Quality Assurance Manager (QAM) will be Ms. Kelly M. Dubois. Ms. Dubois has primary responsibility for monitoring compliance with this SAP and the current version of the HWRB Master QAPP. Ms. Dubois will serve as primary contact

with the analytical laboratory PMs and will also review analytical laboratory data as they are generated and assess the data for compliance with the SAP and for data usability.

- The Sanborn Head Project Health & Safety Officer will be Scott R. Nerney, P.E. Mr. Nerney will also provide senior technical support for the project. Mr. Nerney was the Project Engineer for the RI and FS completed by Sanborn Head at the Beede Waste Oil Superfund Site in Plaistow, NH. Mr. Nerney is the Health & Safety Coordinator for Sanborn Head's Concord, NH office, and is a professional engineer licensed under New Hampshire RSA 310-A.
- Project Engineers/Scientists from Sanborn Head's technical staff perform specific project tasks including collection of field data, review and compilation of analytical data received from the laboratory, summation of the work performed, and presentation of findings in a draft report. Deviations from the SAP will be documented by the Project staff, who will report directly to the QAM, PM, and PIC.

Refer to Appendix A for an illustration of project organization and responsibilities of those individuals involved in the project.

3.0 FIELD MONITORING AND SAMPLING PROTOCOL

The following subsections discuss the general methodology for performing sampling and analysis as part of the overall field activities including specific sampling procedures and data management requirements that will be implemented during the monitoring program. Field activities will be conducted in accordance with this SAP, unless Site conditions require modifications. Any modifications must be approved by Sanborn Head's Project Manager or Principal-in-Charge (PIC) and documented

Specific SOPs are included in Appendix B and referenced herein.

3.1 Sample Identification

In order to properly upload groundwater sample results into the NHDES EMD (Environmental Monitoring Database) samples must be identified using the designated NHDES station identification. Sample results for other media may be uploaded to the NHDES EMD in the future.

- Sample names will include "MHK_" as a prefix. This includes any samples going to outside labs so that later this data may be uploaded into the NHDES EMD;
- Sample names will be 15 characters or less, including the "MHK_";
- Equipment Blanks will be labeled "EQUIP BLANK." A brief description of the equipment from which the equipment blank was collected will be documented in the field log book and indicated in the comments section of the chain-of-custody (COC) form;
- Trip Blanks will be labeled "Trip Blank" without any other designation. Only one Trip Blank per chain-of-custody, per cooler is acceptable;

- Field duplicate samples will be blind to the laboratories and will be designated **OW-[laboratory matrix series #]**, where "laboratory matrix series #" corresponds to the sample deliverable group (SDG) number (e.g., the first soil field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named "OW-101"). Refer to SOP B.10 for additional information on sample naming and SDGs; and
- All new sample location names shall be approved by the NHDES Project Manager and the QA Coordinator in advance, following concurrence with USEPA.

Refer to the SOP B.10 for additional information.

3.2 Multi-Media Sampling and Analysis

Multi-media sampling at the site includes sampling of soil, sediment, groundwater, and surface water from proposed new locations and groundwater from the existing network of monitoring wells.

The tables and figures refer to the following sample types to be collected at the site:

- Figure 1 illustrates the site location.
- Figure 2 illustrates the soil, sediment, groundwater, and surface water sampling locations at the site.
- Table 1 is a summary of site chemicals of concern, associated PALs, and the associated laboratory RLs.
- Table 2 outlines the locations to be sampled, their respective designations, sampling procedure, and analyses to be performed.
- Table 3 outlines analytical methods and sample volume, containers, and hold time requirements.
- Table 4 is a summary of monitoring well construction information, which includes well diameter, geologic unit the well is screened within, screen interval depth, etc.
- Table 5 outlines project-specific Quality Control (QC) sampling requirements for the field program.

Analysis of samples will be divided among the NHDPHS Laboratory, USEPA NERL laboratory, USEPA's contract laboratory, Alpha Analytical, Inc. (Alpha), Eastern Analytical, Inc. (EAI), and Geotesting Express, Inc. (Geotesting)[2]. Refer to Table 1 for sampling methods and a list of analytes.

For <u>soil samples</u>, the following provides the planned analysis responsibilities:

- NHDPHS will be responsible for analyzing samples for select metals.

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[2] Geotesting will perform grain size analyses on sediment samples and this data will not be validated.

- Alpha will be responsible for analyzing samples for total and hexavalent chromium.
- USEPA NERL will be responsible for analyzing samples for VOCs, SVOCs, and asbestos.
- USEPA's contract laboratory will be responsible for analyzing samples for PCB congeners, and dioxins/furans.

For sediment samples, the following provides the planned analysis responsibilities:

- NHDPHS will be responsible for analyzing samples for select metals.
- Alpha will be responsible for analyzing samples for total and hexavalent chromium, and TOC.
- USEPA NERL will be responsible for analyzing samples for VOCs, and SVOCs.
- USEPA's contract laboratory will be responsible for analyzing samples for PCB congeners, and dioxins/furans.
- Geotesting will be responsible for analyzing samples for grain size.

For groundwater samples, the following provides the planned analysis responsibilities:

- NHDPHS will be responsible for analyzing samples for select unfiltered and filtered metals (for groundwater collected from monitoring wells, decisions to collect field filtered samples for metals analysis in addition to unfiltered samples will be based on turbidity values observed during sampling – refer to field SOP B.7; groundwater collected from mini-piezometers will be field filtered for metals analysis – refer to field SOP B.3).
- Alpha will be responsible for analyzing samples for unfiltered and filtered total and hexavalent chromium (for groundwater collected from monitoring wells, decisions to collect field filtered samples for chromium analysis in addition to unfiltered samples will be based on turbidity values observed during sampling – refer to field SOP B.7; groundwater collected from mini-piezometers will be field filtered for metals analysis – refer to field SOP B.3).
- EAI will be responsible for analyzing samples for 1,4-dioxane.
- USEPA NERL will be responsible for analyzing samples for VOCs and unfiltered and filtered SVOCs (for groundwater collected from monitoring wells, decisions to collect field filtered samples for SVOC analysis in lieu of unfiltered samples will be based on turbidity values observed during sampling – refer to field SOP B.7; groundwater collected from mini-piezometers will be field filtered for SVOC analysis – refer to field SOP B.3).

For wetland surface water laboratory analyses, the following provides the planned analyses responsibilities:

- NHDPHS will be responsible for analyzing samples for select unfiltered metals and hardness.
- Alpha will be responsible for analyzing samples for unfiltered total and hexavalent chromium.
- USEPA NERL will be responsible for analyzing samples for VOCs and SVOCs.

Sanborn Head will be responsible for delivering samples to the NHDPHS and USEPA NERL laboratories, and may use Alpha and EAI courier services to deliver these samples under

COC protocols. Samples going to the NHDPHS Laboratory will be transported under the NHDPHS chain-of-custody (COC). Samples going to the USEPA NERL will be transported under a Sanborn Head COC. Refer to field SOP B.10.

Samples being transported to the USEPA contract laboratory will be shipped via commercial carrier (e.g., FedEx) under the Sanborn Head COC.

The Sanborn Head QAM will coordinate sample delivery arrangements with the NHDPHS and USEPA NERL project managers and laboratories directly.

All samples going to Alpha will be transported via Alpha courier using an Alpha COC (refer to field SOP B.10). The Sanborn Head QAM will coordinate sample delivery arrangements directly with Alpha.

All samples going to EAI will be transported via EAI courier using an EAI COC (refer to field SOP B.10). The Sanborn Head QAM will coordinate sample delivery arrangements directly with EAI.

All samples going to Geotesting will be transported using an Alpha COC. The Sanborn Head QAM will coordinate sample delivery arrangements directly with Geotesting.

The laboratory Turn-Around-Time (TAT) requested for all samples will be the standard TAT for each laboratory.

3.2.1 Sample Grid Layout/GPS Position

The sample locations indicated on Figure 2 will be located in the field using a hand-held GPS (Trimble XH with Hurricane antenna, or similar). Depending upon site conditions (e.g., vegetation, terrain, etc.) the expected accuracy of the GPS unit is ±1 meter (about 3 feet). Latitude and longitude of sampling locations will be recorded.

Prior to installation of the mini-piezometers/well points, Sanborn Head will perform a site visit to complete a DigSafe notification (utility clearance) as required by law, and to layout sampling locations.

3.2.2 Installation and Sampling of Mini-Piezometers/Well Points

To provide groundwater quality information and groundwater levels on the Southern Parcel, Sanborn Head will install and sample mini-piezometers/well points at locations specified on Figure 2. Refer to field SOP B.3 regarding specific installation and sampling methodologies.

3.2.3 Mini-Piezometers/Well Points and Staff Gauge Reference Elevation Survey/Update Base Map

The elevations of the newly-installed mini-piezometers/well points will be surveyed using standard rod-and-level methods (refer to field SOP B.4) and referenced to the existing site datum (using existing monitoring wells [e.g., GZ-10, GZ-11, GZ-13, SH-13, or SH-19]). The groundwater elevations will be calculated and plotted on a site plan (refer to field SOP B.4).

Due to dense vegetation and locations distal to existing reference points, only a portion of the mini-piezometers installed along the Nashua River will be surveyed for elevation.

3.2.4 Water Level Measurements (Comprehensive Round – Includes Northern Parcel)

To support preparation of a groundwater elevation contour plan for the Southern Parcel, Sanborn Head will measure groundwater levels and depths to bottoms of existing monitoring wells and mini-piezometer/well points, including select wells located on the Northern Parcel. Refer to field SOP B.5 regarding specific methodologies.

3.2.5 Collection/Analysis of Groundwater Samples

Groundwater monitoring wells identified in Table 2 will be purged and sampled using low flow methodology with a bladder pump. Refer to field SOP B.7 regarding sampling methodologies for monitoring wells using bladder pumps. Well construction information for existing sampling locations is included in Table 4. Mini-piezometers/well points identified in Table 2 will be purged and sampled using a peristaltic pump. Refer to SOP B.3 regarding sampling methodologies for mini-piezometers/well points.

Refer to Tables 2 and 3 for specific laboratory analyses planned for the samples, and Table 5 for associated QC sampling (e.g., equipment blanks, duplicate samples), with respect to groundwater sampling.

Decontamination of non-dedicated equipment (i.e., water level meters) will be completed in accordance with field SOP B.11. Groundwater and decontamination water generated from groundwater sampling activities will be discharged to the ground surface near the point of generation.

3.2.6 Collection/Analysis of Soil Samples

Soil samples will be collected in accordance with field SOP B.1. PID headspace screening on a portion of the soil sample will be completed following sample collection.

Refer to Table 2 and Figure 2 for planned sampling locations. Refer to Tables 2 and 3 for the specific laboratory analyses planned, and Table 5 for associated QC sampling including, duplicate samples, etc., with respect to soil sampling.

Decontamination of sampling equipment (i.e., stainless steel scoops, spoons) will be completed in accordance with field SOP B.11. Excess soil/soil cuttings and decontamination water generated from soil sampling activities will be discharged to/spread on the ground surface near the point of generation.

3.2.7 Collection/Analysis of Sediment Samples

Sediment samples will be collected in accordance with field SOP B.9. PID headspace screening on a portion of the sediment sample will be completed following sample collection.

Refer to Table 2 and Figure 2 for planned sampling locations. In addition to the sampling locations indicated on Figure 2, sediment samples will be collected from one "background" location located in the Nashua River upstream and across the river from the Site, north of a boardwalk along the river. If the results from this background sample and the samples collected from the Site warrant, an additional up to two sediment background locations may be sampled in another phase of work. Refer to Tables 2 and 3 for the specific laboratory analyses planned, and Table 5 for associated QC sampling including, duplicate samples, etc., with respect to sediment sampling.

Decontamination of sampling equipment (i.e., stainless steel scoops, spoons) will be completed in accordance with field SOP B.11. Excess sediment and decontamination water generated from sediment sampling activities will be discharged to/spread on the ground surface near the point of generation.

3.2.8 Collection/Analysis of Wetland Surface Water Samples

Surface water samples will be collected from two wetland locations. Wetland surface water sampling will occur at approximately the same time as the groundwater sampling event. Based on weather reports, the sampling team will select a relatively dry period during the site sampling events to collect the wetland surface water samples, unless otherwise directed by the project manager.

The two wetland surface water sample locations will be co-located (e.g., within approximately 5 feet) with groundwater sample locations.

Surface water samples will be collected in accordance with field SOP B.8. In situ readings for pH, Specific Conductivity, Temperature, ORP and DO shall be collected at each surface water location. A probe guard shall be used with the multiparameter meter in order to protect the probes. Turbidity will be collected using a vial and a separate meter.

Refer to Table 2 and Figure 2 for planned sampling locations. Refer to Tables 2 and 3 for the specific laboratory analyses planned, and Table 5 for associated QC sampling including, duplicate samples, etc., with respect to wetland surface water sampling.

Decontamination of non-dedicated equipment will be completed in accordance with field SOP B.11. Surface water and decontamination water generated from surface water sampling activities will be discharged to the ground surface near the point of generation.

3.2.9 Other Planned Activities

This section discusses other activities planned as part of the field activities at the Mohawk Tannery Southern Parcel.

Sampling of the mini-piezometers/well points located near the Nashua River will be targeted for a time when Nashua River water levels are receding or relatively low static, and piezometer samples are anticipated to be more representative of groundwater conditions, rather than river bank storage conditions as would be the case during rising or high static river stage. Prior to the groundwater sampling event, we will install a staff gauge/stilling well instrumented with a pressure transducer/data logger in the Nashua River adjacent to the site. We will review these water level data as well as recent/anticipated precipitation events, to identify receding/low static Nashua River water levels considered appropriate for groundwater sampling.

4.0 QUALITY CONTROL

This section describes the QC steps used to demonstrate reliability and confidence in the monitoring data collected for this project and includes field equipment maintenance and calibration, field QC sample collection, and data verification and validation.

4.1 Equipment Calibration and Maintenance

The following table provides the preventive maintenance steps for the typical equipment anticipated for the types of monitoring and sampling activates addressed by this SAP to ensure proper functioning of field equipment for the project. Manufacturer's equipment manuals and manufacturer-provided maintenance kits will be available on-site. Calibration procedures are included in Appendix B.

All field instruments shall be calibrated, and have a calibration check, in the office prior to the field event (within one week) to confirm that the equipment is working properly and meets the QA criteria.

Field Equipment - Preventive Maintenance

Instrument	Activity	Frequency
Photovac Model 2020 Photoionization Detector (PID)	Calibration and Calibration Check – pre-sampling event	Once Prior to Sampling Event
	Calibration	Daily and as needed by outcome of calibration checks
	Battery check Calibration check – beginning of day Calibration check – end of day	Daily
Slope Electronic Water Level Indicator	Battery Check	Daily
Hach 2100 P Turbidimeter	Calibration and Calibration Check – pre-sampling event	Once Prior to Sampling Event
	Calibration	As needed by outcome of calibration checks
	Battery check Calibration check – beginning of day Calibration check – end of day	Daily
YSI 600XL/XLM or YSI 556 MPS Multi-Parameter Water Quality Monitor	Calibration and Calibration Check – pre-sampling event	Once Prior to Sampling Event
	Calibration	As needed by outcome of calibration checks
	Battery check Inspect temperature element Calibration check – beginning of day Calibration check – end of day	Daily

Records of calibration and calibration checks will be maintained on a calibration form which will be referenced in the daily entry in the field book. Field personnel will limit contact of sampling equipment and field instruments with the ground surface.

The following tables provide performance requirements of applicable field equipment; and required corrective actions should equipment fail.

PID – Calibration and Corrective Action

Instrument	Calibration Frequency	Calibration Standards	Acceptance Criteria for Daily Calibration Checks	Corrective Action
Photovac 2020 PID	Daily Calibration at the beginning of each day Calibration Check at the beginning of the day after calibration Calibration Check at the end of the day Mid-day calibration checks may be performed, as necessary	100 ppm isobutylene	±10%	**Daily Calibration** – Recalibrate appropriate standard. If value is still outside the acceptance criteria, replace with a different unit. **Morning Calibration Check –** If outside the criteria during the morning check, replace the appropriate calibration standard and recalibrate/check. If recalibration is unsuccessful, replace the unit. **End of the day or Mid-day Calibration Check –** If outside the criteria at the end of the day, the data collected since the last acceptable calibration or calibration check will be qualified by Sanborn Head

Note:

1. The calibration checks are a check of the instrument against the calibration standards and are in "measurement" mode on a run/measurement screen. These are not re-calibrations but rather checks.

PIDs will be calibrated at the start of each day. Calibration checks, made in the run mode, shall be performed following morning calibration at the beginning of each sampling day to confirm the equipment is in calibration, and again at the end of the day of use to confirm that the instruments have remained in calibration throughout the day. Mid-day calibration checks may also be performed. If the beginning of the day check is unsuccessful, the PID must be recalibrated and the calibration must be checked again.

YSI/Hach – Calibration and Corrective Action

Instrument	Calibration Frequency	Calibration Standards	Acceptance Criteria for Daily Calibration Checks	Corrective Action
Hach 2100 P	Daily Calibration Check at the beginning of each day Calibration of any parameter not within range during the calibration check Calibration Check at the end of the day Mid-day calibration checks may be performed, as necessary	Calibrate to <0.1, 20, 100, and 800 NTUs (StablCal Formazin Primary Turbidity Standards)	±5% for 20 NTU	**Morning Calibration Check** -If outside the criteria during the morning check, calibrate only the parameter(s) that was out of range. If still out of range replace the appropriate calibration standards and recalibrate/check. If recalibration is unsuccessful, replace the unit. **End of the day or Mid-day Calibration Check –** If outside the criteria at the end of the day, the data collected since the last acceptable calibration or calibration check will be qualified by Sanborn Head.
YSI 600 XL/XLM or YSI 556 MPS *1.) Dissolved Oxygen and temperature*		Calibrate to 100% water-saturated air and use zero DO solution for check	0-0.5 mg/l (zero DO)	
2.) Oxygen Reduction Potential		Zobell solution (calibration and check)	±5%	
3.) Specific Conductance		Calibrate: 1,413 µS/cm Calibration Check: 700 µS/cm	±5%	
4.) pH		Calibrate to pH 4 , 7 and 10 and use pH 7 to check	±5% for pH 7	

Note:

2. The calibration checks are a check of the instrument against the calibration standards and are in "measurement" mode on a run/measurement screen. These are not re-calibrations but rather checks.

Calibration checks for the YSI/Hach, made in the run mode, shall be performed following morning calibration at the beginning of each sampling day to confirm the equipment is in calibration, and again at the end of the day of use to confirm that the instruments have remained in calibration throughout the day. Mid-day calibration checks may also be performed. If the beginning of the day check is unsuccessful for any parameter, that parameter must be calibrated and the calibration must be checked again. If a calibration check is unsuccessful for a parameter, the data collected for that parameter since the last acceptable calibration or calibration check shall be qualified in its use.

In addition, should repeated erratic or illogical readings occur between calibrations, the instrument shall be recalibrated in order to confirm that representative measurements are obtained. All calibration and check values shall be documented on the calibration log maintained for each piece of equipment. Refer to the calibration procedures for YSI and Hach Field Instruments in field SOP B.6 for specific calibration procedures.

In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, tested, and inspected according to the manufacturer's instructions.

4.2 Field QA/QC Sampling

QA/QC samples are collected and analyzed to provide information on the variability and usability of the sample results. They assist in identifying the origin of analytical discrepancies which in turn help to determine how the analytical results should be used. QA/QC results may suggest the need for modifying sample collection, preparation, handling, or analytical procedures if the resultant data do not meet quality assurance objectives.

The following provides a general description of the field QC sampling that will occur for the project. Refer to Table 5 which includes a summary of QC samples to be collected.

Field Sampling Requirements for Quality Control

QC Sample	Frequency
VOC and 1,4-Dioxane Trip Blanks	1 per cooler containing VOC or 1,4-dioxane samples
Performance Evaluation (PE) Sample	1 per analyte type (e.g., VOCs, dioxins/furans) per matrix for all laboratories except NHDPHS lab, as available from the USEPA
Temperature Blank	1 per cooler containing samples
Equipment Rinseate Blank	If non-dedicated equipment is used, once per sampling event during equipment use duration; per equipment type (refer to Table 5).
Duplicate	1 duplicate per batch of 20 samples, per matrix, per parameter, as indicated in Table 5
Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	1 MS/MSD per batch of 20 samples, per matrix, per parameter (except PCB congener and dioxin/furan analyses)

Notes:

1. VOC trip blanks will be prepared by the USEPA NERL and maintained with the sample containers. 1,4-Dioxane trip blanks will be prepared by EAI and maintained with the sample containers.
2. Equipment rinseate blank samples will be designated as "EQUIP BLANK." Note that a comment is required on the COC indicating what the equipment blank is for (i.e., bladder pump). See Table 5.
3. Field duplicate samples will be blind to the laboratories and will be designated **OW-[matrix series #]**, where "matrix series #" corresponds to the sample deliverable group (SDG) number (e.g., the field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named "OW-101"). Refer to SOP B.10 for additional information on sample naming and SDGs.

4.3 Data Verification and Validation

Data review, which includes Sanborn Head's in-house examination to confirm data have been recorded, transmitted, and processed correctly, and data verification, which includes the evaluation of completeness, correctness, and conformance/compliance of a specific data set, will be performed by Sanborn Head's QAM.

Field measurement data will be reviewed by the Sanborn Head's QAM, PM or designee daily for all matrices. Review will generally consist of the following: 1) review of field calibration data and end of the day check; and 2) review of raw field data and field notes for outliers or inconsistencies that may indicate a problem with the equipment or sampling procedure.

Laboratory data generated by the NHDPHS will be reviewed/validated by NHDPHS personnel; and laboratory data generated by USEPA NERL, USEPA contract laboratories, Alpha, and EAI will be reviewed/validated by USEPA personnel.

The NHDPHS laboratory report will consist of the following:

- Data Qualifier Description Page;
- Sample Summary Page: includes laboratory IDs, Corresponding Client Sample IDs, Matrix, Date/Time Collected and Date Received;
- Analytical Report Comments and Qualifiers Page;
- Analytical Results Pages: Method Citation, results, units, RDL, prep date, analyzed date, CAS# Regulatory Limit if applicable and Qualifier Code; and
- Completed COC.

The NHDPHS Laboratory will evaluate Field Quality Control samples for all samples analyzed by the NHDPHS Lab and will flag data that does not meet the acceptance criteria under Field Sampling Requirements for Quality Control listed in Section 4.2 above.

The USEPA laboratory report will consist of the following:

- Data Qualifier Description Page;
- Sample Summary Page: includes laboratory IDs, Corresponding Client Sample IDs, Matrix, Date/Time Collected and Date Received;
- Analytical Report Comments and Qualifiers Page;
- Analytical Results Pages: Method Citation, results, units, RDL, prep date, analyzed date, CAS# Regulatory Limit if applicable and Qualifier Code; and
- Completed COC

The USEPA laboratory does not evaluate Field Quality Control samples for the samples analyzed by their or other laboratories, and does not flag data that does not meet the acceptance criteria under Field Quality Control Requirements. Sanborn Head will be required to perform these tasks and include the findings in their report of the sampling event.

The Alpha Analytical laboratory report will consist of the following:

- Data Qualifiers;
- Analytical Results Pages: Laboratory project number, Client project name, client project number, Matrix, Lab sample number, sampled date and time, received date, Method Number, results, units, Practical Quantitation Limits (PQLs), analysis date and personnel initials, and Qualifier Codes;
- QC Pages: prep methods; analysis methods; and results, units, true spike concentrations, RDLs, % recovery, control limits, for method blanks, LCS, LCSD, MS and MSD samples; and Completed COC.

The EAI laboratory report will consist of the following:

- Sample conditions;
- Analytical Results Pages: Laboratory project number, Client project name, client project number, Matrix, Lab sample number, sampled date, received date, Method Number, results, units, Reporting Limits (RLs), analysis date and personnel initials, surrogate recoveries;
- QC Pages: analysis method; results, units, true spike concentrations, RLs, % recovery, control limits, for method blanks, LCS, LCSD, MS and MSD samples; and Completed COC.

Data generated by Alpha and EAI will be reviewed/validated by USEPA personnel. The USEPA laboratory does not evaluate Field Quality Control samples for the samples analyzed by their or other laboratories, and does not flag data that does not meet the acceptance criteria under Field Quality Control Requirements. Sanborn Head will be required to perform these tasks and include the findings in their report of the sampling event.

4.4 Quality Assurance Field Audits

At the beginning of each major field task, Sanborn Head's QAM shall perform an informal audit/assessment of the field staff to evaluate if sampling procedures and field data collection are being completed and documented in accordance with the requirements specified in the SAP and the current HWRB Master QAPP. These audits shall include review of field logs, field instrument calibration notebooks, field sampling sheets, and COC documents.

Field audits may be performed during the sampling round by NHDES and EPA.

Corrective action procedures will be implemented based on unacceptable audit results or upon detection of data unacceptability. The data generation process will be audited by assessing adherence to specified control limits. If required, corrective action procedures will be developed on a case-by-case basis. The enacted corrective actions will be documented in the appropriate field notebook, laboratory notebook, instrument log, and/or project file.

5.0 DATA MANAGEMENT AND DOCUMENTATION

Field records will be maintained to provide a complete, reconstructable record of activities conducted. All field operations records will be retained for in-house use, and will be included in the final project summary report.

Field notes, analytical data, calculations, correspondence, memoranda, reports, and other pertinent notes, data, or documents associated with the project will be systematically organized and maintained in a file dedicated to this project. All notes, data, documents, and drawings related to this investigation will be identified with a file number which is unique to this project.

Letters, memoranda, and reports will be prepared in Sanborn Head's standard format to maintain consistency in our work product. Documentation of sample collection will be completed on Sanborn Head's standard forms. Field logs/forms (e.g., Soil Field Sampling

Summary forms, Groundwater Quality Field Sampling Summary forms) will be reviewed by the Sanborn Head PM, QAM, or designee, as appropriate.

Sanborn Head's policy is that all reports, letters, and technical memoranda providing recommendations be authored/reviewed by the PIC and Project Reviewer. The Project Reviewer is experienced in the technical aspects of the particular project and familiar with loss prevention and risk management issues. The Project Reviewer will not be involved in day-to-day aspects of the project, to provide a "fresh," objective review.

Final laboratory reports will include a laboratory narrative, data, quality control data, modifications, and corrections. These final reports will be included in Sanborn Head's final report for the project and will be distributed to the NHDES and USEPA PMs.

5.1 Field Books

Field operations will be documented on an on-going basis as they occur. Documentation will be made in indelible ink in a bound notebook with consecutively numbered pages. In some instances, individual sheets such as test boring/monitoring well logs or groundwater sampling records will be used. Each page of the field book will be initialed and dated by the field staff making the entry; the final page of each daily entry will include a complete signature. When loose sheets (e.g., logs, forms) are used they will be referenced in the daily field book entry. The sheets will be retained in project files.

Information recorded in daily logbook entries shall include at a minimum: the date; names of project personnel on-Site; activities they were engaged in, including general method(s) used; weather conditions; details of any deviation from the field operations plan or standard operating procedures, including who authorized the deviation; location, description and unique identifier for all photographs taken in association with the field activity (if not noted on field forms); and notable observations. Errors in the bound notebook will be corrected by making a single line through the entry in indelible ink such that it is still legible, and will be initialed and dated by the responsible person. Copies of all field books shall be included in the final report prepared by Sanborn Head.

5.2 Sampling Records and Exploration Logs

Sample collection will be documented, including sample number, sample medium, date and time, depth, method of collection, location description including maps or diagrams as necessary, and sample-specific observations such as color, odor, sheen, or field instrumentation response. Each sample will be identified by a unique sample number written in indelible ink on an adhesive label applied to the sample container.

To standardize the recording of information relevant to sampling of environmental media and completion of subsurface explorations, sampling forms and logs will be completed to document these activities in addition to the more general information described above which will be recorded in a bound field book. The information contained on the logs need not be repeated in the field book, but the existence of these records will be referenced. QA/QC samples, such as duplicates and equipment rinseate blanks, will also be documented on field forms. Copies of the handwritten forms/logs shall be included in the final report prepared by Sanborn Head. These forms/logs may also be typed for legible presentation in the final report.

5.3 Chain-of-Custody Records

Chain-of-custody records will be maintained for all samples destined for laboratory analysis from the original sampling location to the laboratory and to their ultimate disposal. These records will include a project identifier, sample number, medium, date and time of collection, analyses requested, and the signatures of the sampler(s) and the individuals who had custody of the samples at each point during sample handling.

5.4 Analytical Laboratory QA/QC Documentation

In addition to the sample results, the NHDPHS and USEPA laboratories, Alpha, and EAI will also submit QA/QC summary packages that will be used in assessing data quality. The laboratory QA/QC summary packages will include, at a minimum, method blank results, surrogate recoveries and acceptance limits, MS/MSD results (if performed as part of the laboratories internal QA/QC program) and acceptance limits, laboratory control samples (LCSs)/laboratory control sample duplicates (LCSDs) (if applicable to the given analysis) and acceptance limits, and a project narrative describing problems or issues, if any, related to the analysis of the samples.

5.5 Project Report

Following performance of field activities, and review of the field and laboratory data, Sanborn Head will prepare a project summary report that documents the findings of the Southern Parcel study. We anticipate the report will include the following:

- Summary of sampling activities;
- Copies of all field sampling sheets/forms and field logbook pages;
- Representative photographs of the Site and sampling activities;
- A copy of the laboratory data reports and applicable data validation reports;
- Data summary tables of the compounds/parameters, highlighting compounds/ parameters that exceed cleanup goals;
- A table of the groundwater levels and elevations at each well;
- Site features map;
- Groundwater elevation contour map;
- Compound/parameter distribution map(s);
- QA/QC information (refer to Section 5.5.1 below); and
- Recommendations including additional investigations or remedial activities.

5.5.1 Data Quality Assessment

Sanborn Head will assimilate and evaluate data obtained from the sampling and analytical program, and present and interpret these data as part of our final summary report. QA/QC procedures performed by Sanborn Head as part of the evaluation and presentation of data are discussed below.

Data generated during field tasks will be reviewed by Sanborn Head's PM, QAM, and/or designee by cross-referencing field forms, sampling records and final reduced data to verify that the data under review contain an accurate summary of information collected. Data for which complete documentation are found to exist will be accepted. Laboratory data reports will be reviewed by Sanborn Head's QAM and/or designee for consistency and completeness. As part of the assessment process, the QA/QC summary package provided by the analytical laboratories will be reviewed by the Sanborn Head QAM and/or designee. Apparent discrepancies will be brought to the attention of the laboratory and resolved to the satisfaction of Sanborn Head, or the data may be rejected. Observations and conclusions about the quality of the data, including limitations on the way in which the data should be used, will be documented in a final report.

5.5.2 Data Usability

The overall intent is to provide an objective, technically sound report to be used in a risk assessment supportive of a recommendation for full or partial de-listing of the Site's southern parcel. Standard procedures (as described in this SAP and the current version of the HWRB Master QAPP) will be used so that known and acceptable data quality is achieved for the data set. The results of the field sample collection and analyses will be reviewed to confirm that the field data collection methods were of adequate precision to yield acceptable data as indicated in the following table.

Data Usability Requirements for Field Sampling Quality Control

QC Sample	Acceptance Criteria	Corrective Action
VOC and 1,4-Dioxane Trip Blanks	No contaminants are detected	Flag in project report
Temperature Blank	Within the range of 4±2°C	Flag in project report
Equipment Blank	No contaminants are detected	Flag in project report
Duplicate	See Note 1	Flag in project report
Matrix Spike/Matrix Spike Duplicate	See Note 2	Flag in project report

Notes:

1. Field duplicate results will be compared to the primary sample results. Duplicate pairs are compared by calculating the relative percent difference (RPD) between the two results, using the following formula:

$$RPD = \left(\frac{|Result_1 - Result_2|}{\frac{Result_1 + Result_2}{2}} \right) * 100$$

Data for solid matrices (e.g., soil and sediment) will be considered flagged if the RPD between detected concentrations in the primary sample and duplicate sample is greater than 50 percent for results reported above 4 times the reporting level. For results reported below 4 times the reporting level, the data will be accepted as reported by the laboratory.

Data for aqueous matrices (e.g., groundwater and surface water) will be considered flagged if the RPD between detected concentrations in the primary sample and duplicate sample is greater than 30 percent for organics concentrations reported above 2 times the reporting limit, and inorganics concentrations reported above 4 times the reporting limit. For results reported below 2 times or 4 times the reporting level, as indicated above, the data will be accepted as reported by the laboratory.

2. Site-specific MS/MSD samples will be submitted to the laboratory(ies) for analysis. For MS/MSD sample pairs, the percent recovery of each matrix spike analyte will be compared by calculating the RPD between the matrix spike analysis percent recovery and matrix spike duplicate analysis percent recovery. If the RPD is greater than the laboratory's acceptance limits, the result in the primary sample will be flagged.

   Also, percent recoveries of the individual spikes will be reviewed. Any compounds for which the percent recovery is outside the laboratory's acceptance limits will be flagged in the primary sample.

Since it is likely the field portion of this work will be completed prior to obtaining results from the laboratory, if Sanborn Head's review of laboratory data usability indicates that corrective actions should have been taken during the collection of field data, those corrective actions will be implemented for supplemental phases of work if any are requested by NHDES and USEPA.

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TABLES

TABLE 1A
Summary of Project Action Limits, Analytical Methods, and Laboratory Reporting Limits – Soil
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Chemical of Concern	CAS No.	Project Action Limits (PALs)				Laboratory Reporting Limit
		Human Health Risk		Ecological Risk		
		Residential RSL	NHDES Soil Standards	Lowest EcoSSL	Other Benchmark[1]	mg/kg (dry weight unless otherwise noted)
		mg/kg	mg/kg	mg/kg	mg/kg	
VOCs – USEPA Lab by VOAGCMS9 Revision 9						
Chlorobenzene	108-90-7	290	6	NA	13.1	0.05
Dichlorobenzene (1,2-)	95-50-1	19,000	88	NA	2.96	0.05
Dichlorobenzene (1,4-)	106-46-7	2.4	7	NA	0.546	0.05
SVOCs – USEPA Lab by BNAGCMS Revision 7						
Benzo(a)pyrene	50-32-8	0.015	0.7	NA	1.52	0.00167
Naphthalene	91-20-3	3.6	5	NA	0.0994	0.00167
Methylnaphthalene (2-)	91-57-6	310	96	NA	3.24	0.083
Methylphenol (4-)	106-44-5	310	0.7	NA	163	0.167
Pentachlorophenol	87-86-5	0.89	3	2.1	0.119	0.167
USEPA Contract Lab – PCB Congeners by SOW CBC01.2 – Dioxins/Furans by SOW DLM02.2						
Total PCBs	–	0.22	1	NA	0.000332	0.000002 †
Dioxin (2,3,7,8-TCDD)	34465-46-8	0.0000045	0.00007**	NA	0.000000199	0.000001 ‡
Metals - NHDPHS Methods 200.7/200.8/7471A (Laboratory Reporting Limit is mg/kg wet weight)						
Antimony	7440-36-0	31	9	0.27	0.142	0.25
Arsenic	7440-38-2	0.39	11	18	5.7	0.25
Barium	7440-39-3	15,000	1,000	330	1.04	1.25
Cadmium	7440-43-9	70	33	0.36	0.00222	0.25
Lead	7439-92-1	400	400	11	0.0537	0.25
Manganese	7439-96-5	1,800	5,200	220	220	1.25
Mercury	7439-97-6	23	6	NA	0.1	0.1
Thallium	7440-28-0	0.78	10	NA	0.0569	0.25
Vanadium	7440-62-2	390	NA	7.8	1.59	1.25
Metals - Alpha Methods 6010C/7196A						
Chromium	7440-47-3	NA	1,000 (III) *	34 *	34 *	0.40
Chromium VI	18540-29-9	0.29	130			0.16

[1] Buchman, M. F. 2008. NOAA Screening Quick Reference Tables, NOAA OR&R Report 08-1, Seattle, WA, Office of Response and Restoration Div., NOAA, 34pp.

RSL = Regional Screening Level

EcoSSL = EPA Ecological Soil Screening Level (http://www.epa.gov/ecotox/ecossl/)

NHDES Soil Standards = Soil Remediation Standards promulgated in Env-Or 600 (July 2008)

Project Action Limits (PALs) provided to Sanborn Head by NHDES on July 19, 2012.

Chromium PALs for ecological risk were provided by the USEPA via an e-mail from Rick Sugatt dated August 9, 2012.

NA = not applicable

Analytical method references and reporting limits provided by the respective laboratories. Actual reporting limits achieved will be higher than those listed above due to moisture content and dilution. To the extent feasible, samples will be analyzed without dilution.

Laboratories will report dry weight.

Yellow shading indicates the lowest applicable PAL.

Blue shading indicates laboratory reporting limit which does not meet the lowest PAL.

"*" As part of this sampling event, samples will be analyzed for total chromium, with a subset of samples also analyzed for hexavalent chromium. Chromium results will be compared to the indicated PAL(s). If a total chromium result with no corresponding hexavalent chromium result exceeds the PAL, then subsequent sampling as part of a separate phase of work may be required for chromium speciation.

"**" Robin Mongeon at the NHDES indicated that the on-line version of Env-Or 600 (July 2008) has a typographical error. The published Soil Standard for dioxin (2,3,7,8-TCDD) is 0.001 mg/kg, but it should be 0.00007 mg/kg.

"†" Indicates the RL listed for Total PCBs is the contract required RL for individual PCB congeners. The actual RL may be different based on actual samples/matrices. The contract laboratory will report the concentrations of the 12 dioxin-like PCB congeners, the sum of the 209 PCB congeners, and the PCB homologues.

"‡" Indicates the RL listed for dioxin (2,3,7,8-TCDD) is the contract required RL. The actual RL may be different based on actual samples/matrices. The contract laboratory will report the concentrations of the 17 dioxin and furan congeners, and the dioxin/furan homologues.

TABLE 1B
Summary of Project Action Limits, Analytical Methods, and Laboratory Reporting Limits – Sediment
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Chemical of Concern	CAS No.	Project Action Limits (PALs)		Laboratory Reporting Limit
		Ecological Risk		
		EPA R3 mg/kg	TEC mg/kg	mg/kg (dry weight unless otherwise
VOCs – USEPA Lab by VOAGCMS9 Revision 9				
Chlorobenzene	108-90-7	0.00842	NA	0.05
Dichlorobenzene (1,2-)	95-50-1	0.0165	NA	0.05
Dichlorobenzene (1,4-)	106-46-7	0.599	NA	0.05
SVOCs – USEPA Lab by BNAGCMS Revision 7				
Benzo(a)pyrene	50-32-8	0.15	0.15	0.00167
Naphthalene	91-20-3	0.176	NA	0.00167
Methylnaphthalene (2-)	91-57-6	0.0202	NA	0.083
Methylphenol (4-)	106-44-5	0.67	NA	0.167
Pentachlorophenol	87-86-5	0.504	NA	0.167
USEPA Contract Lab – PCB Congeners by SOW CBC01.2 – Dioxins/Furans by SOW DLM02.2				
Total PCBs	–	0.0598	0.0598	0.000002 †
Dioxin (2,3,7,8-TCDD)	34465-46-8	0.00000085	NA	0.000001 ‡
Metals - NHDPHS Methods 200.7/200.8/7471A (Laboratory Reporting Limit is mg/kg wet weight)				
Antimony	7440-36-0	2	NA	0.25
Arsenic	7440-38-2	9.8	9.79	0.25
Barium	7440-39-3	NA	NA	1.25
Cadmium	7440-43-9	0.99	0.99	0.25
Lead	7439-92-1	35.8	35.8	0.25
Manganese	7439-96-5	460	NA	1.25
Mercury	7439-97-6	0.18	0.18	0.1
Thallium	7440-28-0	NA	NA	0.25
Vanadium	7440-62-2	NA	NA	1.25
Metals - Alpha Methods 6010C/7196A				
Chromium	7440-47-3	43.4 *	43.4 *	0.40
Chromium VI	18540-29-9			0.16
Total Organic Carbon - Alpha Lloyd Kahn				
TOC	–	NA	NA	0.01%

EPA R3 = EPA Region 3 (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm)
TEC = Threshold Effect Concentration, from MacDonald et al (2000;
http://ptc.mtech.edu/pmunday/CFRevival/MacDonald%202000%20Sediment%20Quality%20Guidelines.pdf)
Project Action Limits (PALs) provided to Sanborn Head by NHDES on July 19, 2012.
NA = not applicable
Analytical method references and reporting limits provided by the respective laboratories. Actual reporting limits achieved will be higher than those listed above due to moisture content and dilution. To the extent feasible, samples will be analyzed without dilution.
Laboratories will report dry weight.
Yellow shading indicates the lowest applicable PAL.
Blue shading indicates laboratory reporting limit which does not meet the lowest PAL.
"*" As part of this sampling event, samples will be analyzed for total chromium, with a subset of samples also analyzed for hexavalent chromium. Chromium results will be compared to the indicated PAL(s). If a total chromium result with no corresponding hexavalent chromium result exceeds the PAL, then subsequent sampling as part of a separate phase of work may be required for chromium speciation.
"†" Indicates the RL listed for Total PCBs is the contract required RL for individual PCB congeners. The actual RL may be different based on actual samples/matrices. The contract laboratory will report the concentrations of the 12 dioxin-like PCB congeners, the sum of the 209 PCB congeners, and the PCB homologues.
"‡" Indicates the RL listed for dioxin (2,3,7,8-TCDD) is the contract required RL. The actual RL may be different based on actual samples/matrices. The contract laboratory will report the concentrations of the 17 dioxin and furan congeners, and the dioxin/furan homologues.

TABLE 1C
Summary of Project Action Limits, Analytical Methods, and Laboratory Reporting Limits – Groundwater
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Chemical of Concern	CAS No.	Project Action Limits (PALs)						Laboratory Reporting Limit
		Human Health Risk (Monitoring Wells only)			Ecological Risk (Mini-Piezometers only) #			
		MCL	NHDES AGQS	Tapwater RSL	NRWQC	NHDES SWQC	EPA R3	
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
VOCs – USEPA Lab by VOAGCMS9 Revision 9								
Chlorobenzene	108-90-7	100	100	72	NA	50 [1]	1.3	1.0
Dichlorobenzene (1,2-)	95-50-1	600	600	280	NA	763 [1]	0.7	1.0
Dichlorobenzene (1,4-)	106-46-7	75	75	0.42	NA	763 [1]	26	1.0
VOCs – EAI by Method 8260B-SIM								
1,4-Dioxane	123-91-1	NA	3	NA	NA	NA	NA	0.25
SVOCs – USEPA Lab by BNAGCMS Revision 7								
Benzo(a)pyrene	50-32-8	0.2	0.2	0.0029	NA	NA	0.015	0.5
Naphthalene	91-20-3	NA	20	0.14	NA	620	1.1	0.5
Methylnaphthalene (2-)	91-57-6	NA	280	27	NA	NA	4.7	2.5
Methylphenol (4-)	106-44-5	NA	40	72	NA	NA	543	5.0
Pentachlorophenol	87-86-5	1	1	0.17	15	4.05	0.5	5.0
Metals - NHDPHS Methods 200.7/200.8/245.1								
Antimony	7440-36-0	6	6	6	NA	1600	30	1
Arsenic	7440-38-2	10	10	0.045	150	150	5	1
Barium	7440-39-3	2,000	2,000	2,900	NA	NA	4	5
Cadmium	7440-43-9	5	5	6.9	0.25	0.8	0.25	1
Lead	7439-92-1	15	15	NA	2.5	0.54	2.5	1
Manganese	7439-96-5	NA	840	320	NA	NA	120	5
Mercury	7439-97-6	2	2	4.3	0.77	0.77	0.026	0.50
Thallium	7440-28-0	2	2	0.16	NA	40	0.8	1
Vanadium	7440-62-2	NA	NA	78	NA	NA	20	5
Metals - Alpha Methods 6010C/SM3500Cr-D								
Chromium	7440-47-3	100	100	NA	74 (III) *	24 (III) *	85 (total) 74 (III) *	10
Chromium VI	18540-29-9	NA	NA	0.031	11	11	11	3.5

RSL = Regional Screening Level
MCL = Maximum Contaminant Level
NHDES AGQS = Ambient Groundwater Quality Standards (AGQSs) promulgated in Env-Or 600 (July 2008)
[1] The values listed are for totals where there are more than one isomer.
NRWQC = National Recommended Water Quality Criteria, Freshwater CCC Chronic (http://water.epa.gov/scitech/swguidance/standards/current/index.cfm)
EPA R3 = EPA Region 3 (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm)
NHDES SWQC = New Hampshire Surface Water Quality Criteria for Toxic Substances as defined in Env-Ws 1703.21 and contained in Table 1703.1 Surface Water Quality Criteria for Toxic Substances (May 2008)
Project Action Limits (PALs) provided to Sanborn Head by NHDES on July 19, 2012.
NA = not applicable
Analytical method references and reporting limits provided by the respective laboratories. Actual reporting limits achieved may be higher than those listed above due to dilution. To the extent feasible, samples will be analyzed without dilution.
Yellow shading indicates the lowest applicable PAL.
Blue shading indicates laboratory reporting limit which does not meet the lowest PAL.
"*" As part of this sampling event, samples will be analyzed for total chromium, with a subset of samples also analyzed for hexavalent chromium. Chromium results will be compared to the indicated PAL(s). If a total chromium result with no corresponding hexavalent chromium result exceeds the PAL, then subsequent sampling as part of a separate phase of work may be required for chromium speciation.
"#" If an ecological risk PAL is exceeded in a mini-piezometer sample, a dilution analysis to estimate the discharge concentration to the Nashua River may be performed.

TABLE 1D
Summary of Project Action Limits, Analytical Methods, and Laboratory Reporting Limits – Surface Water
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Chemical of Concern	CAS No.	Project Action Limits (PALs)					Laboratory Reporting Limit
		Human Health Risk		Ecological Risk			
		NRWQC Water & Organism	NHDES SWQC	NRWQC	NHDES SWQC	EPA R3	
		µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
VOCs – USEPA Lab by VOAGCMS9 Revision 9							
Chlorobenzene	108-90-7	130	20	NA	50[1]	1.3	1.0
Dichlorobenzene (1,2-)	95-50-1	420	2700	NA	763[1]	0.7	1.0
Dichlorobenzene (1,4-)	106-46-7	63	400	NA	763[1]	26	1.0
SVOCs – USEPA Lab by BNAGCMS Revision 7							
Benzo(a)pyrene	50-32-8	0.0038	0.0044	NA	NA	0.015	0.5
Naphthalene	91-20-3	NA	NA	NA	620	1.1	0.5
Methylnaphthalene (2-)	91-57-6	NA	NA	NA	NA	4.7	2.5
Methylphenol (4-)	106-44-5	NA	NA	NA	NA	543	5.0
Pentachlorophenol	87-86-5	0.27	0.28	15	4.05	0.5	5.0
Metals - NHDPHS Methods 200.7/200.8/245.1							
Antimony	7440-36-0	NA	14	NA	1600	30	1
Arsenic	7440-38-2	0.018	0.018	150	150	5	1
Barium	7440-39-3	1000	1000	NA	NA	4	5
Cadmium	7440-43-9	NA	NA	0.25	0.8	0.25	1
Lead	7439-92-1	NA	NA	2.5	0.54	2.5	1
Manganese	7439-96-5	NA	50	NA	NA	120	5
Mercury	7439-97-6	0.3	0.05	0.77	0.77	0.026	0.50
Thallium	7440-28-0	0.24	1.7	NA	40	0.8	1
Vanadium	7440-62-2	NA	NA	NA	NA	20	5
Metals - Alpha Methods 6010C/SM3500							
Chromium	7440-47-3	NA	NA	74 (III) *	24 (III) *	85 (total) 74 (III) *	10
Chromium VI	18540-29-9	NA	1	11	11	11	3.5

[1] The values listed are for totals where there are more than one isomer.
NRWQC = National Recommended Water Quality Criteria, Freshwater CCC Chronic (http://water.epa.gov/scitech/swguidance/standards/current/index.cfm)
EPA R3 = EPA Region 3 (http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm)
NHDES SWQC = New Hampshire Surface Water Quality Criteria for Toxic Substances as defined in Env-Ws 1703.21 and contained in Table 1703.1 Surface Water Quality Criteria for Toxic Substances (May 2008)
Project Action Limits (PALs) provided to Sanborn Head by NHDES on July 19, 2012.
NA = not applicable
Select metals (e.g., cadmium, hexavalent chromium, and lead) have hardness dependent PALs. The PAL values for these analytes indicated above are subject to change depending upon site-specific hardness values to be obtained as part of these sampling activities.
Analytical method references and reporting limits provided by the respective laboratories. Actual reporting limits achieved may be higher than those listed above due to dilution. To the extent feasible, samples will be analyzed without dilution.
Yellow shading indicates the lowest applicable PAL.
Blue shading indicates laboratory reporting limit which does not meet the lowest PAL.
"*" As part of this sampling event, samples will be analyzed for total chromium, with a subset of samples also analyzed for hexavalent chromium. Chromium results will be compared to the indicated PAL(s). If a total chromium result with no corresponding hexavalent chromium result exceeds the PAL, then subsequent sampling as part of a separate phase of work may be required for chromium speciation.

TABLE 2A
Field Sampling Summary
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Medium	Sample Depth	Location	Number of Locations	No. of Samples												
				Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Cr (total)	Cr+6*	SVOCs**	VOCs**	1,4-Dioxane	PCB Congeners	Dioxins/ Furans	Asbestos	TOC	Grain Size	Hardness	pH,T,DO, SpCon,ORP,Turb
				NHDPHS	Alpha	Alpha	USEPA	USEPA	EAI	USEPA Contract	USEPA Contract	USEPA	Alpha	Geotesting	NHDPHS	Field
Groundwater	Various	Existing wells on parcel	6	6	6	1	6	6	6							6
		Minipiezometers in 2 wetlands	5	5	5	1	5	5	5							5
		Minipiezometers along river bank	10	10	10	1	10	10	10							10
Surface Soil (SS)	0-0.5 ft bgs	Southern 80% of parcel - Larger grid squares	20	20	20	2	5	5		5	5	20				
		Northern 20% of parcel - Smaller grid squares	20	20	20	2	5	5		5	5	20				
		River bank soil - Co-located with minipiezometers	10	10	10	1	5	5		5	5	10				
		Targeted dirt bike area	5	5	5	5	5	5		5	5	5				
		Asbestos Areas Identified in 7/10/12 Site Visit	12									12				
Subsurface Soil	1-2 ft bgs	Southern 80% of parcel - Larger grid squares	5 co-located w/SS	5	5	1	5	5		5	5					
		Northern 20% of parcel - Smaller grid squares	5 co-located w/SS	5	5	1	5	5		5	5					
Wetland Surface Water	<1 inch above sediment	Wetlands (1 sample in each of 2 wetlands)	2	2	2	1	2	2							2	2
Sediment	<1 ft bws	Co-located with river bank SS samples and minipiezometers	10	10	10	1	10	10		10	10		10	10		
		Co-located with minipiezometers in 2 wetlands	5	5	5	1	5	5		5	5		5	5		
		Background (upstream and across the Nasua River, north of the boardwalk)	1	1	1	1	1	1		1	1		1	1		
				104	104	19	69	69	21	46	46	67	16	16	2	23

bgs = below ground surface

bws = below water surface

SS = Surface Soil

pH, T, DO, SpCon, ORP, Turb = pH, temperature, dissolved oxygen, specific conductance, oxidation reduction potential, turbidity

PCB Congeners = 12 dioxin-like congeners and total PCB concentration by summation of congeners

TOC = total organic carbon

Surface soil samples (SS) collected from grid locations which have co-located subsurface soils will be analyzed for the expanded list of parameters (i.e., metals, SVOCs, VOCs, PCB congeners, and dioxins/furans).

Up to two additional sediment background samples may be collected during a separate phase of work if the results of this phase of work warrant it.

If metals are detected above PALs in sediment samples, a second phase of sampling may be completed for AVS/SEM analyses in sediment.

"*" indicates hexavalent chromium analyses will be completed on a subset (approximately 10% of samples analyzed for metals) of randomly selected samples from each medium/area, and on all samples collected from the targeted dirt bike area.

If hexavalent chromium is detected in sediment samples, a second phase of sampling will include hexavalent chromium analysis in surface water.

"**" indicates Sanborn Head has assumed tentatively identified compounds (TICs) will be reported for SVOC and VOC analyses.

Numbers of samples included in this table do not include QA/QC samples (e.g., field duplicates, MS/MSDs, equipment rinseate blanks, PE samples).

TABLE 2B
Sample Locations and Analytical Parameters – Soil
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Location	Sample Name	Sample Depth (ft)	Sampling SOP / Method	Analytical Parameters
Southern 80% of Parcel	MHK_SS-101_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-102_0-.5	0-0.5		
	MHK_SS-103_0-.5	0-0.5		
	MHK_SS-104_0-.5	0-0.5		
	MHK_SS-105_0-.5	0-0.5		
	MHK_SS-106_0-.5	0-0.5		
	MHK_SS-107_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-107_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-108_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-109_0-.5	0-0.5		
	MHK_SS-110_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-110_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-111_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-111_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-112_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-113_0-.5	0-0.5		
	MHK_SS-114_0-.5	0-0.5		
	MHK_SS-115_0-.5	0-0.5		
	MHK_SS-116_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-116_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-117_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-117_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-118_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-119_0-.5	0-0.5		
	MHK_SS-120	0-0.5		

TABLE 2B
Sample Locations and Analytical Parameters – Soil
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Location	Sample Name	Sample Depth (ft)	Sampling SOP / Method	Analytical Parameters
Northern 20% of Parcel	MHK_SS-121_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-122_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-122_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-123_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-124_0-.5	0-0.5		
	MHK_SS-125_0-.5	0-0.5		
	MHK_SS-126_0-.5	0-0.5		
	MHK_SS-127_0-.5	0-0.5		
	MHK_SS-128_0-.5	0-0.5		
	MHK_SS-129_0-.5	0-0.5		
	MHK_SS-130_0-.5	0-0.5		
	MHK_SS-131_0-.5	0-0.5		
	MHK_SS-132_0-.5	0-0.5		
	MHK_SS-133_0-.5	0-0.5		
	MHK_SS-134_0-.5	0-0.5		
	MHK_SS-135_0-.5	0-0.5		
	MHK_SS-136_0-.5	0-0.5		
	MHK_SS-137_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-137_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-138_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-138_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-139_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-139_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-140_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-140_1-2	1-2	SOP B.1 / Hand Auger or Manually-Drive Geoprobe	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan

TABLE 2B
Sample Locations and Analytical Parameters – Soil
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Location	Sample Name	Sample Depth (ft)	Sampling SOP / Method	Analytical Parameters
River Bank Soils	MHK_SS-141_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-142_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-143_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-144_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-145_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-146_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-147_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-148_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
	MHK_SS-149_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-150_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr USEPA Lab: Asbestos
Targeted Dirt Bike Area	MHK_SS-151_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	NHDPHS Lab: Metals Alpha: Total Cr, Hex Cr USEPA Lab: Asbestos, VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan
	MHK_SS-152_0-.5	0-0.5		
	MHK_SS-153_0-.5	0-0.5		
	MHK_SS-154_0-.5	0-0.5		
	MHK_SS-155_0-.5	0-0.5		

TABLE 2B
Sample Locations and Analytical Parameters – Soil
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Location	Sample Name	Sample Depth (ft)	Sampling SOP / Method	Analytical Parameters
Asbestos Areas	MHK_SS-156_0-.5	0-0.5	SOP B.1 / Stainless Steel Scoop/Bowl	USEPA Lab: Asbestos
	MHK_SS-157_0-.5	0-0.5		
	MHK_SS-158_0-.5	0-0.5		
	MHK_SS-159_0-.5	0-0.5		
	MHK_SS-160_0-.5	0-0.5		
	MHK_SS-161_0-.5	0-0.5		
	MHK_SS-162_0-.5	0-0.5		
	MHK_SS-163_0-.5	0-0.5		
	MHK_SS-164_0-.5	0-0.5		
	MHK_SS-165_0-.5	0-0.5		
	MHK_SS-166_0-.5	0-0.5		
	MHK_SS-167_0-.5	0-0.5		

Notes:
1. Yellow highlighting indicates samples to be analyzed for hexavalent chromium.

TABLE 2C
Sample Locations and Analytical Parameters – Sediment
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Location	Sample Name	Sample Depth (ft)	Sampling SOP / Method	Analytical Parameters
River Bank Sediment	MHK_SED-01_0-.3	0-0.3	SOP B.9 / Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	NHDPHS Lab: Metals Alpha: TOC, Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size
	MHK_SED-02_0-.3	0-0.3		
	MHK_SED-03_0-.3	0-0.3		
	MHK_SED-04_0-.3	0-0.3		
	MHK_SED-05_0-.3	0-0.3		
	MHK_SED-06_0-.3	0-0.3	SOP B.9 / Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	NHDPHS Lab: Metals Alpha: TOC, Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size
	MHK_SED-07_0-.3	0-0.3	SOP B.9 / Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	NHDPHS Lab: Metals Alpha: TOC, Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size
	MHK_SED-08_0-.3	0-0.3		
	MHK_SED-09_0-.3	0-0.3		
	MHK_SED-10_0-.3	0-0.3		
Wetland Sediment	MHK_SED-11_0-.3	0-0.3	SOP B.9 / Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	NHDPHS Lab: Metals Alpha: TOC, Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size
	MHK_SED-12_0-.3	0-0.3		
	MHK_SED-13_0-.3	0-0.3	SOP B.9 / Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	NHDPHS Lab: Metals Alpha: TOC, Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size
	MHK_SED-14_0-.3	0-0.3	SOP B.9 / Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	NHDPHS Lab: Metals Alpha: TOC, Total Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size
	MHK_SED-15_0-.3	0-0.3		
Background Sediment	MHK_SED-16_0-.3	0-0.3	SOP B.9 / Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	NHDPHS Lab: Metals Alpha: TOC, Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size

Notes:
1. Background sediment sample (MHK_SED-16_0-.3) will be collected from the Nashua River upstream and across the river from the Site, north of a boardwalk along the river. If the results from this background sample and the samples collected from the Site warrant, up to two additional sediment background locations may be sampled in another phase of work.
2. Yellow highlighting indicates samples to be analyzed for hexavalent chromium.

TABLE 2D
Sample Locations and Analytical Parameters – Groundwater
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Location	Sample Name	Sampling SOP / Method	Analytical Parameters
Monitoring Wells	MHK_GZ-10	SOP B.7 / Bladder Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_GZ-11	SOP B.7 / Bladder Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_GZ-13		
	MHK_GZ-14		
	MHK_SH-13		
	MHK_SH-19		
River Bank Mini-Piezometers	MHK_PZ-01	SOP B.3 / Peristaltic Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_PZ-02		
	MHK_PZ-03		
	MHK_PZ-04		
	MHK_PZ-05		
	MHK_PZ-06	SOP B.3 / Peristaltic Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_PZ-07	SOP B.3 / Peristaltic Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_PZ-08		
	MHK_PZ-09		
	MHK_PZ-10		
Wetland Mini-Piezometers	MHK_PZ-11	SOP B.3 / Peristaltic Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_PZ-12		
	MHK_PZ-13	SOP B.3 / Peristaltic Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_PZ-14	SOP B.3 / Peristaltic Pump	NHDPHS Lab: Metals, 1,4-Dioxane Alpha: Total Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_PZ-15		

Notes:
1. Groundwater samples collected from monitoring wells for metals analysis will be collected as unfiltered (total) samples, unless elevated turbidity (>20 NTUs) is observed. Refer to SOP B.7 for additional discussion.
2. Groundwater samples collected from mini-piezometers for metals and SVOC analyses will be collected as filtered (dissolved) samples. Refer to SOP B.3 for additional discussion.
3. Yellow highlighting indicates samples to be analyzed for hexavalent chromium.

TABLE 2E
Sample Locations and Analytical Parameters – Surface Water
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Location	Sample Name	Sampling SOP / Method	Analytical Parameters
Wetland Surface Water	MHK_SW-01	SOP B.8 / Sample Container	NHDPHS Lab: Metals, Hardness Alpha: Total Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity
	MHK_SW-02	SOP B.8 / Sample Container	NHDPHS Lab: Metals, Hardness Alpha: Total Cr, Hex Cr USEPA Lab: VOCs, SVOCs Field: pH, Temp, DO, Specific Conductance, ORP, Turbidity

Notes:
1. Samples for metals analysis will be collected as unfiltered (total) samples.
2. Yellow highlighting indicates samples to be analyzed for hexavalent chromium.

TABLE 3
Media and Laboratory Requirements
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Analysis	Matrix	Analytical Laboratory and Method	Containers (Type and Size)	Preservation Requirements	Maximum Holding Time
Soil Sampling					
Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Soil	NHDPHS: 200.7/200.8/7471A	8 oz Plastic	Cool (4±2°C)	28 Days (Hg); 6 months (rest)
Total Chromium, pH, Eh		Alpha: Cr - 6010C; pH and Eh - 9045	4 oz glass	Cool (4±2°C)	Cr: 6 months; pH and Eh: 24 hours
Hexavalent Chromium		Alpha: 7196A	1 x 4 oz amber glass	No Head Space; Cool (4±2°C)	30 Days
VOCs		USEPA: VOAGCMS9 Revision 9	1 x 40 mL VOA	10 mL MEOH; Cool (4±2°C) (10 grams sample)	14 Days
SVOCs		USEPA: BNAGCMS Revision 7	1 x 4 oz amber glass	Cool (4±2°C)	14 days to extract; 40 days to analysis
Asbestos		USEPA: PLM	1 x 4 oz glass	none	not applicable
PCB Congeners		USPEA Contract Lab: SOW CBC01.2	1 x 4 oz amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)
Dioxins/Furans		USPEA Contract Lab: SOW DLM02.2	1 x 4 oz amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)
Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Aqueous (Equipment Rinseate Blank)	NHDPHS: 200.7/200.8/7471A	500 mL HDPE	HNO_3; Cool (4±2°C)	28 Days (Hg); 6 months (rest)
Total Chromium		Alpha: Cr - 6010C; pH and Eh - 9045	250 mL HDPE	HNO_3; Cool (4±2°C)	6 months
Hexavalent Chromium		Alpha: SM3500Cr-D	500 mL HDPE	Cool (4±2°C)	24 Hours
VOCs		USEPA: VOAGCMS9 Revision 9	4 x 40 mL VOA	HCl; Cool (4±2°C)	14 Days
SVOCs		USEPA: BNAGCMS Revision 7	2 x 1 L amber glass	Cool (4±2°C)	7 days to extract; 40 days to analysis
PCB Congeners		USPEA Contract Lab: SOW CBC01.2	2 x 1 L amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)
Dioxins/Furans		USPEA Contract Lab: SOW DLM02.2	2 x 1 L amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)
Sediment Sampling					
Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Sediment	NHDPHS: 200.7/200.8/7471A	8 oz Plastic	Cool (4±2°C)	28 Days (Hg); 6 months (rest)
Total Chromium, pH, Eh		Alpha: Cr - 6010C; pH and Eh - 9045	8 oz glass	Cool (4±2°C)	Cr: 6 months; pH and Eh: 24 hours
Hexavalent Chromium		Alpha: 7196A	1 x 4 oz amber glass	No Head Space; Cool (4±2°C)	30 Days
VOCs		USEPA: VOAGCMS9 Revision 9	1 x 40 mL VOA	10 mL MEOH; Cool (4±2°C) (10 grams sample)	14 Days
SVOCs		USEPA: BNAGCMS Revision 7	1 x 4 oz amber glass	Cool (4±2°C)	14 days to extract; 40 days to analysis
TOC		Alpha: Lloyd Kahn	1 x 4 oz glass	Cool (4±2°C)	28 Days
PCB Congeners		USPEA Contract Lab: SOW CBC01.2	1 x 4 oz amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)
Dioxins/Furans		USPEA Contract Lab: SOW DLM02.2	1 x 4 oz amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)
Grain Size		Geotesting: ASTM D-422	1 x 8 oz amber glass	None	None
Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Aqueous (Equipment Rinseate Blank)	NHDPHS: 200.7/200.8/7471A	500 mL HDPE	HNO_3; Cool (4±2°C)	28 Days (Hg); 6 months (rest)
Total Chromium		Alpha: Cr - 6010C; pH and Eh - 9045	250 mL HDPE	HNO_3; Cool (4±2°C)	6 months
Hexavalent Chromium		Alpha: SM3500Cr-D	500 mL HDPE	Cool (4±2°C)	24 Hours
VOCs		USEPA: VOAGCMS9 Revision 9	4 x 40 mL VOA	HCl; Cool (4±2°C)	14 Days
SVOCs		USEPA: BNAGCMS Revision 7	2 x 1 L amber glass	Cool (4±2°C)	7 days to extract; 40 days to analysis
PCB Congeners		USPEA Contract Lab: SOW CBC01.2	2 x 1 L amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)
Dioxins/Furans		USPEA Contract Lab: SOW DLM02.2	2 x 1 L amber glass	Cool (4±2°C)	1 year (stored in the dark at <6 °C)

TABLE 3
Media and Laboratory Requirements
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Analysis	Matrix	Analytical Laboratory and Method	Containers (Type and Size)	Preservation Requirements	Maximum Holding Time
Groundwater from Monitoring Wells					
Total and Dissolved Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Aqueous (Groundwater and Equipment Rinseate Blank)	NHDPHS: 200.7/200.8/245.1	500 mL HDPE	HNO_3; Cool (4±2°C)	28 Days (Hg); 6 months (rest)
Total Chromium		Alpha: 6010C	250 mL HDPE	HNO_3; Cool (4±2°C)	6 months
Hexavalent Chromium		Alpha: SM3500Cr-D	500 mL HDPE	Cool (4±2°C)	24 Hours
VOCs		USEPA: VOAGCMS9 Revision 9	4 x 40 mL VOA	HCl; Cool (4±2°C)	14 Days
Low Level 1,4-Dioxane		EAI: 8260B-SIM	2 x 40 mL VOA	Cool (4±2°C)	14 Days
SVOCs		USEPA: BNAGCMS Revision 7	2 x 1 L amber glass	Cool (4±2°C)	7 days to extract; 40 days to analysis
Groundwater from Minipiezometers					
Dissolved Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Aqueous (Groundwater and Equipment Rinseate Blank)	NHDPHS: 200.7/200.8/245.1	150 mL HDPE per sample; extra 300 mL for MS/MSD	HNO_3; Cool (4±2°C)	28 Days (Hg); 6 months (rest)
Total Chromium		Alpha: 6010C	50 mL HDPE extra 50 mL for MS/MSD	HNO_3; Cool (4±2°C)	6 months
Hexavalent Chromium		Alpha: SM3500Cr-D	100 mL HDPE extra 100 mL for MS/MSD	Cool (4±2°C)	24 Hours
VOCs		USEPA: VOAGCMS9 Revision 9	2 x 40 mL VOA	HCl; Cool (4±2°C)	14 Days
Low Level 1,4-Dioxane		EAI: 8260B-SIM	2 x 40 mL VOA	Cool (4±2°C)	14 Days
SVOCs		USEPA: BNAGCMS Revision 7	1 x 1 L amber glass; extra 1 L amber for MS/MSD	Cool (4±2°C)	7 days to extract; 40 days to analysis
Surface Water Sampling					
Total Metals (Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V)	Aqueous (Surface Water)	NHDPHS: 200.7/200.8/245.1	500 mL HDPE	HNO_3; Cool (4±2°C)	28 Days (Hg); 6 months (rest)
Hardness		NHDPHS: 200.7			
Total Chromium		Alpha: 6010C	250 mL HDPE	HNO_3; Cool (4±2°C)	6 months
Hexavalent Chromium		Alpha: SM3500Cr-D	500 mL HDPE	Cool (4±2°C)	24 Hours
VOCs		USEPA: VOAGCMS9 Revision 9	4 x 40 mL VOA	HCl; Cool (4±2°C)	14 Days
SVOCs		USEPA: BNAGCMS Revision 7	2 x 1 L amber glass	Cool (4±2°C)	7 days to extract; 40 days to analysis

TABLE 4
Summary of Existing Monitoring Well Construction and Water Level Information
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Well Designation	Well Diameter (inches)	Stratigraphic Units Screened	Sampling/ Purging Method	Reference Point Elevation - Top of PVC (ft)	Ground Surface Elevation (ft)	Installed Boring Depth (ft bmp)	Well Screen Depth (ft bmp)		Well Screen Elevation (ft)		Well Screen Length (ft)	Depth to Midpoint of Screen = Sampling Point (ft bmp)	Sample Intake for Partially Saturated Screens (ft bmp)	Distance between intake and bottom of screen (ft)	Groundwater Depth (ft bmp)	Groundwater Elevation (ft)
							Top	Bottom	Top	Bottom						
Southern Parcel (water level data from July 20, 2012 and August 14, 2012 site visits)																
GZ-10	2	Sludge; Fine Sand	Low-flow/ bladder pump	125.8	124.8	18.5	8.5	18.5	117.3	107.3	10	13.5	N/A	5.0	8.2	117.6
GZ-11**		Gravelly Sand; Fine Sand		125**	124.1**	22.4	10.9	20.9	114.1	104.1	10	15.9		5.0	7.6	117.4
GZ-13**		Sand; Till; Bedrock		123.7**	121.9**	23.8	7.8	23.8	115.9	99.9	16	15.8		8.0	7.5	116.2
GZ-14**		Fine Sand; Till		119.6**	118.3**	44.0	9.0	39.0	109.3	79.3	30	24.0		15.0	7.5	116.2
SH-13		Sand		174.4	171.1	65.3	49.3	64.3	125.1	110.1	15	N/A	59.7	4.6	55.1	119.3
SH-19		Fine Sand		130.2	127.0	25.2	8.2	23.2	122.0	107.0	15		17.6	5.6	12.0	118.2
Southern Parcel – Well Destroyed/Not Located																
GZ-12*	2	Fine Sand	N/A	128.9*	128.0*	N/A									*	*
Northern Parcel (water level data from August 2003)																
GZ-01	1.5	Fine Sand	Water Level Measurement Only	190.7	190.6	80.1	59.5	79.5	131.1	111.1	20	N/A			69.8	120.9
GZ-04	2	Till; Bedrock		128.7	126.5	17.8	5.0	15.6	121.5	110.9	10.6				12.2	116.5
GZ-06		Sludge Sand; Till; Bedrock		131.1	130.9	31.7	16.5	31.5	114.4	99.4	15				14.2	116.9
GZ-09		Sludge Sand; Till		131.3	130.1	37.2	15.1	31.1	115.0	99.0	16				14.1	117.1
SH-01		Fine Sand		189.7	190.3	80.4	64.0	79.0	126.3	111.3	15				68.0	121.7
SH-02		Fine Sand		158.9	156.1	48.8	29.0	44.0	127.1	112.1	15				36.0	122.9
SH-03		Fine Sand; Till		152.7	149.5	39.6	20.0	35.0	129.5	114.5	15				30.1	122.6
SH-04		Bedrock		135.3	131.5	33.8	10.0	30.0	121.5	101.5	20				18.8	116.6
SH-05		Fill; Sludge Sand; Till		140.8	137.6	28.2	10.0	25.0	127.6	112.6	15				17.0	123.8
SH-06		Sand; Till		151.3	148.4	39.9	22.0	37.0	126.4	111.4	15				30.2	121.1
SH-07		Sand; Till		162.9	159.7	51.2	33.0	48.0	126.7	111.7	15				41.2	121.6
SH-08		Fine Sand		192.5	189.1	81.4	63.0	78.0	126.1	111.1	15				71.8	120.7
SH-09		Sand		161.6	158.1	58.5	32.0	47.0	126.1	111.1	15				41.2	120.4
SH-10		Sand		160.5	157.5	56.0	32.0	47.0	125.5	110.5	15				40.0	120.5
SH-11		Sand		174.3	170.8	65.5	45.0	60.0	125.8	110.8	15				54.0	120.3
SH-12		Fine Sand		175.5	173.0	67.5	48.0	63.0	125.0	110.0	15				55.6	119.9
SH-14		Fine Sand; Bedrock		128.8	125.7	24.6	4.0	21.5	121.7	104.2	17.5				12.2	116.6
SH-15		Fill; Sludge Sand; Till		133.6	130.6	26.4	8.0	23.0	122.6	107.6	15				15.6	118.0
SH-16S		Sludge Sand		133.1	130.1	37.5	8.0	23.0	122.1	107.1	15				15.9	117.2
SH-16D		Bedrock		133.3	130.1	53.2	35.0	50.0	95.1	80.1	15				15.9	117.4
SH-17		Sludge Sand; Till		130.1	127.5	26.0	7.0	22.0	120.5	105.5	15				12.9	117.2
SH-18		Sand; Fine Sand		142.3	139.7	30.6	13.0	28.0	126.7	111.7	15				20.0	122.4
Northern Parcel – Well Destroyed/Not Located																
GZ-02*	2	Sand; Fine Sand; Till	NA	139.7*	138.5*	43.7	17.5	37.5	121.0	101.0	20	N/A			*	*
GZ-07*		Sand; Bedrock		152.6*	150.2*	50.9	28.5	43.5	121.7	106.7	15				*	*

Notes:
1. SH-series monitoring wells were completed by Environmental Drilling, Inc. of Sterling, Massachusetts, and were observed and logged by Sanborn Head. These wells are constructed of 2.0-inch I.D. Schedule 40 PVC. Shallow wells were installed using hollow stem auger drilling methods; bedrock wells were installed using hollow stem auger techniques for drilling the overburden and a downhole air rotary hammer for drilling through bedrock.
2. GZ-series monitoring wells were installed under the direction of GZA as part of earlier investigations. These monitoring wells are constructed of 2.0-inch I.D. Schedule 40 PVC, except for GZ-01 which is constructed of 1.5-inch I.D. Schedule 40 PVC.
3. Elevations are presented in feet (ft). Reference point and ground surface elevations are based on a Site survey performed by Charles H. Sells, Inc. of Nashua, New Hampshire on August 19 and 20, 2003. The vertical datum is NAVD88.
4. "*" Indicates the monitoring well could not be located during the OU1 Remedial Investigation (RI) and is presumed destroyed. Reference point and ground surface elevations for these wells were obtained from a report by GZA entitled "Phase II Hydrogeologic Study and Conceptual Closeout Plan" dated October 1985 (GZA Report). Elevations were converted from the GZA datum to the current OU1 RI datum by determining the difference in surveyed elevations for GZ-01 between the two data (i.e., determine the difference in data), and using this difference to adjust the elevations of the other monitoring wells from the GZA datum to the current datum.

"**" Reference point and ground surface elevations for these wells were obtained from the GZA Report. Elevations were converted from the GZA datum to the current OU1 RI datum by determining the difference in surveyed elevations for GZ-01 between the two data (i.e., determine the difference in data), and using this difference to adjust the elevations of the other monitoring wells from the GZA datum to the current datum.
5. Water level measurements for southern parcel wells were made by Sanborn Head during a site visit with NHDES on July 10, 2012, with the exception of GZ-14, which was measured on August 14, 2012. Water level measurements for northern parcel wells were made on August 5, 2003 by Sanborn Head. Refer to the RI Report for additional information.
6. "bmp" = Below groundwater level measurement point (top of PVC).
7. "N/A" = Not applicable
8. "Installed Boring Depth" refers to the maximum installed boring depth bmp.
9. "Well Screen Depth" refers to the depth of the well screen bmp.
10. Stratigraphic Unit description is generalized from boring logs. Refer to logs in RI Report for additional information.

TABLE 5
Summary of Quality Assurance Samples to Be Collected
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Samples	Associated Sampling Equipment	Number of Samples	Sample Name	Designated NOTE to be used on Chain-of-Custody	Analyses
Equipment Rinseate Blank Samples					
Soil	Hand Auger and Sampling Tools (Stainless Steel Scoop/Bowl)	1	EQUIP BLANK	Hand Auger & Equipment	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr USEPA CL: PCBs, Dioxin/Furan
Soil	Manually-Drive Geoprobe and Sampling Equipment (Stainless Steel Scoop/Bowl) (if used)	1	EQUIP BLANK	Manual Geoprobe & Equipment	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr USEPA CL: PCBs, Dioxin/Furan
Sediment	Hand Auger and Sampling Tools (Stainless Steel Scoop/Bowl)	1	EQUIP BLANK	Hand Auger & Equipment	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: TOC, Total Cr, Hex Cr USEPA CL: PCBs, Dioxin/Furan
Sediment	Ekman Sampler and Sampling Tools (Stainless Steel Scoop/Bowl) (if used)	1	EQUIP BLANK	Ekman Sampler & Equipment	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: TOC, Total Cr, Hex Cr USEPA CL: PCBs, Dioxin/Furan
Groundwater	Water Level Meter	1	EQUIP BLANK	Water Level Meter	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr EAI: 1,4-Dioxane
Groundwater	Bladder Pump and other associated non-disposable sampling equipment	1	EQUIP BLANK	Bladder Pump & Equipment	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr EAI: 1,4-Dioxane
Field Duplicate Samples					
Soil	Stainless Steel Scoop/Bowl Hand Auger or Manually-Drive Geoprobe	1	OW-101 OW-201 OW-301 OW-401	NA	NHDPHS Lab: Metals USEPA Lab: Asbestos, VOCs, SVOCs Alpha: Total Cr, Hex Cr USEPA CL: PCBs, Dioxin/Furan
		1	OW-102 OW-202 OW-302	NA	NHDPHS Lab: Metals USEPA Lab: Asbestos Alpha: Total Cr
		1	OW-103 OW-203 OW-303	NA	NHDPHS Lab: Metals USEPA Lab: Asbestos Alpha: Total Cr
		1	OW-104 OW-204 OW-304	NA	NHDPHS Lab: Metals USEPA Lab: Asbestos Alpha: Total Cr
		1	OW-205	NA	USEPA Lab: Asbestos

TABLE 5
Summary of Quality Assurance Samples to Be Collected
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Samples	Associated Sampling Equipment	Number of Samples	Sample Name	Designated NOTE to be used on Chain-of-Custody	Analyses
Sediment	Stainless Steel Scoop/Bowl, Hand Auger, or Ekman Sampler	1	OW-111 OW-211 OW-311 OW-411 OW-611	NA	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: TOC, Total Cr, Hex Cr USEPA CL: PCBs, Dioxin/Furan Geotesting: Grain Size
Groundwater from Monitoring Wells	Bladder Pump	1	OW-121 OW-221 OW-321 OW-621	NA	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr EAI: 1,4-Dioxane
Groundwater from Mini-Piezometers	Peristaltic Pump	1	OW-131 OW-231 OW-331 OW-631	NA	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: Total Cr EAI: 1,4-Dioxane
Surface Water	Laboratory Containers	1	OW-141 OW-241 OW-341	NA	NHDPHS Lab: Metals, Hardness USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr
Performance Evaluation (PE) Samples					
Soil	NA	1	TBD	NA	USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr USEPA CL: PCBs
		2	TBD	NA	USEPA CL: Dioxin/Furan
Sediment	NA	1	TBD	NA	USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr USEPA CL: PCBs
		2	TBD	NA	USEPA CL: Dioxin/Furan
Groundwater	NA	1	TBD	NA	USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr EAI: 1,4-Dioxane (if available)
Surface Water	NA	1	TBD	NA	USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr
Trip Blank/Temperature Blank Samples					
Aqueous VOCs	NA	1 per cooler with aqueous VOC samples	TRIP BLANK	NA	USEPA Lab: VOCs
Solid VOCs	NA	1 per cooler with solid VOC samples	TRIP BLANK	NA	USEPA Lab: VOCs

TABLE 5
Summary of Quality Assurance Samples to Be Collected
Sampling and Analysis Plan
Mohawk Tannery Southern Parcel
Nashua, New Hampshire

Samples	Associated Sampling Equipment	Number of Samples	Sample Name	Designated NOTE to be used on Chain-of-Custody	Analyses
1,4-Dioxane Trip Blank	NA	1 per cooler with 1,4-Dioxane samples	TRIP BLANK	NA	EAI: 1,4-Dioxane
Temperature Blank Labs will measure the cooler temperature upon receipt either by use of an infrared thermometer or by measuring the temperature of the temperature blank included in the cooler.	NA	each cooler	NA	If a temperature blank is included in a cooler, it will be noted in the notes section of the COC or the temperature blank box will be checked.	Temperature (4±2°C)
MS/MSDs	NA	NA	NA	NA	NHDPHS Lab: Metals USEPA Lab: VOCs, SVOCs Alpha: Total Cr, Hex Cr EAI: 1,4-Dioxane
For samples from mini-piezometers, MS/MSDs will be chosen in the field based on hydraulic response. The laboratories will choose site-specific MS/MSDs for the remaining samples (for analyses to which they pertain). Refer to Section 4.2 of the text.					

Notes:
1. Groundwater samples collected from monitoring wells for metals analysis will be collected as unfiltered (total) samples, unless elevated turbidity (>20 NTUs) is observed. Refer to SOP B.7 for additional discussion.
2. Groundwater samples collected from mini-piezometers for metals and SVOC analyses will be collected as filtered (dissolved) samples. Refer to SOP B.3 for additional discussion.

FIGURES

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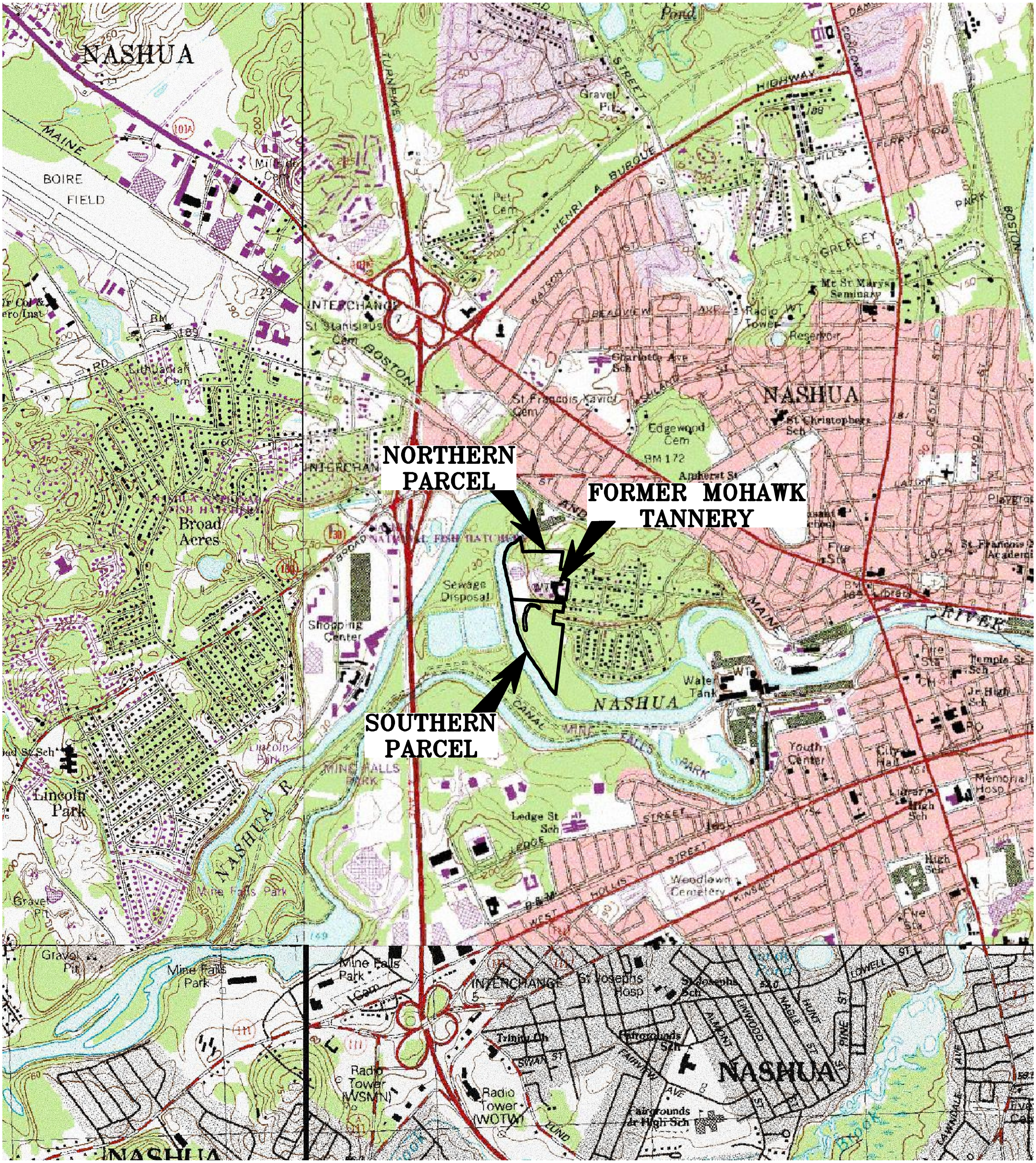

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Notes:
Base map taken from 7.5 minute USGS Quadrangle Maps: South Merrimack, New hampshire 1968, Nashua North, New Hampshire 1968, Pepperell, Massachusetts 1988, Nashua South, New hampshire 1987

Drawn By:	D. Dombrowsky
Designed By:	T. White
Reviewed By:	C. Crocetti
Project No:	2158.01
Date:	September 2012

1000' 0 2000' Feet

SANBORN HEAD

Figure 1

Locus Plan

Sampling and Analysis Plan

Mohawk Tannery Site
Southern Parcel
Nashua, New Hampshire

Figure 2

Proposed Sampling Location Plan

Sampling and Analysis Plan

Mohawk Tannery Site
Southern Parcel Study
Nashua, New Hampshire

Drawn By: D. Dombrowsky
Designed By: K. Dubois
Reviewed By: C. Crocetti
Project No: 2158.01
Date: September 2012

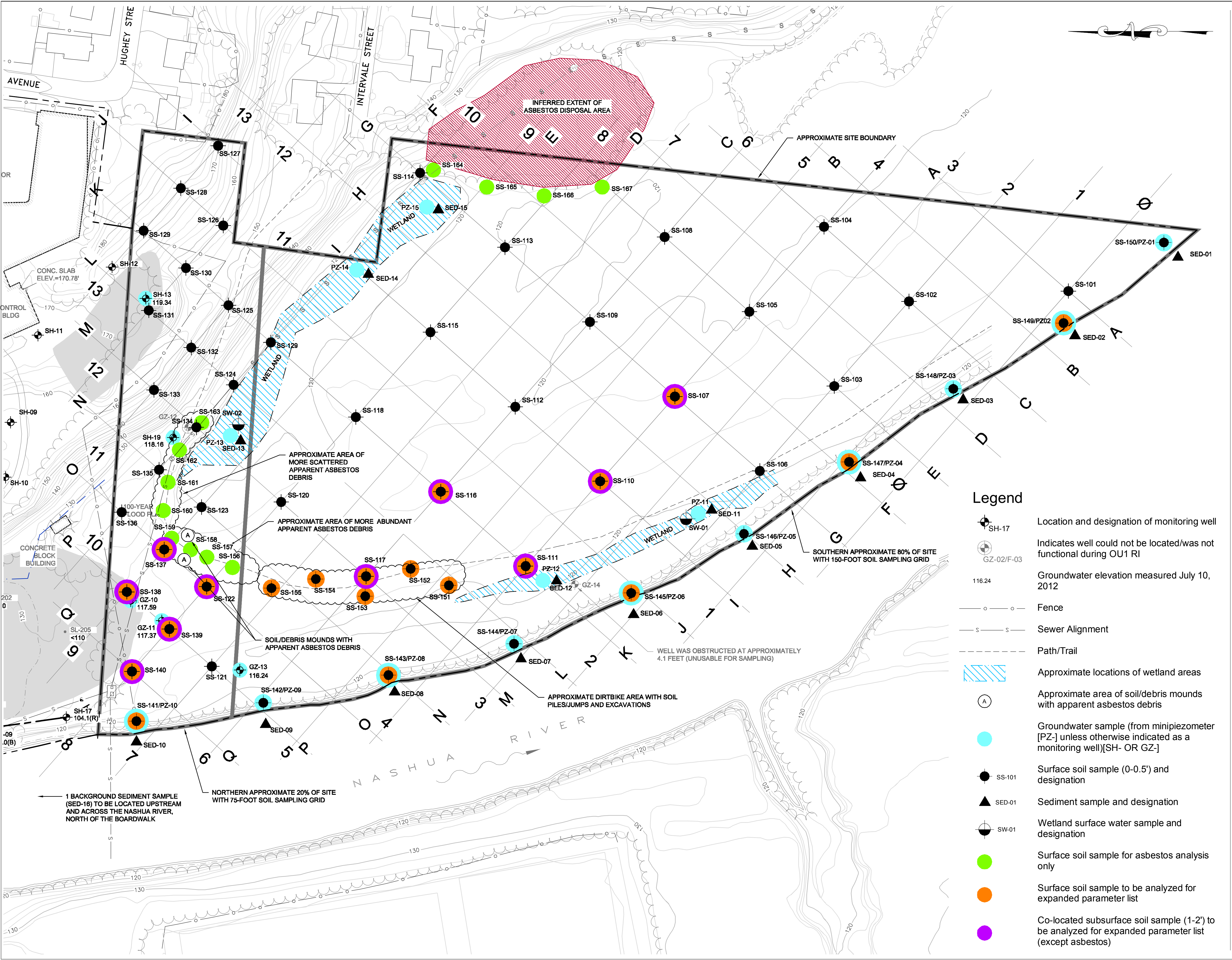
Notes

1. The base map was drawn from a plan entitled, "Site Plan and Sampling Location Plan, Mohawk Tannery Site, Nashua, New Hampshire" prepared by Tetra Tech Nus, Inc. (TTNUS) dated October 17, 2001. original scale: 1"=60'.

2. The location of the site and site features should be considered approximate only, including locations of site features based on observations from Sanborn Head's site visit on July 10, 2012.

3. The angle of orientation of the grids was selected by using a random number table generated by the Stat Trek website(http://stattrek.com/statistics/random-number-generator.aspx) on July 16, 2012. The table included 360 random numbers from 1 to 360 with no duplicates. The angle of 146 degrees from east was selected by an employee touching a highlighter to the table while his eyes were closed.

4. Refer to the text and tables for further discussion.



Legend

- SH-17 Location and designation of monitoring well
- GZ-02/F-03 Indicates well could not be located/was not functional during OU1 RI
- 116.24 Groundwater elevation measured July 10, 2012
- —o—o— Fence
- —S—S— Sewer Alignment
- - - - - Path/Trail
- ▨ Approximate locations of wetland areas
- Ⓐ Approximate area of soil/debris mounds with apparent asbestos debris
- ● Groundwater sample (from minipiezometer [PZ-] unless otherwise indicated as a monitoring well)[SH- OR GZ-]
- SS-101 Surface soil sample (0-0.5') and designation
- ▲ SED-01 Sediment sample and designation
- SW-01 Wetland surface water sample and designation
- ● Surface soil sample for asbestos analysis only
- ● Surface soil sample to be analyzed for expanded parameter list
- ● Co-located subsurface soil sample (1-2') to be analyzed for expanded parameter list (except asbestos)

SANBORN HEAD

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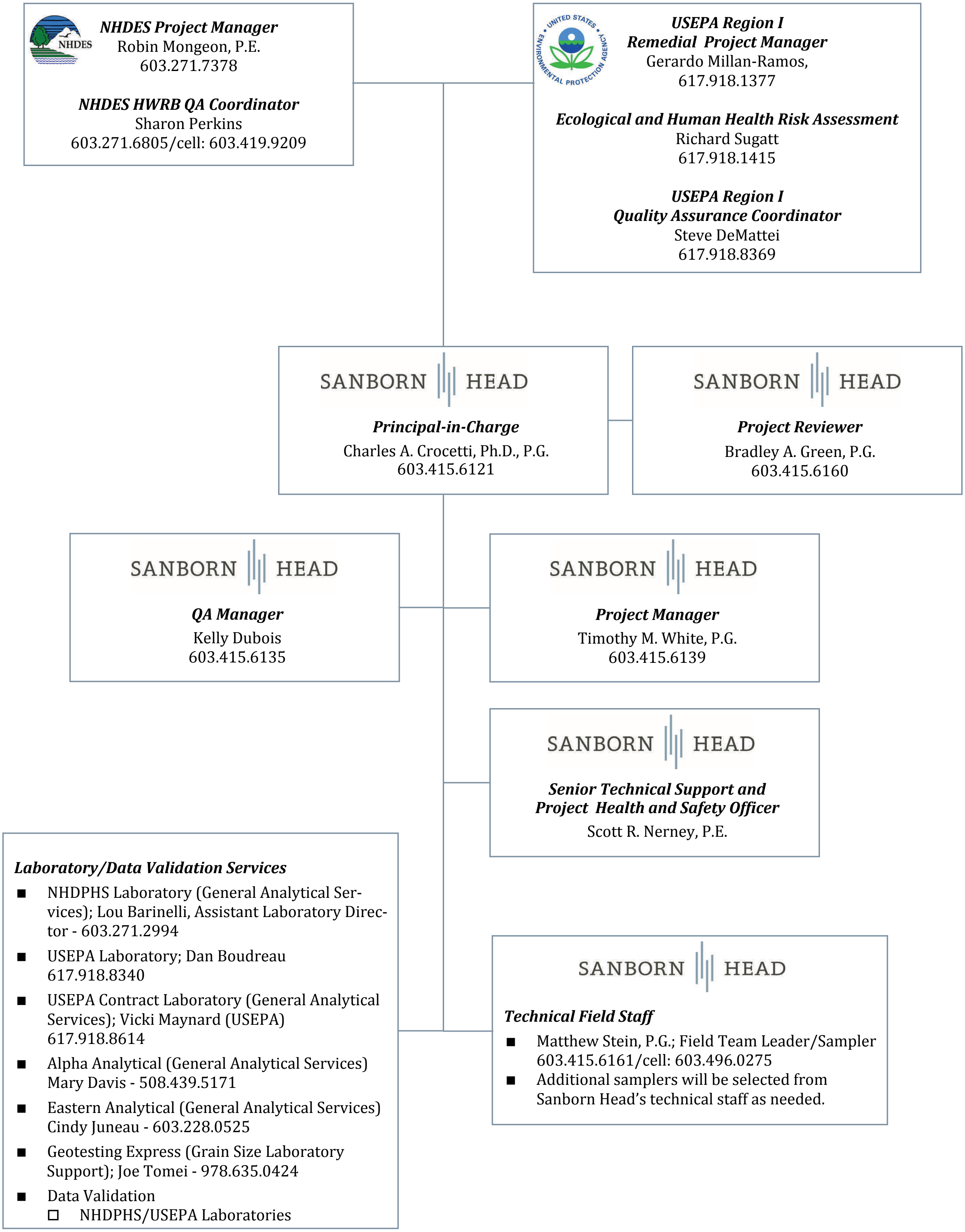
APPENDIX A

PROJECT ORGANIZATIONAL CHART AND RESPONSIBILITIES

PROJECT ORGANIZATION AND RESPONSIBILITIES - SAMPLING ANALYSIS PLAN

Mohawk Tannery Site - Southern Parcel Study, Nashua, New Hampshire
NHDES Site No. 198404002



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Senior Technical Support and
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Scott R. Nerney, P.E.

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- USEPA Laboratory; Dan Boudreau 617.918.8340
- USEPA Contract Laboratory (General Analytical Services); Vicki Maynard (USEPA) 617.918.8614
- Alpha Analytical (General Analytical Services) Mary Davis - 508.439.5171
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- Geotesting Express (Grain Size Laboratory Support); Joe Tomei - 978.635.0424
- Data Validation
  - ☐ NHDPHS/USEPA Laboratories

SANBORN HEAD
Technical Field Staff

- Matthew Stein, P.G.; Field Team Leader/Sampler 603.415.6161/cell: 603.496.0275
- Additional samplers will be selected from Sanborn Head's technical staff as needed.

APPENDIX B

SANBORN HEAD
FIELD STANDARD OPERATING PROCEDURES (SOPs)

SOP B.1

SOIL SAMPLING

TABLE OF CONTENTS

ATTACHMENTS

Description and Classification of Soil
Surficial Soil Field Sampling Summary Form
Soil Boring Log

1.0 SCOPE AND APPLICABILITY

Soil samples will be collected according to the guidelines discussed in this section on the Southern Parcel of the Mohawk Tannery Site in Nashua, New Hampshire. Soil samples will be classified and logged on-site by the field representative using a modified Burmister Soil Classification System; a Description and Classification of Soil "key" is included as an attachment. Sampling locations shall be established, prior to sampling and as described in the Sampling and Analysis Plan (SAP), using a global positioning system (GPS) unit.

VOC sample collection will be conducted in accordance with the New Hampshire Department of Environmental Services (NHDES) SOP "Preservation of VOCs in Soil Samples" included in the current NHDES Hazardous Waste Remediation Bureau Master Quality Assurance Project Plan (HWRB Master QAPP).

Surface (0 to 0.5 feet below ground surface [bgs]) and shallow subsurface (1 to 2 feet bgs) soil samples will be collected using a stainless steel spade/shovel, spoon/scoop/spatula, hand auger, or manually-driven Geoprobe® (Large Bore [LB®] Soil Sampler or equivalent) sampler as described below. Sample handling shall be in accordance with Standard Operating Procedure (SOP) B.10.

Soil sampling procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 SURFICIAL SOIL SAMPLE COLLECTION

A stainless steel spade/shovel, spoon/scoop/spatula (tool), or similar hand tool will be used to collect surficial soil samples (i.e., from 0- to 0.5-foot depth). The following procedures will be used for collecting soil samples with a hand tool from shallow excavations/borings (excavations).

1. Clear the sample location of any surface debris and spread out plastic sheeting adjacent to the sampling location for staging equipment.

2. Remove the soil to the required depth using a stainless steel hand tool and place the recovered soil into a stainless steel mixing bowl (staged on the plastic sheeting).

3. Upon completion of the shallow excavation, collect the VOC sample. In order to limit exposure to air and potential loss of volatile contaminants, the VOC sample shall be collected from the side wall of the excavation at the approximate midpoint of the depth interval using a graduated disposable syringe. The proper volume of soil is then added to the methanol preserved VOA vials (approximately 10 grams of soil in each vial). Close tightly with the screw-on cap, label, and place in ice for delivery to the laboratory. A separate dry weight sample will not be necessary as long as the dry weight analysis is added to the analysis for the SVOC container.

4. Collect a discrete soil sample from the side wall of the boring for field-screening with a photoionization detector (PID). Partially fill a new re-closable plastic bag or a clean glass container, providing adequate headspace. Aluminum foil may be placed over the top of the open jar, and the cap screwed on over the foil. PID screening will be performed in accordance with SOP B.2.

5. Using a stainless steel tool, transfer additional soil from the excavation to the stainless steel mixing bowl. Continue to collect additional soil until sufficient material has been gained to fill the remaining sample containers. Mix the sample volume thoroughly to obtain a homogeneous sample using a stainless steel tool in a manner which limits the introduction of air into the sample as much as is practicable (i.e., "stirred" not "whipped"). Fill the containers provided by the laboratory appropriate for the intended chemical analyses, close tightly with the screw-on cap, label, and place on ice for delivery to the laboratory.

6. After the VOCs are collected, the sample containers should be filled in the following order:

    - SVOCs,
    - Metals (using the appropriate containers for each lab)
    - PCB Congeners
    - Dioxins/Furans
    - Asbestos

7. Collect field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples by filling a separate container for each analysis immediately following the actual field sample collection and it should be in the same priority order as indicated above (VOCs are collected first). Field duplicate samples will be blind to the laboratories and will be designated **OW-[laboratory matrix series #]**, where "laboratory matrix series #" corresponds to the sample deliverable group (SDG) number (e.g., the first soil field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named "OW-101"). Refer to SOP B.10 for additional information on sample naming and SDGs. Refer to **Table 5** included in the SAP for specific quality control (QC) sampling requirements.

8. Between each sampling location, hand sampling equipment will be cleaned with a brush and decontaminated following the procedures described in field SOP B.11.

9. Equipment blanks are required for soil sampling equipment. Following sample collection and after equipment decontamination, gently pour DI water over the equipment used to collect the soil samples (e.g. stainless steel tools, bowl, and mixing spoon). Collect the rinseate that flows off the equipment into the appropriate sample containers. Refer to Table 5 included in the SAP for specific QC sampling requirements and analysis.

Field observations will be recorded on Sanborn Head Surficial Soil Sampling Summary Forms, or in a tabular format.

3.0 SHALLOW SUBSURFACE SOIL SAMPLE COLLECTION

Shallow subsurface (i.e., from 1- to 2-foot depth) soil samples intended to be submitted for chemical analyses will be collected using a hand auger or a manually-driven Geoprobe®.

3.1 Sampling with Hand Auger

A hand auger may be used to advance boreholes and collect soil sample from 1- to 2-foot depth. The stainless steel auger bucket with cutting head is advanced by simultaneously pushing and turning an attached handle with extensions (if needed). Boreholes are advanced one bucket at a time until the sample depth is achieved.

Once the auger bucket has been retrieved to the ground surface a sample aliquot for laboratory analyses will be collected in a manner similar to that described in Section 2.0 of this SOP. VOC samples shall be collected directly from the auger bucket. Equipment blanks shall be collected on the sampling equipment after decontamination. Refer to Table 5 included in the SAP for specific QC sampling requirements and analysis.

Field observations will be recorded on Sanborn Head Soil Sampling Summary Forms, or in a tabular format.

3.2 Sampling with Manually-Driven Geoprobe® LB® Soil Sampler

Soil samples may be collected continuously using direct push methods. The Geoprobe® Large Bore® (LB) Sampler is a solid barrel direct push sampler used primarily for collection of subsurface soil samples. The sample barrel is approximately 30-inches long and has a 1.5-inch outside diameter. The LB® Sampler is capable of recovering a discrete sample core 22 inches x 1.0 inch contained inside a removable plastic liner. The LB® sampler is typically hand driven using a slide hammer and extension rods. Alternatively an electric impact-hammer drill (or equivalent) can also be used to drive the sampler.

Once the LB® Sampler has been retrieved to the ground surface and the cutting shoe removed, the liner with the soil core will be pulled from the sample tube. The liner will then be split using a cutting tool to expose the soil sample. A sample aliquot for laboratory analyses will then be collected in a manner similar to that described in Section 2.0 of this SOP. VOC samples shall be collected directly from the liner. Equipment blanks shall be collected on the sampling equipment after decontamination. Refer to Table 5 included in the SAP for specific QC sampling requirements and analysis.

Field observations will be recorded on Sanborn Head Soil Sampling Summary Forms, or in a tabular format.

3.3 Subsurface Soil Samples for Chemical Analyses

Upon recovery of the hand auger or manually-driven Geoprobe®, soil samples will be collected. The samples for VOCs will be collected and transferred into containers provided by the analytical laboratory upon recovery of the sampling device to limit exposure to air and potential loss of volatile contaminants, and placed on ice for delivery to the laboratory.

The remaining contents of the sampling device will be placed in a stainless steel mixing bowl by Sanborn Head's field representative, blended, and packed in containers provided by the laboratory for the intended analyses, closed tightly with the screw-on cap, labeled, and placed on ice for delivery to the laboratory.

PID screening, discussed in SOP B.2, will be completed on a portion of the soil sample. The PID screening will be used to provide a relative indication of the presence of VOCs in the soil sample.

Sampling equipment will be decontaminated between each sample as described in SOP B.11.

Field observations will be recorded on Sanborn Head Soil Sampling Summary Forms, or in a tabular format.

4.0 PID FIELD SCREENING

PID field screening will be performed in accordance with field SOP B.2.

5.0 FIELD EQUIPMENT CLEANING/DECONTAMINATION PROCEDURES (ALL SOIL SAMPLING METHODS)

Soil sampling (i.e., split spoons, hand augers, manually-driven Geoprobe® and spades/shovels) and mixing (i.e., mixing bowl, spoon/scoop/spatula) equipment will be decontaminated between each sample collection as described in SOP B.11.

Equipment blanks shall be collected on each set of sampling tools used after decontamination for each method. Refer to Table 5 in the SAP for analysis.

6.0 EQUIPMENT/SUPPLIES

- Stainless steel spade/shovel
- Stainless steel hand auger
- Manually-driven Geoprobe® Sampler with plastic liners and cutting tool
- Slide hammer
- Electric impact-hammer drill and generator

- Stainless steel spoon/scoop/spatula
- Stainless steel mixing bowl
- Laboratory provided sample containers and soil transfer tools (e.g., plastic syringes)
- PID
- Aluminum foil, re-closeable plastic bags
- Plastic sheeting
- Decontamination buckets, brushes, and non-phosphatic detergent, potable water, Deionized Water (DI) / distilled water
- Cooler, ice, chain-of-custody forms and seals
- Personal protective equipment (PPE)
- Measurement tape
- Field notebook
- Soil Sampling Summary Forms
- Mohawk SAP

7.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

Description and Classification of Soil

1. Density or Consistency: The density or consistency of a soil sample is based on the Standard Penetration Test N-value according to the following table:

Density of Granular Soil	SPT N-Value		Consistency of Cohesive Soil
Very Loose	0-4	<2	Very Soft
Loose	4-10	2-4	Soft
Medium Dense	10-30	4-8	Medium Stiff
Dense	30-50	8-15	Stiff
Very Dense	>50	15-30	Very Stiff
		>30	Hard

The Standard Penetration Resistance, or N-value in blows per foot, is the sum of the blows recorded over the second and third 6-inch interval.

A number followed by "/3" indicates the distance that the sampler advanced. For example "100/4" indicates that 100 blows of a 140 pound hammer falling 30 inches advanced the sampler 4 inches. "WOR/24" indicates the weight of the drilling rods without the hammer caused the sampler to advance 24 inches.

“WOH” indicates the static weight of the 140 pound hammer and the drilling rods attached to the split spoon sampler were sufficient to cause the sampler to advance.

“WOR” indicates the static weight of the drilling rods attached to the split spoon sampler was sufficient to cause the sampler to advance.

2. Color: The color of a soil sample is based on visual observation.

3. Soil Components

A. Description: The components of a soil sample are described by visually estimating the percentage of each component by weight of the total sample using a Modified Burmister System.

i. Major Component: The major soil component is written with upper case letters for granular soil (e.g., SAND, GRAVEL) and a combination of upper and lower case letters for fine grained soil (e.g., Silty CLAY, Clayey SILT).

ii. Minor Component: The minor soil components are written with the first letter of each soil type in upper case, and the remaining letters in lower case (e.g., Gravel, Silt). The minor components are identified and prefaced in the description based on the following percentages:

Preface	Percentage
and	35-50
some	20-35
little	10-20
trace	0-10

iii. Note: The actual percentages of gravel soil may differ from that measured when sampling with a standard split spoon sampler because of the relatively small sampler diameter. Also, it is not possible to identify the presence of boulders and cobbles using a standard split spoon sampler.

B. Definitions

i. Granular Soil: A granular soil sample is defined by the following particle sizes as referenced to a standard sieve:

Material	Description	Standard Sieve Limit	
		Upper	Lower
Boulders	C-sized	--	36 inch
	B-sized	36 inch	24 inch
	A-sized	24 inch	12 inch
Cobbles	--	12 inch	3 inch
Gravel	coarse	3 inch	3/4 inch
	fine	3/4 inch	No. 4
Sand	coarse	No. 4	No. 10
	medium	No. 10	No. 40
	fine	No. 40	No. 200

ii. Fine Grained Soil: The degree of plasticity of fine-grained soils is defined as follows:

Material	Degree of Plasticity	Plasticity Index (PI)	Smallest Thread Diameter (in.)
SILT	Non-Plastic	0	None
Clayey SILT	Slight	1 to 5	1/4
SILT & CLAY	Low	5 to 10	1/8
CLAY & SILT	Medium	10 to 20	1/16
Silty CLAY	High	20 to 40	1/32
CLAY	Very High	40+	1/64

iii. Organic Soil: An organic soil sample is classified by observation of the sample structure as follows:

Material	Description
TOPSOIL	Surficial soils that support plant life and which contain organic matter.
SUBSOIL	Soil underlying the topsoil which may contain roots or plant fibers.
PEAT	Deposits of plant remains in which the original plant fibers or root structure are visible.
ORGANIC SILT	Deposit of plant remains in which the original plant fibers or root structure have decomposed.

iv. Non-Soil Constituents: Non-soil constituents (artificial or anthropogenic material, organic materials, cobbles and boulders) are described as follows:

The following terminology is used to denote size ranges of non-soil constituents such as man-made objects or fill material:

Descriptive Term	Size Range	Comparative Term
Specks	< No. 200 Sieve	Silt and Clay fines
Particles	No. 200 Sieve to No. 4 Sieve	Sand
Fragments	No. 4 Sieve to 3 in.	Gravel
Pieces	3 in. to 12 in.	Cobbles
Blocks	> 12 in.	Boulders

The following terminology is used to describe the frequency that a non-soil constituent is observed by estimating the percentage of the constituent by weight of the total sample:

Descriptor	Percentage
very few	0-5
few	5-10
common	10-20
frequent	20-35
numerous	35-50

4. Moisture Content: The moisture content of a soil sample is based on the observable presence of water according to the following table:

Dry	Moisture is not apparent, dusty.
Moist	No visible water.
Wet	Visible free water.

5. Other Pertinent Characteristics: Pertinent characteristics observed in a soil sample should be noted according to the following table:

Soil Structure Produced by Deposition of Sediments	
Stratified	Random soil deposits of varying components of color.
Varved	Alternating soil deposits of varying thickness (i.e., clays or silts).
Stratum	Soil deposit > 12 inches thick.
Layer	Soil deposit 3 inches to 12 inches thick.
Seam	Soil deposit 1/8 inch to 3 inches thick.
Parting/Lens	Soil deposit <1/8 inch thick.

Surficial Soil Field Sampling Summary

Sampler's Signature:

SANBORN HEAD	Project Number:	Date:
	Project Name:	
	Project Location:	

PID Meter:	Project Manager:
Sampling Equipment:	Collector(s):
Other:	Weather:

Field Measurements

Sampling Location					
Sampling Depth Interval (ft bgs)					
Sampling Time					
PID (ppm)					
Sample Odor					
Sample Color					
Burmeister Soil Description					
Other					
Comment Reference Number					

Comments

1.
2.
3.
4.
5.
6.
7.
8.

SANBORN HEAD

Sanborn, Head & Associates, Inc.

Project:
Location:
Project No.:

Log of Boring

Ground Elevation:

Drilling Method:

Sampling Method:

Drilling Company:
Foreman:
Date Started: **Date Finished:**
Logged By: **Checked By:**

Groundwater Readings

Date	Time	Depth to Water	Ref. Pt.	Depth of Casing	Depth of Hole	Stab. Time

Depth (ft)	Sample Information					Stratum		Geologic Description	Remarks
	Sample No.	Depth (ft)	Spoon Blows per 6 in	Pen/ Rec (in)	Field Testing Data	Log	Description		
0							-----0'-----		
2									
4									
6									
8									
10									
12									
14									
16									
18									
20									
22									
24									

BORING LOG S:\CONDATA\GINT\BLANK.GPJ 2010 SANBORN HEAD V1.GLB 2010 SANBORN HEAD V1.GDT 10/24/10

Sheet: 1 of

SANBORN HEAD

Sanborn, Head & Associates, Inc.

Project:
Location:
Project No.:

Log of Boring

Ground Elevation:

Drilling Method:

Sampling Method:

Drilling Company:
Foreman:
Date Started: **Date Finished:**
Logged By: **Checked By:**

Groundwater Readings

Date	Time	Depth to Water	Ref. Pt.	Depth of Casing	Depth of Hole	Stab. Time

Depth (ft)	Sample Information					Stratum		Geologic Description	Remarks
	Sample No.	Depth (ft)	Spoon Blows per 6 in	Pen/ Rec (in)	Field Testing Data	Log	Description		
26									
28									
30									
32									
34									
36									
38									
40									
42									
44									
46									
48									
50									

SANBORN HEAD

Sanborn, Head & Associates, Inc.

Project:
Location:
Project No.:

Log of Boring

Ground Elevation:

Drilling Method:

Sampling Method:

Drilling Company:
Foreman:
Date Started: **Date Finished:**
Logged By: **Checked By:**

Groundwater Readings

Date	Time	Depth to Water	Ref. Pt.	Depth of Casing	Depth of Hole	Stab. Time

Depth (ft)	Sample Information					Stratum		Geologic Description	Remarks
	Sample No.	Depth (ft)	Spoon Blows per 6 in	Pen/ Rec (in)	Field Testing Data	Log	Description		
50									
52									
54									
56									
58									
60									
62									
64									
66									
68									
70									
72									
74									

SANBORN HEAD

Sanborn, Head & Associates, Inc.

Project:
Location:
Project No.:

Log of Boring

Ground Elevation:

Drilling Method:

Sampling Method:

Drilling Company:
Foreman:
Date Started: **Date Finished:**
Logged By: **Checked By:**

Groundwater Readings

Date	Time	Depth to Water	Ref. Pt.	Depth of Casing	Depth of Hole	Stab. Time

Depth (ft)	Sample Information					Stratum		Geologic Description	Remarks
	Sample No.	Depth (ft)	Spoon Blows per 6 in	Pen/ Rec (in)	Field Testing Data	Log	Description		
76									
78									
80									
82									
84									
86									
88									
90									
92									
94									
96									
98									
100									

SOP B.2

PHOTOIONIZATION DETECTOR CALIBRATION, MAINTENANCE, AND HEADSPACE FIELD SCREENING

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1.0 SCOPE AND APPLICABILITY

This document identifies field equipment and calibration procedures to be used for screening of soil samples using a photoionization detector (PID) on the Southern Parcel of the Mohawk Tannery Site in Nashua, New Hampshire. The PID will be used and calibrated following the procedures provided in the equipment's User Manual and this SOP. A copy of the instrument's User Manual will be kept on-site during field activities. Historical documentation for Sanborn Head field equipment calibration and maintenance is filed at Sanborn Head's offices in Concord, New Hampshire.

This document also describes the procedure for performing soil headspace measurements on soil and sediment samples collected during sampling activities. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 PHOTOVAC MODEL 2020 (PID) OR EQUIVALENT

This instrument will be used to monitor air quality for volatile organic compounds (VOCs) in work areas (refer to HASP) and as a screening tool to indicate relative levels of contamination in environmental media (e.g., soil). It will be equipped with a 10.6 eV lamp, which allows the PID to respond to gases and vapors which ionize at 10.6 eV or less. For a Photovac Model 2020 PID, refer to Page 21 of the Owner's Manual for a list of compounds and their associated response factors when measured with a 10.6 eV lamp. If using an equivalent meter, refer to that instrument's User Manual.

The PID will be calibrated at a minimum daily (typically in the morning, or, before its use) using a standard span gas equivalent to 100 ppm isobutylene in air. Calibration instructions for the Photovac Model 2020 PID are documented on Page 11 of the User Manual and presented below (if an equivalent meter is being used, refer to the instrument's Owner's Manual for appropriate instructions). The PID calibration will be checked a minimum of twice per day. Calibration checks will consist of screening a sample of the span gas. A reading of ±10% of the known span gas concentration will be considered acceptable. A reading outside this range will require re-calibration of the instrument. The calibration and calibration check of the instrument should be performed on a non-contaminated portion of the Site. The span gas used for calibration will be obtained from commercial vendors.

2.1 Photovac Model 2020 (PID) Calibration Procedure

- Connect the regulator to the calibration gas cylinder.
- When the regulator is connected properly, you can read the cylinder contents from the regulator gauge.
- Connect the adapter tubing to the regulator.

- Remove debris potentially present near/in the sample probe inlet
- Connect sample probe to the 2020 inlet
- Press the **ENTER** key
- Select "**Set**", "**Cal**" and then "**Mem**"
- Select the desired Cal Memory. 2020 has 15 Cal Memories and can be calibrated with 15 different span gases or response factors if required. Only one Cal Memory can be used at a time. Each Cal Memory stores a different response factor, zero point, sensitivity, and alarm levels.
- Select **"Chng**" and then "**User**". Enter a name for the calibration memory.
- Press the **ENTER** key and enter a response factor (RF). Refer to Appendix 8.6, in the owner's manual, for a list of Response Factors. If the compound is not listed in Appendix 8.6 or you are measuring gas mixtures, then enter a value of 1.0. The concentration detected by 2020 will be multiplied by the response factor before it is displayed and logged.
- Press the **ENTER** key and enter an alarm level for **STEL**, **TWA** and **PEAK**.
- Press **ENTER** and expose 2020 to a supply of zero air.
- Select "**Set**", "**Cal**", and "**Zero**". Allow 2020 to set its zero point.
- Select "**Set**", "**Cal**" and "**Span**". 2020 asks for the span gas concentration. Enter the known span gas concentration, without pressing the **ENTER** key to confirm it.
- Insert the 2020 sample probe into the adapter tubing from the regulator.
- Position the calibration gas cylinder upright and open the regulator by turning the valve counterclockwise. Open the regulator until the ball is mid-way between its rest position and the top of the flow rate indicator.
- Press the **ENTER** key. 2020 sets its sensitivity.
- When the display reverts to the default display, 2020 is calibrated and ready for use.
- Remove the adapter tubing from the inlet and close the regulator.
- If you turn off the 2020 in the middle of zeroing or spanning, the next time you turn it on it will display a Cal status. This indicates that you need to calibrate the 2020.
- Typical default settings used by Sanborn Head for the Photovac Model 2020 PID include a response factor of 1.0 with the 100 ppm isobutylene in air standard. The PID is usually set to operate in Peak Mode which displays the current detected concentration.
- Record the calibration information on the calibration form accompanying the equipment.

If using an equivalent meter, follow the instructions in the instrument's User Manual.

2.2 Photovac Model 2020 (PID) Routine Maintenance

Routine maintenance including cleaning of the UV lamp window and replacement of the sample inlet filter for the Photovac Model 2020 (PID) is described in Section 5.0 of the User Manual. If using an equivalent meter, refer to that instrument's Owner's Manual for appropriate procedures.

Cleaning the UV Lamp Window
During the course of normal operation, a film builds up on the window of the UV lamp. The rate at which the film develops depends on the type and concentration of the gases and vapors being sampled and results from the UV light interacting with them. Hot gases and vapors may contribute to a decrease in sensitivity because they may condense on the lamp window. Condensation may eventually evaporate off the window, but it will usually leave a residue that must be removed by cleaning the lamp window. As a guide, clean the window every 24 hours of operation.

- Do not remove or replace the detector lamp in a hazardous location.
- Turn off the instrument.
- Use the 2020 multi-tool to remove the lamp housing cover.
- Tilt the 2020 slightly and remove the UV lamp.
- Do not touch the wire grid inside the detector cell. Any dust or dirt in the detector cell can be blown out with a gentle jet of compressed air. Do not insert any object, other than the UV lamp, into the lamp holder.
- To remove the film, gently rub the window of the lamp with a lint free tissue moistened with methanol. Use only HPLC grade or spectroscopic grade methanol to clean the lamp window.
- Allow the window to dry and then, without touching the window, place it back into the 2020.
- Replace the lamp housing cover, tighten the cover down with the multi-tool. Do not overtighten.
- Calibrate all the Cal Memories that you are using and then continue normal operation.

Replacing the Sample Inlet Filter
The 2020 is equipped with a combined dust and water filter to reduce detector contamination. As the filter collects dust, the 2020's inlet flow rate and sensitivity decreases. The filter will not allow water to pass through, but the filter will not stop all solvents. Replace the filter on a weekly basis, or more frequently if the 2020 is used in a dusty or wet environment. You must replace the filter if the 2020 has been exposed to liquid water. If you are sampling hot gases or vapors, condensation in the sample line may also affect the filter. The pump will sound labored when the filter requires replacement.

- Do not replace the inlet filter in a hazardous location.

- Turn the instrument off. Unscrew the filter housing from the detector housing. Be careful not to lose the O-ring seal.
- Each filter is protected by a piece of blue plastic. Remove the plastic before installing the filter in the 2020.
- Remove the Teflon/Polypropylene filter and install the new filter (Photovac Part No. 396000 or 396015). Place the filter so that the Teflon side is facing down in the filter housing and the mesh side is facing the 2020.
- Handle the filter disk only by the edges. The mesh may be damaged or contaminated by excessive handling. Use forceps if possible.
- Replace the filter housing.
- Calibrate all Cal Memories that you are using, and then continue normal operation.
- Do not operate the 2020 without an inlet filter.

3.0 PID FIELD-SCREENING

Upon recovery of samples, Sanborn Head's field representative will place a portion of the sample in a new re-closable plastic bag(s) or a glass jar(s) with screw-on cap. The headspace of this sample will be screened for the presence of VOCs utilizing a PID employing a 10.6 eV lamp (or equivalent) following the general procedures described below.

1. Calibrate PID as indicated above.

2. Provide adequate head space in sample bag or jar, prior to sealing, to allow insertion of PID intake without entraining soil into the instrument (if a jar is used, aluminum foil may be placed over the top of the open jar, then screw on the cap over the foil);

3. Allow sealed bag or jar to heat up to approximately 70°F;

4. Shake bag or jar moderately;

5. Unseal bag or unscrew cap and open just enough to allow insertion of PID intake, taking care to limit, as much as practicable, entrainment of soil into the instrument (or, if aluminum foil was used, remove the cap and puncture the aluminum foil with the PID intake);

6. Monitor head space readings for approximately 20 to 30 seconds, or if readings significantly above background are indicated, until head space readings achieve a maximum value and then decline. Erratic meter response may be due to high organic levels, air humidity, and/or sample moisture;

7. Reseal container;

8. Record highest PID reading as value for sample.

Field instruments (e.g., PID) used during the investigations will be calibrated, as appropriate, in general accordance with the instrument manufacturer's recommendations prior to the day's investigations. A calibration check will be performed following the day's investigations. Records of daily calibration will be maintained on a calibration form which will be referenced in the daily entry in the field book. Field personnel will limit contact of sampling equipment and field instruments with the ground surface. Sampling equipment will be brought to the site in new plastic bags and remain in the bags until used or decontaminated prior to use.

4.0 EQUIPMENT/SUPPLIES

- Photoionization detector (PID)
- Glass jars or re-closable plastic bags
- Calibration gas, regulator, and tubing
- Aluminum foil
- Equipment calibration log
- Field book
- Field sampling summary forms/boring logs
- Personal protective equipment (PPE)
- Mohawk SAP

5.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

SOP B.3

INSTALLATION AND SAMPLING OF MINI-PIEZOMETERS/WELL POINTS

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ATTACHMENT

Mini-Piezometer Purge and Sample Data Sheet

1.0 SCOPE AND APPLICABILITY

Sanborn Head proposes to install and sample mini-piezometers/well points to provide groundwater quality information and groundwater levels on the Southern Parcel of the Mohawk Tannery site. Mini-piezometers/well points are anticipated to be constructed with well screens that are approximately one foot in length.

The low flow procedure is not applicable to the mini-piezometers/well points as they have an inside diameter (I.D.) of less than approximately 1-inch, which precludes measuring groundwater levels during pumping. When a test mini-piezometer was installed in the fine sand material at the site, it did not yield much water and was easily dewatered by pumping with a peristaltic pump. This warrants a simple approach to sampling that limits the amount of purging.

This procedure calls for one tubing volume of water to be purged at a low purge rate (approximately 50 ml/minute) before the sample is collected. The goal is to sample the water in the screened zone at a low pumping rate to minimize disturbance. The theory is that the water in the screened zone is in equilibrium with the aquifer, and purging one tubing volume is sufficient to collect a representative sample. Groundwater turbidity will be measured in the field prior to sampling. Mini-piezometer/well point installation and sampling procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 PROCEDURES

2.1 Mini-piezometer/Well Point Installation

Mini-piezometers/well points will be constructed using approximately ¾-inch I.D. diameter stainless steel screen and riser, and will be installed by hand, using a hand-held slide hammer or an electric impact-hammer drill (or equivalent)[1]. Locations shall be established, prior to installation and as described in the SAP, using a global positioning system (GPS) unit.

The following general procedures will be used to install mini-piezometers/well points:

1. Visually inspect mini-piezometer/well point components and installation tools prior to use.

2. Assemble a section of stainless steel screen and stainless steel riser, as necessary. Using a hand-held hammer or electric impact-hammer drill, advance the screened

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[1] Should a gasoline-powered generator be used to power the electric hammer drill, the generator will be staged on plastic sheeting/plastic container some distance (e.g., greater than 25 feet) from the mini-piezometer/well point in an apparent side- or downgradient location to reduce the potential for possible gasoline-related impacts.

section until additional riser pipe is necessary or until the well screen is advanced to the desired depth. Remove the hammer.

3. Connect a section of solid stainless steel riser, and tighten securely. Using a hand-held hammer or electric impact-hammer drill, advance the screened section until additional riser pipe is necessary or until the well screen is advanced to the desired depth. The mini-piezometer/well points will be driven to a depth such that the bottom of the well screen is approximately three to four feet below the observed water table (as encountered during installation), as conditions allow. The depth of the well screen relative to the observed water table may be adjusted based on anticipated water table fluctuation (e.g., if water table is thought to be near its maximum seasonal high elevation, the screen may be set deeper relative to the observed water table). Additional riser pipe may be added, if necessary, to allow for a stick-up of at least one to two feet above the ground surface.

4. A lockable compression cap will be installed on the top of the riser pipe.

5. After allowing the mini-piezometer/well point to "equilibrate" for up to 2 hours, a qualitative hydraulic performance evaluation will be performed.
    a. Measure the water level.
    b. Calculate the standing volume of water above the well screen.
    c. Set the tubing at the top of the well screen and pump at approximately 50 mL/minute for up to approximately 15 minutes, or until bubbles are observed in the discharge line. If applicable, record the elapsed time at which bubbles are first observed.
    d. Stop pumping, remove the tubing, and measure the depth to water.
    e. Monitor the recharge of the mini-piezometer by taking and recording periodic water level measurements for up to half an hour.

2.2 Records and Documentation

Mini-piezometer/well point installations will be recorded by Sanborn Head's field representative. Installation details and measurements to be recorded will include:

- Mini-piezometer/well point designation
- Date/time of installation
- Equipment used
- Total depth
- Relative resistance
- Height of stick-up above the ground surface
- Depth to water at the time of installation relative to the top of the stainless steel riser pipe
- Data from above-described hydraulic performance evaluation

2.3 Mini-piezometer/Well Point Purging and Sampling

For this SOP, mini-piezometers/well points will be purged and sampled using a variable flow rate peristaltic pump with Teflon® lined polyethylene tubing. For newly constructed mini-piezometers/well points, groundwater samples will not be collected until after an "equilibration" period of approximately two weeks or more.

Water quality meters used shall be calibrated in accordance with SOP B.6 within one week prior to the sampling event. A calibration check will be performed at the beginning of each day and following the day's sampling. A calibration check may also be performed mid-day. Records of calibration and calibration checks will be maintained on a calibration form which will be referenced in the daily entry in the field book. Field personnel will limit contact of sampling equipment and field instruments with the ground surface.

1. Lay out sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, bucket, etc.).
2. Lower the water level meter to the top of the water table and measure and record the water level.
3. The tubing intake within each mini-piezometer/well point should be located at the top of the saturated well screen length (approximately 1 foot from the bottom of the mini-piezometer). Setting the tubing at the top of the screened interval will preclude the water level from dropping below the top of the screen, and limit the potential for introducing air into the screened interval which may alter redox conditions.
4. Care must be taken during tubing installation and sampling to minimize the disturbance of particulates that can extend the purge time by increasing turbidity.
5. Calculate the volume of water needed to purge one tubing volume of water.
6. Start the pump at its lowest speed setting and slowly increase the speed until a laminar flow rate is achieved (approximately 50 ml/min).
7. From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated beaker/bucket to estimate the total volume of groundwater purged. Purge the piezometer at this rate until one tubing volume of water has been removed. Record total volume purged on the Mini-Piezometer Purge and Sample Data Sheet.
8. If air bubbles are observed they can usually be removed by elevating the discharge tube and pump to allow the air to continue rising until discharged with the water. Prevent sample tubing from crimping and avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.
9. Once the correct volume has been removed, measure groundwater turbidity and record the value on the worksheet.

2.4 Groundwater Sample Collection

Groundwater samples will be collected with the same device used for purging, and at the same or slightly slower flow rate to limit aeration, bubble formation, and/or loss of volatiles.

We propose to collect only field-filtered (using single-use, in-line, 0.45-micron filters) samples for hexavalent chromium, metals and SVOC samples from the mini-piezometers. Since we anticipate needing multiple purge cycles to collect the full suite of laboratory analyses, there is a potential for high variability in the turbidity over the course of sample collection. Further, because we anticipate being limited by the amount of water the mini-piezometers yield, collecting both filtered and unfiltered samples may not be practical, and results from filtered samples are expected to be most representative of potential aqueous-phase contaminants migrating with groundwater. For low-yielding mini-piezometers, SVOC samples may not be collected during the first mobilization to the field, as discussed during the September 12, 2012 team conference call. In this situation, the field sampler will document field conditions and Sanborn Head will discuss a recommended course of action with the project team.

Turbidity will be measured prior to and after collecting the laboratory samples for evaluating how turbidity may have changed during pumping. Following the sample collection and the final turbidity measurement, other field water quality parameters (i.e., pH, DO, ORP, temperature, and specific conductance) will be measured by over-filling the YSI storage cap with water and submerging the multi-parameter sonde (or equivalent), and the measurements recorded on the worksheet. The intent of the field water quality measurements is to evaluate field water quality (i.e., a "screening level" analysis), and not to assess field parameter stabilization.

The addition of groundwater to sample containers will be conducted in a controlled manner to limit aeration, overflow of bottles, or loss of preservative. Pre-preserved sample containers provided by the laboratories will be used when required for the selected analyses. Field SOP B.10 also provides additional information on sample handling.

Samples will be collected and containerized in the following order:

i. Field turbidity measurement
ii. Filtered Hexavalent Chromium
iii. Volatile Organic Compounds (VOCs)
iv. 1,4-Dioxane
v. Filtered Metals (using appropriate container(s) for each lab)
vi. Filtered Semi-Volatile Organic Compounds (SVOCs)
vii. Field turbidity measurement
viii. Field water quality parameters

Field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples should be collected by filling a separate container for each analysis immediately following the actual field sample collection. Field duplicate samples will be blind to the laboratories and will be designated **OW-[laboratory matrix series #]**, where "laboratory matrix series #" corresponds to the sample deliverable group (SDG) number (e.g., the first soil field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named "OW-101"). Refer to SOP B.10 for additional information on sample naming and SDGs. Refer to **Table 5** in the SAP for specific quality control (QC) sampling requirements.

Samples to be submitted for chemical analysis will be stored on ice in a cooler. Sample handling is discussed in field SOP B.10.

In the event that all samples cannot be collected at one time due to dewatering, allow the well to recover and continue sample collection. The duration of water level recovery will be selected by the sampler and recorded in the field notes. The sampler may choose to move onto another well while allowing the well to recover. Note: Individual VOC vials must be collected at one time (i.e., during a single piezometer purging) with no headspace.

3.0 EQUIPMENT DECONTAMINATION

Disposable down-hole sampling equipment (i.e., tubing) will be discarded after sample collection. The water level meter will be decontaminated between locations using a distilled or deionized (DI) water rinse. Disposition of produced groundwater and rinse water will be handled as investigation-derived waste (IDW) as discussed in field SOP B.12.

4.0 EQUIPMENT AND SUPPLIES

The following equipment may be employed by Sanborn Head during installation of mini-piezometers/well points:

4.1 Installation

- Stainless steel solid riser
- Stainless steel screen with sacrificial drive point
- Stainless steel couplings (one required for each extension)
- Drive Hammer – manual
- Electric impact-hammer drill and generator
- Locks
- Locking compression caps
- General installation equipment (e.g., pipe wrench, vise grip, etc.)
- Decontamination buckets, brushes, and non-phosphatic detergent, potable water, de-ionized water.
- Measurement tape
- Water level meter
- Field notebook
- Mohawk SAP
- Personal protective equipment (PPE)

4.2 Sampling

- Laboratory-supplied (Sanborn Head-supplied in the case of analyses to be performed by USEPA lab) sample containers
- Ice, coolers and packing materials
- Site and well keys
- YSI 600 XL/XLM multi-parameter sonde (or equivalent)
- Hach 2100P turbidity meter and calibration standards. Refer to SOP B.6 (or equivalent)
- Slope (or equivalent) Water Level Meter
- Calibration solutions and supplies for the YSI and Hach meters. Refer to SOP B.6.
- 3-way stopcock/valve
- Lint-free cloth (e.g., Kimwipes® or equivalent)
- Adjustable rate Geotech Peristaltic Pump Series II Variable Speed pump 300 + 600 RPM with Easy Load Peristaltic Pump Heads (that allow 50 ml/minute) (or equivalent) and a battery (marine, battery pack, etc)
- Teflon® lined polyethylene tubing (for sample collection).
- Paraphernalia to adequately shade equipment and tubing to prevent temperature variations in the readings, bubbles forming in the tubing, and to prevent the acid preservative in the sample containers from volatilizing
- Flow measurement supplies/graduated cylinder
- Stop watch
- Graduated Beaker/Bucket to collect purge water
- Clean plastic storage bags
- Plastic ground cloth
- Single-use, in-line 0.45 micron filters for dissolved analyses (as applicable)
- Decontamination buckets, brushes, and non-phosphatic detergent, potable water, de-ionized water, decontamination solvent (if necessary) Refer to Decontamination SOP B.11
- Sturdy field table
- Mini-Piezometer Purge and Sample Data Sheets
- Groundwater Field Sampling Forms
- Field book
- Personal protective equipment (PPE)
- Mohawk SAP

5.0 REVIEW OF MINI-PIEZOMETER/WELL POINT CONSTRUCTION MATERIALS AND SUPPLIES

Materials and supplies used for mini-piezometer/well point construction will be inspected by a Sanborn Head representative prior to use. Materials which come in plastic/paper packaging will not be used if they arrive at the site with damaged or missing packaging or other signs of contamination/defect.

6.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

Mini-Piezometer Purge and Sample Data Sheet

Sampler's Signature:

SANBORN HEAD	Project No.: 2158.01	Mini-Piezometer ID: ¾"	Water Level:	Well No.:
	Location: Mohawk Tannery	Reference Point: Top of Stainless Riser	Total Depth:	Date:
	Sanborn Head Rep.:	Intake Depth:	Screen Interval:	Weather:

Instrumentation
DO, Conductivity, Temperature, pH, ORP: YSI 556 MPS S/N: ___
YSI 600 XLM Probe S/N: ___ Meter S/N: ___
Water Level Make, Model & S/N: ___
Turbidity Make, Model & S/N: ___

Pumping Equipment and Materials
Peristaltic Pump Make, Model & S/N: ___
Water Tubing Diameter (in): ID ___ OD ___
Water Tubing Material: Teflon-Lined Poly
Other:

Time	Purging		Recharging			Comments
	Flow (mL/min)	Cum. Purge Vol. (mL)	Depth to Water (ft)	Depth Standing Water Above Screen (ft)	Vol. Standing Water Above Screen (mL)	

Total Purge Volume (mL):	

Unit Volume of Standing Water Above Screen (mL/ft)	73

Tubing Volume Calculations	
Tubing Unit Volume (mL/ft)	
Total Tubing Length (ft)	
Total Tubing Volume (mL)	

Sample and Water Quality Information	
Turbidity (NTU) (Pre-Sample Collection)	
Laboratory Sample ID	
Collection Date and Time	
Temperature (°C)	
Specific Conductance (µS/cm)	
DO (mg/l)	
pH (s.u.)	
ORP (mV)	
Turbidity (NTU) (Post-Sample Collection)	
Water Level (ft) (Post-Sampling)	

SOP B.4

SURVEYING MONITORING WELL REFERENCE ELEVATIONS

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1.0 SCOPE AND APPLICABILITY

Surveying is a necessary part of the groundwater monitoring program on the Southern Parcel of the Mohawk Tannery Site in Nashua, New Hampshire. The reference elevations of monitoring wells and mini-piezometers/well points are surveyed so they may be accurately used to develop and interpret hydrogeologic data (e.g., groundwater flow direction).

The accuracy of the elevation survey is usually to the nearest 0.01 foot. The elevations should be surveyed using a common datum. A commonly used datum is the National Geodetic Vertical Datum (NGVD), established by the National Geodetic Survey. If it is not practical to reference the elevations to a known datum (due to budget constraints, time, distance, etc.), an assumed datum can be used. For an assumed datum, an arbitrary point is selected (usually one of the existing surveyed monitoring wells or a prominent site feature) and assigned an elevation. The elevations of the other monitoring wells are then surveyed with reference to this one point.

The reference elevations of the protective casing (with the cap off or hinged back), the well riser (usually the top of the PVC well riser), and the ground surface should be surveyed for each monitoring well.

Surveying procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 SURVEYING

2.1 Automatic Level

An automatic, or self-leveling, level will generally be used for elevation surveying. After being manually leveled with the circular, or bull's eye, level before each set up, the instrument self compensates as the leveling circuit is run. Each time the instrument is brought out of "bubble", it must be manually leveled again.

Because the level is delicate and can be brought out of calibration easily, it must be handled with care during use and travel. The level is to be kept in its protective case when not in actual use. The level is to be stored securely in the cab of the vehicle. Eyecups should be placed over the lenses at all times when not in use. The leveling pegs should be screwed or run up into the level housing to protect against damage. When in transport at a survey site, the level should either remain in the case or firmly attached to the tripod. The tripod should be carried with two hands when moving a mounted level.

2.2 Tripod

The level is mounted to a metal tripod with adjustable legs and stake-like feet. It is important that the tripod travels in a secure manner and is set in a stable area for measurement.

2.3 Leveling Rod

The leveling rod commonly used is a multi-section fiberglass rod with gradations marked to the nearest tenth of a foot. Hundredths are denoted by black hash marks with each black mark representing an odd number and the intervening white representing an even number.

The rod should never be carried over the shoulder with any section extended. Always check the booted end for cleanliness during measurements of monitoring points, and never drag the end along any surface.

2.4 Running a Basic Level Circuit

A basic level circuit can be divided into the following steps.

2.4.1 Establish the Initial Elevation

The initial elevation can be set in one of two ways. If a benchmark (BM) with a known datum is used, the known elevation of the BM is used and is the initial elevation of the survey. If the site does not already have a known survey datum, an arbitrary elevation of 100 feet is typically used as the initial elevation of the survey.

2.4.2 Establish the Initial Height of Instrument

The initial height of instrument (HI) is established by adding the initial backsight, which is the first measurement taken, to the BM elevation. As long as the instrument remains set, this HI will be used to establish elevations at all points.

2.4.3 Establish Elevations of All Remaining Points

As long as the instrument remains stable (does not move due to site conditions or length of shot), sideshots may be used to establish the elevations of all remaining survey points. To obtain the elevation, the foresight measured during each sideshot is subtracted from the initial HI. However, because not all measurements may be taken from the same position, intermediate HIs may need to be determined. The intermediate HIs are set by establishing the elevation at a turning point (TP), moving and re-leveling the instrument, and re-establishing the HI by taking an intermediate backsight to the same TP. When intermediate HIs are used, the elevations of the following points are set from the new HI.

2.4.4 Establish a Closeout HI for the Remainder of the Circuit

All basic survey circuits will have at least one TP and a change in the HI. This change occurs at the beginning of the closeout of the circuit. By doing this, the initial placement of the instrument can be eliminated as a factor in biasing elevations. When beginning the closeout, the tripod and level must be completely lifted off the ground and taken out of level. The instrument is then re-leveled and the closeout HI is established.

3.0 EQUIPMENT/SUPPLIES

- Automatic level
- Tripod
- Leveling Rod
- Measurement tape
- Calculator
- Field notebook
- Mohawk SAP
- Personal protective equipment (PPE)

4.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

SOP B.5

MEASURING WATER LEVELS, CALCULATING GROUNDWATER ELEVATIONS, AND GENERATING GROUNDWATER CONTOURS

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ATTACHMENT

1.0 SCOPE AND APPLICABILITY

This procedure identifies field equipment and procedures to be used for groundwater level measurements at the Mohawk Tannery Site in Nashua, New Hampshire. The groundwater level measurements will be collected to measure depth of groundwater below the ground surface and groundwater elevations, and monitor groundwater flow direction.

Groundwater level measurement procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 SLOPE WATER LEVEL METER OR EQUIVALENT

This instrument will be used to measure depth to water. The sensitivity of the indicator will be adjusted, if warranted, for each measurement as specified on the equipment's instruction sheet.

The procedures outlined below are for Slope water level meters. If an equivalent water level meter is used, refer to that instrument's User Manual for appropriate procedures.

2.1 Slope Water Level Meter Use

Set Sensitivity

To check that the unit is operational, turn the sensitivity knob on and press the test button on the face plate. The visual/audible alarm will be activated. If the battery is low, the audible alarm may be weak, and the battery should be replaced. The sensitivity knob switches the indicator on and sets sensitivity. To obtain the highest accuracy with the indicator, be sure to set the sensitivity for each well monitored. Setting 1, the lowest sensitivity, is for very saline (high total dissolved solids) or contaminated water. Setting 10, the highest sensitivity, is for low salinity (low total dissolved solids), fresh water. To determine the proper setting, turn the sensitivity knob to 10. Lower the probe until the indicator's light and buzzer signal that the probe is touching water. Raise the probe out of the water. Turn the sensitivity knob to a lower setting until the light and the buzzer turn off. Repeat these steps until the light and the buzzer turn off promptly when the probe is withdrawn from the water. To maintain accuracy, do not set sensitivity lower than necessary.

Read Cable Marks

White graduations are 1/100-foot; white numbers are 1/10-foot; and yellow numbers are feet. Foot numbers are set off with two marks. Use the lower mark (toward probe). Lower the probe down the standpipe until the indicator's light first turns on. With gloved fingers, pinch the cable where it emerges from the top of the standpipe. This marks the water level, assuming that the top of the standpipe is used as the reference.

2.2 Slope Water Level Meter Cleaning/Decontamination

Rinse probe and, at a minimum, the portion of cable which comes into contact with the interior of the well with distilled or deionized water between monitoring wells.

3.0 ORS OIL-WATER INTERFACE PROBE OR EQUIVALENT

This instrument will be used to measure the depths to groundwater and, if present, free-phase hydrocarbon in wells suspected or known to contain NAPL. It will be equipped with a minimum 100-foot reel with a built-in electronics module and signal cable. Graduations on the signal cable allow the depth to liquid to be read to 1/100 foot.

The procedures outlined below are for ORS oil-water interface probe meters. If an equivalent meter is used, refer to that instrument's User Manual for appropriate procedures.

3.1 ORS Oil-Water Interface Probe Use

Use of the probe is described below:

- To turn the unit on, unfold the crank handle away from the reel housing. This activates a power switch inside the reel.

- To verify that the unit is operational, press the test button on the face plate. If the power is ON, the visual/audible alarm will be activated. A low battery condition will cause the Low Battery indicator to be illuminated.

- To release the probe, pull the protector tube outward from the reel casing. To lower the probe, tilt the front of the reel housing forward and press the brake release. The brake release is located just forward of the handle. The tape will reel out as long as the brake release is depressed. Lower the probe into the well taking care not to allow the probe or tape to rub against the well casing. Refer to Appendix B of User's Manual for an alternative means of probe deployment.

- When the probe contacts liquid, the visual/audible alarm on the reel will be activated. An oscillating alarm indicates water, a continuous alarm indicates hydrocarbon. To measure the thickness of a hydrocarbon layer, the probe should be slowly lowered to the air/hydrocarbon interface until the alarm is activated. With the probe at the exact point where the alarm comes on, read the numbers on the tape to determine the distance from the top of the wellhead to the air/hydrocarbon interface. Next, lower the probe through the hydrocarbon layer and well into the water. An oscillating alarm will be obtained. The probe should then be raised slowly to the hydrocarbon/water interface until the point is reached where the alarm changes from oscillating to continuous. The thickness of the hydrocarbon layer is determined by subtracting the first reading from the second reading.

- After taking a measurement, snap the protector tube shut so that the wiper rests against the tape. Release the brake and slowly reel in the tape until the probe is just below the wiper. If free-phase hydrocarbon was encountered in the well, the oil should be cleaned from the tape and probe prior to reeling the oil covered tape/probe into the housing (see Section 3.2 below). Do not allow the probe to bottom out against the wiper, as this will apply stress to the tape. Next, open the protector tube and gently reel the probe 2/3 of the way into the tube. Forcibly reeling the probe all the way into the tube may stress or break the measuring tape. Now, turn the entire Interface Probe assembly upside down so that the probe falls the rest of the way into the protector tube. Make sure that the probe is entirely within the protector tube. Finally, close the protector tube.

3.2 ORS Oil-Water Interface Probe Cleaning/Decontamination

The probe and, at a minimum, the length of tape which came into contact with the interior of the well, shall be cleaned prior to reeling the tape/probe into the housing. Clean the tape/probe by first wiping off oil with a paper towel (or equivalent). Then clean in a non-phosphatic detergent wash, followed by a potable water rinse and a final distilled or deionized water rinse. If no free-phase hydrocarbon was encountered, the probe and the portion of tape which came into contact with the interior of the well should be rinsed with distilled or deionized water.

4.0 WATER LEVEL MEASUREMENTS

The following steps will be followed when performing groundwater elevation monitoring.

- Prior to starting water elevation monitoring, decontaminate the water level meter or oil-water interface probe and check that it is in proper working condition.

- Prior to opening the protective casing or flush-mount roadbox, clear away dirt, debris, or liquid from the vicinity of the monitoring well. Once the protective cover is removed, clean/remove debris from the interior of the casing/roadbox and around watertight seals. During this process, any damage to the roadbox, protective casing, or monitoring well should be recorded in the field book or field form.

- Measurements shall be collected from a previously marked measuring point on the riser (groundwater monitoring wells are typically marked on the PVC riser).

- If the highest point on the riser is too deep within the well casing to reach and/or read the measurement on the water level meter tape, the depth to water measurement shall be collected from the top of the protective casing. If not marked, measure to the highest point on the riser. The difference between the top of PVC riser and top of the protective casing in a flush-mount roadbox should also be measured using a tape measure.

- Measure and record the depth to water on the attached Water Level Worksheet to the nearest 0.01 feet. If non-aqueous phase liquid (NAPL) is known or suspected in a monitoring well, use an oil-water interface probe to check and measure the presence of a NAPL layer. Record the distance from the reference point to LNAPL/water interface on the Water Level Worksheet. An oil-water interface probe should be used only on monitoring locations with known or suspected NAPL.

- Secure the protective casing or flush-mount roadbox.
- Decontaminate the water level meter or oil-water interface probe using either a distilled or deionized water rinse (for a water level meter) or a non-phosphate detergent wash followed by a potable water rinse and a final distilled or deionized water rinse (for an oil-water interface probe).

5.0 CALCULATION OF GROUNDWATER ELEVATIONS

Measured groundwater levels are subtracted from reference elevations established by the site survey to calculate groundwater elevations.

6.0 GENERATION OF GROUNDWATER CONTOURS

Using data for groundwater elevations, groundwater contours can be developed using generally accepted hydrogeologic practices (linear interpolation and professional judgment). The contours are intended to depict inferred trends in groundwater flow conditions.

7.0 EQUIPMENT/SUPPLIES

- Electronic water level meter and/or oil-water interface probe
- Tape measure
- Decontamination equipment – refer to decontamination SOP B.11
- Field notebook
- Mohawk SAP
- Personal protective equipment (PPE)

8.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

Water Level Measurement Form

Sampler's Signature:

SANBORN HEAD

Project Number: 2158.01

Date:

Project Name: Mohawk Tannery Southern Parcel

Project Location: Nashua, NH

NHDES Site No.: 198404002

Water Level Meter:

Project Manager: T. White

Weather:

Collector:

Location	Reference Elev. (ft)	Reference Point	Date	Time	DTP (ft)	DTW (ft)	Water Elev. (ft)	Note Number(s)
Northern Parcel								
GZ-01	190.69	PVC						
GZ-04	128.72	PVC						
GZ-06	131.09	PVC						
GZ-09	131.26	PVC						
SH-01	189.68	PVC						
SH-02	158.86	PVC						
SH-03	152.67	PVC						
SH-04	135.33	PVC						
SH-05	140.80	PVC						
SH-06	151.31	PVC						
SH-07	162.85	PVC						
SH-08	192.47	PVC						
SH-09	161.63	PVC						
SH-10	160.45	PVC						
SH-11	174.31	PVC						
SH-12	175.53	PVC						
SH-14	128.80	PVC						
SH-15	133.56	PVC						
SH-16S	133.06	PVC						
SH-16D	133.27	PVC						
SH-17	130.10	PVC						
SH-18	142.33	PVC						
Southern Parcel								
GZ-10	125.80	PVC						
GZ-11	125.00	PVC						
GZ-13	123.70	PVC						
SH-13	174.42	PVC						
SH-19	130.19	PVC						
GZ-14	119.60	PVC						
Mini-piezometers								
PZ-01		SSR						
PZ-02		SSR						
PZ-03		SSR						
PZ-04		SSR						
PZ-05		SSR						
PZ-06		SSR						

Water Level Measurement Form

Sampler's Signature:

SANBORN HEAD

Project Number: 2158.01

Date:

Project Name: Mohawk Tannery Southern Parcel

Project Location: Nashua, NH

NHDES Site No.: 198404002

Water Level Meter:

Project Manager: T. White

Weather:

Collector:

Location	**Reference Elev. (ft)**	**Reference Point**	**Date**	**Time**	**DTP (ft)**	**DTW (ft)**	**Water Elev. (ft)**	**Note Number(s)**
PZ-07		SSR						
PZ-08		SSR						
PZ-09		SSR						
PZ-10		SSR						
PZ-11		SSR						
PZ-12		SSR						
PZ-13		SSR						
PZ-14		SSR						
PZ-15		SSR						
Other Locations								

Notes

1.

2.

3.

4.

5.

DTP = Depth to Product
DTW = Depth to Water
PVC = Top of PVC Well Riser
SSR = Top of Stainless Steel Riser

SOP B.6

CALIBRATION AND USE OF FIELD WATER QUALITY EQUIPMENT

TABLE OF CONTENTS

TABLES

ATTACHMENTS

1.0 SCOPE AND APPLICABILITY

This appendix identifies field equipment and calibration procedures to be used during groundwater and surface water sampling field activities at the Mohawk Tannery Site in Nashua, New Hampshire. Field equipment will be used and calibrated following this Standard Operating Procedure (SOP), which is based on the procedures provided in the equipment's User Manual. Table 6-1 provides field equipment calibration frequencies. Calibration will be documented on an Equipment Calibration Form that accompanies each piece of field equipment; a copy of this calibration form is included in this SOP.

Field equipment to be used during groundwater and surface water sampling activities includes:

- Hach 2100P Turbidity Meter (or equivalent)
- YSI Series 600 XL/XLM Sonde and YSI 650 MDS or equivalent with a transparent flow through cell (FTC) with a maximum capacity of 250 milliliters, including: dissolved oxygen (DO), temperature, pH, oxidation reduction potential (ORP) and specific conductivity probes. A sensor guard will be used when collecting surface water readings.

User Manuals of the instruments will be kept on-site during field activities. Historical documentation for Sanborn Head field equipment calibration and maintenance is filed at Sanborn Head's offices in Concord, New Hampshire.

Calibration standard values, check results, temperature and barometer checks, and maintenance for each piece of equipment shall be documented on the calibration logs and included in the reports. This information includes dates, personnel, calibration standards expiration dates, etc. A calibration log is provided at the end of this SOP.

Field water quality equipment procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 HACH 2100P TURBIDITY METER OR EQUIVALENT

This instrument will be used to measure turbidity levels in groundwater samples collected during low flow purging and in surface water during surface water screening. The Primary Standards used will be StablCal™ Standards (formazin standards which are premixed and come in concentrations of <0.1 nephelometric turbidity units [NTU], 20 NTU, 100 NTU, and 800 NTU) purchased from Hach. Calibration of the instrument is described below. The turbidity meter will be calibrated in the office a maximum of one week prior to use in the field. The calibration shall be checked daily prior to use and again at the end of the day to evaluate that the instrument has remained in calibration. A mid-day calibration check may also be performed. Should any erratic or illogical readings occur between calibrations, a calibration check should be performed on the instrument to evaluate that representative measurements are obtained. If a calibration check is not within the acceptable range for a parameter, the data collected since the last acceptable calibration or calibration check for that parameter shall be qualified in its use. This qualification shall be documented on the calibration log and the field sheets/logs for the appropriate sampling locations.

The procedures outlined below are for Hach 2100P turbidity meters. If an equivalent meter is used, refer to that instrument's Owner's Manual for appropriate procedures.

2.1 Hach 2100P Turbidity Meter Calibration Procedure

- The meter should be in the Auto Range. "Auto Rng" and 0.00 NTUs should show on the display. If not, press the range key until it is in the auto range and reading to two (2) decimal points (e.g., 0.00)

- Gently invert the standards to thoroughly mix the contents. (**DO NOT SHAKE**)

- Wipe the standards with a soft, lint free cloth or Kimwipe to make sure the outside surfaces are dry, free from fingerprints and dust.

- Insert the cell containing the <0.1 NTU standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid. Press **I/O**.

- Press: **CAL**. The "**CAL**" and "**SO**" icons will be displayed (the "0" will flash). The 4-digit display will show the value of the **SO** standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank. Press → to get a numerical display.

- Press: **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), read the blank. The display will automatically increment to the next standard. Remove the cell containing the <0.1 NTU standard from the cell compartment.

- The display will show the "**S1**" (with the 1 flashing) and "20 NTU" or the value of the **S1** standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. Insert the cell containing the 20 NTU standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

- Press: **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. The display will automatically increment to the next standard. Remove the cell containing the 20 NTU standard from the cell compartment.

- The display will show the "**S2**" (with the 2 flashing) and "100 NTU" or the value of the **S2** standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. Insert the cell containing the 100 NTU standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

- Press: **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then, the display will automatically increment to the next standard. Remove the cell containing the 100 NTU standard from the cell compartment.

- The display will show the "**S3**" (with the 3 flashing) and "800 NTU" or the value of the **S3** standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the ↑ key to scroll to the correct number. Insert the cell containing the 800 NTU standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

- Press: **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then the display will increment back to the **SO** display. Remove the cell containing the 800 NTU standard from the cell compartment.

- Press: **CAL** to accept the calibration. The instrument will return to measurement mode automatically.

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ**, **I/O**, ↑ and → keys function. Signal averaging and range mode must be selected before entering the calibration mode.

- If E1 or E2 are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (E1 or E2). To continue without repeating the calibration, press I/O twice to restore the previous calibration. If "**CAL?**" is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Recalibrate.

<u>Calibration Check</u>

The 2100P Turbidimeter does not require standardization before every measurement as some turbidimeters do. The calibration shall be checked at the end of the day of use to assess that the instrument has remained in calibration throughout the day. A mid-day calibration check may also be performed. In addition, should any erratic or illogical readings occur between calibrations, a calibration check should be performed on the instrument in order to evaluate that representative measurements are obtained. Check the instrument calibration using the 20 NTU StablCal™ standard. The standard should be properly aligned when inserting (diamond aligns with orientation mark). If the reading is not within 5% of the standard value, the instrument should be recalibrated with all the StablCal™ primary standards as described above, and the data collected since the last acceptable calibration or calibration check shall be qualified in its use. This qualification shall be documented on the calibration log and the field sheets/logs for the appropriate sampling locations.

2.2 Measurement of Turbidity of Groundwater Samples using the Hach 2100P Turbidity Meter

Use of the Hach 2100P Turbidity Meter, outlined below, is based on the User's manual.

- Collect a sample in a clean sample cell. Fill a sample cell to the indicated line, taking care to handle the sample cell by the top. For a groundwater sample the sample must be collected directly from the 3-way stopcock/valve located upstream of the FTC.

- Wipe the cell with a soft, lint-free cloth (e.g. Kimwipes® or equivalent) to remove water spots and fingerprints.

- Press: **I/O**. The instrument will turn on. Place the instrument on a flat, stable surface (above the ground surface). Do not hold the instrument while making measurements.

- Put the sample cell in the instrument's cell compartment so the orientation mark aligns with the raised orientation mark in front of the cell compartment. Close the cover.

- Select automatic range selection by pressing the **RANGE** key. The display will show "**AUTO RNG**" when the instrument is in automatic range selection.

- Select signal averaging mode by pressing the **SIGNAL AVERAGE** key. The display will show "**SIG AVG**" when the instrument is using signal averaging.

- Press: **READ**. After the lamp symbol turns off, record the turbidity value on the appropriate field sampling summary form.

- Close the sample compartment lid during measurement and storage. Do not leave a sample cell in the cell compartment for extended periods of time.

- Proper measurement techniques are important in limiting the effects of instrument variation, strong light and air bubbles.

- Measure samples immediately to limit temperature changes and settling. Particles suspended in the original sample may dissolve or otherwise change characteristics when the sample temperature changes. If it is necessary to set a full sample cell down, place it on its side wrapped in a dry lint-free cloth.

- Avoid operating in direct sunlight.

- Check to see if cold samples "fog" in the sample cell. If they do, re-wipe with a dry lint-free cloth.
- For measurements on very low turbidity samples, use a single sample cell for all measurements. Using one cell provides the best precision and repeatability.
- Use clean, dry sample cells that are in good condition. Dirty, scratched, wet or damaged cells can cause inaccurate readings.

2.3 Measurement of Turbidity of Surface Water using the Hach 2100P Turbidity Meter

- Refer to the Surface Water Sampling SOP B.8.
- Rinse out a turbidity vial downstream of the sampling location (if sufficient surface water is present).
- Collect an aliquot of water for the Hach at the same depth as the samples were collected and analyze the sample for turbidity as indicated above in Section 2.2. Record the NTU value on Surface Water Quality Sampling Summary Form.

2.4 Hach 2100P Turbidity Meter Cleaning/Decontamination

The inside and outside of the sample cells can be cleaned by washing with a non-phosphatic detergent wash, followed by multiple rinses with distilled or deionized water. Allow cells to air dry. Handle cells only by the top to minimize dirt, scratches and fingerprints in the light path. Furthermore, the glass used to make cells is easily scratched. If significant scratching of the sample cell is suspected either use another sample cell or minor imperfections can be effectively masked by applying silicon oil as outlined in Section 2.3.2 of the instrument's User's Manual.

3.0 YSI SERIES 600XL/XLM SONDE AND YSI 650 MDS (MULTIPARAMTER DISPLAY SYSTEM) OR EQUIVALENT

The instrument includes a handheld meter with display (YSI 650 MDS), a sonde unit with multiple sensors (YSI 600 XL/XLM), a 250 ml or less transparent FTC for low flow, and sensor guard for the end of the sonde for surface water field screening. This instrument will be used to screen groundwater during low flow sampling and to screen surface water during sampling and to assess stabilization of water quality parameters. The water quality parameters monitored include: temperature, specific conductance, pH, oxidation reduction potential (ORP) and DO. Note: pH and ORP are measured from a single probe. Prior to use the instrument will be configured to display temperature in °C, DO in milligrams per liter (mg/l), specific conductance in microSiemens per centimeter (µS/cm), and ORP in millivolts (mV).

The procedures outlined below are for YSI 600XL/XLM sonde and YSI 650 MDS systems. If an equivalent system is used, refer to that system's Owner's Manual for appropriate procedures.

3.1 Calibration Procedure

The instrument and calibration standards will be allowed to equilibrate to ambient temperature prior to calibration. The specific conductivity, pH, ORP, and DO probes will be calibrated following the manufacturer's instructions described below.

New buffer solutions will be used daily. ORP, pH, specific conductivity, and DO standards will be purchased from commercial vendors.

<u>Calibration Acceptance Criteria</u>
All field instruments shall be calibrated, and have a calibration check, in the office prior to the field event (within one week) to evaluate that the equipment is working properly and meets the QA criteria.

For this project, once the equipment is calibrated, and checked, prior to the sampling event, it is not necessary to recalibrate the instruments at the beginning of each sampling day. Instead, a calibration check shall be performed at the beginning of each sampling day to verify the instruments have remained in calibration.

If one or more parameters are not within the appropriate range during the beginning of the day calibration check, only those parameters shall be calibrated and the calibration shall be checked again, to verify the instrument was calibrated properly. If that calibration check is not within the acceptable range for any parameter, the instrument shall be recalibrated using all the standards for that parameter and the calibration shall be checked again. See individual parameters for specific instructions. If problems with the instrument continue, backup instruments shall be calibrated and used in place of the inoperable unit.

The calibration shall be checked again at the end of the day of use to verify that the instruments have remained in calibration throughout the day. In addition, should any erratic or illogical readings occur between calibrations, a calibration check should be performed on the instrument evaluate that representative measurements are obtained. All calibration and check values shall be documented on the calibration log maintained by each user (see attached log).

If a calibration check is not within the acceptable range for a parameter, the data collected since the last acceptable calibration or calibration check for that parameter shall be qualified in its use. This qualification shall be documented on the calibration log and the field sheets/logs for the appropriate sampling locations. For example: pH measurements are collected as part of the low flow sampling procedure. If a pH calibration check was not within the acceptable range, the pH data collected by that instrument since the last acceptable calibration or calibration check would be qualified as useful only for determining stabilization and not as representative pH measurements of the water being sampled. That qualification would then be documented on the calibration log and the sampling sheet for each of those locations. All calibration and check values shall be documented on the calibration log maintained by each user (see attached log).

Specific Conductivity Probe

- Specific conductance is the conductivity value corrected to 25°C. The specific conductivity probe will be calibrated following the procedure described below. A one-point calibration using a conductivity solution in the anticipated range of the samples to be screened that day will be used (e.g., 1,413 µS/cm, the minimum conductivity calibration standard value recommended by YSI).

- A calibration check will be completed on the probe immediately after calibration to check the calibration of the probe and operation of the instrument. A calibration check will be conducted using a second standard (e.g., 700 µS/cm), which will generally be used as a check on the linearity of the instrument. If the check is not within ±5% of the standard, recalibration is required.

- Another calibration check will be completed at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed. Calibration checks will be completed using the 700 µS/cm calibration standard as a sample. If the check is not within ±5% of the standard, the specific conductance data collected since the last acceptable calibration or calibration check shall be qualified in its use.

Specific Conductivity Calibration

1. Allow the calibration standards to equilibrate to the ambient temperature.
2. Remove the probe from its storage container, rinse the probe with a small amount of the first (1,413 µS/cm) specific conductance standard (discard the rinseate), and place the probe into the standard. Be sure that the temperature sensor and the probe's vent hole are immersed in the standard. Gently move the sonde up and down to dislodge any air bubbles from the conductivity cell.
3. Allow at least one minute for temperature equilibrium before proceeding.
4. Select the calibration mode for specific conductance. Enter the calibration value of the standard being used (1,413 µS/cm). Allow the temperature and specific conductance to stabilize. If the reading does not change within 30 seconds, press enter to accept the calibration.
5. To check the calibration, select the monitoring/run mode (a run/measurement screen). Remove the probe from the higher standard, rinse the probe with distilled water and then a small amount of the second, lower standard (discard the rinseate), and place the probe into the second (700 µS/cm) standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument. Record the value on the calibration log, and compare the value to the standard. The value must be ±5%. (665-735 µS/cm for the 700 µS/cm standard). If not, recalibrate using new standards and check again. If the re-

calibration does not correct the problem, clean the probe, consult the manufacturer/ vendor or replace the unit.

6. Remove probe from the specific conductance check standard, rinse with distilled water, and gently blot dry.

Dissolved Oxygen Probe

- Filter membranes and electrode solution on the dissolved oxygen probe will be replaced prior to initial equipment use. DO will be calibrated as described below. A one-point calibration will be completed using conditions of water-saturated air as the calibrating medium. The YSI instrument has a built in barometer that will be used to input local atmospheric pressure.

- A calibration check will be completed on the probe immediately after calibration to check the calibration of the probe. The value for water-saturated air displayed on the 650 MDS will first be compared with Table 6-2 (theoretical values of DO for given temperatures and barometric pressures) using ambient barometric pressure and temperature. The instrument should read ±10% of the appropriate value on Table 6-2, if not the instrument should be recalibrated. Next, check the calibration of the probe with a measurement of a zero mg/l DO standard prepared according to Standard Method 4500-OG or an equivalent purchased from a commercial vendor. The standard must be filled to the top of its container and the probe must fit tightly into the standard's container (no headspace). The instrument should read <0.5 mg/l and the value is not negative. If the instrument cannot reach this range, clean the probe, and change the membrane and electrolyte solution and recalibrate the instrument.

- An additional calibration check will be completed at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed. To perform calibration checks of the DO probe, take a measurement of a zero mg/l DO standard. If the measured DO value is not within 0-0.5 mg/l, the DO data collected since the last acceptable calibration or calibration check shall be qualified in its use.

DO Calibration/Calibration Check Procedure

1. Gently dry the temperature sensor according to manufacturer's instructions and inspect the DO membrane for air bubbles and nicks.

2. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container to create a 100 percent water-saturated air environment.

3. Loosely fit the DO probe into the calibration container to prevent the escape of moisture evaporating from the sponge or paper towel while maintaining ambient pressure (see manufacturer's instructions on attaching the calibration container to the instrument). Do not allow the probe to come in contact with the wet sponge or paper towel.

4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn on the instrument to allow the DO probe to warm-up according to the manufactures directions. Make sure that

both the DO reading and the temperature have stabilized before starting the calibration sequence.

5. Select calibration mode; then select "DO %".
6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument using an on-site hand held barometer, unless the instrument already has a temperature-compensated barometer.
7. Record the barometric pressure on the calibration log.
8. The instrument should indicate that the calibration is in progress. Observe the readings for percent dissolved oxygen and temperature. When they show no significant change for approximately 30 seconds, press enter. After calibration, the instrument should display dissolved oxygen in mg/L (% DO is only used for calibration).
9. Record the initial DO reading in mg/L and temperature reading in ˚C on the calibration log immediately after calibration.
10. To check the calibration in the run/measurement mode (on a run/measurement screen), remove the probe from the container and place it into a 0.0 (zero) mg/L DO standard. Do not put the DO probe back into the storage cup (w/sponge), prior to performing the zero check.
11. Wait until the "mg/L DO" and temperature readings have stabilized. Record the zero mg/L DO reading on the calibration log. The instrument must read 0 to 0.5 mg/L DO. If the instrument cannot reach this value, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this is unsuccessful, use a new 0.0 mg/L DO standard. If these measures are still unsuccessful, consult the manufacturer/vendor or replace the unit.
12. Remove probe from the zero DO standard, rinse with distilled water, and gently blot dry.

pH Probe

- pH will be calibrated following a 3-point calibration procedure as described below. Buffer solutions with pH values of 4.00, 7.00, and 10.00 will be used.

- A calibration check will be completed after calibration to assess that the probe has maintained accuracy. If the check is not within ±5% for pH 7.00, recalibration of all three pH standards is required.

- A calibration check will be completed at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed. If a calibration check is not within ±5% for pH 7.00, the pH data collected since the last acceptable calibration or calibration check shall be qualified in its use.

pH Calibration/Calibration Check Procedure

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

2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.
3. Remove probe from its storage container, rinse with distilled water, and gently blot dry with a Kimwipe. Use caution during drying that the dissolved oxygen probe membrane is not disturbed.
4. Select the calibration mode for a three point pH calibration.
5. Immerse probe into the initial standard, pH 7. Enter the buffered standard value (pH 7) into instrument. Wait until temperature and pH readings stabilize. If the readings do not change within 30 seconds, press enter to accept the calibration.
6. Remove probe from the initial standard, rinse with distilled water, and gently blot dry.
7. Immerse probe into the second standard (pH 4). Repeat step 5.
8. Remove probe from the second standard, rinse with distilled water, and gently blot dry.
9. Immerse probe in third buffered standard (pH-10) and repeat step *5.*
10. Remove probe from the third standard, rinse with distilled water, and gently blot dry.
11. To check the calibration in the run/measurement mode (on a run/measurement screen), immerse the probe into the pH 7 buffer solution. Wait for the temperature and pH readings to stabilize. Record the pH value on the calibration log. The value must be pH 7 ±5% (pH 6.65-7.35). If the calibration check failed re-calibrate the instrument using fresh standards for all three values and check it again. If re-calibration fails, clean the pH probe, consult the manufacture/vendor or replace the unit.
12. Remove probe from the pH 7 check standard, rinse with distilled water, and gently blot dry.

Oxidation Reduction Potential Probe

- ORP will be calibrated by placing the probe in a Zobell solution as outlined below.

- A calibration check will be completed immediately after calibration to determine whether the sensor is functioning correctly. This check will be completed by placing the sensor in a Zobell solution. The measured ORP must be within the range of ±5% mV at normal ambient temperature for use. If the reading is outside of the range, the probe can be calibrated to the correct value according to the temperature using the calibration procedure below.

  - ☐ Immerse probe in Zobell solution and allow temperature to stabilize, then read temperature.

  - ☐ Using Table 6-3 lookup the mV value for the stabilized temperature. Enter the temperature corrected to ORP value into the instrument.
  - ☐ A calibration should be performed to determine if probe is measuring within ±20 mV of temperature corrected value.

- A calibration check will be completed at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed. If a calibration check is not within ±5% mV at normal ambient temperature for use, the ORP data collected since the last acceptable calibration or calibration check shall be qualified in its use.

<u>ORP Calibration/Calibration Check Procedure</u>

1. Allow the Zobell solution calibration standard to equilibrate to ambient temperature.
2. Remove the probe from its storage container, rinse the probe with distilled water, gently blot dry with a Kimwipe and place it into the standard.
3. Select monitoring/run mode.
4. Wait for the probe temperature to stabilize, and then read the temperature. Record the temperature reading on the calibration log.
5. Look up the millivolt (mV) value at this temperature on Table 6-3. These values have been rounded to the nearest whole number. Record this value on the calibration log.
6. Select the calibration mode for ORP. Enter the temperature-corrected ORP value into the instrument. Once the temperature and ORP values stabilize, press enter to accept the calibration.
7. To check the calibration in the monitoring/run mode (on a run/measurement screen), immerse the probe in the Zobell solution, read the ORP on the instrument. Record the check value on the calibration log, and compare the value to the ORP value of the standard in step 5. The instrument value must be ±5% of the calibration value. See Table 6-3 for the check range. If it is not within ±5%, recalibrate using a new Zobell solution. If the re-calibration is not successful, consult the manufacture/vendor or replace the unit. For subsequent calibration checks, the instrument must be within ±5% of the mV value for the current temperature.
8. Remove the probe from the ORP check standard, rinse with distilled water, and gently blot dry.

3.2 Measurement of Temperature, Specific Conductance, pH, Oxidation Reduction Potential (ORP), and Dissolved Oxygen (DO) in Groundwater Using a Transparent Flow Through Cell (FTC)

Measurement of temperature, specific conductance, pH, ORP and DO using the YSI Series 600XL/XLM Sonde in groundwater with FTC is described below:

- Remove sensor guard from end of sonde if not already removed.

- Calibrate instrument as indicated above for DO, pH, ORP and specific conductance using standards as indicated above.

- Slide FTC onto the end of the sonde unit.

- At sampling location, connect sample tubing leading from the discharge end of the pump (Note: there will be a 3-way stopcock/valve installed upstream of the FTC on this section of tubing if turbidity is to be measured) onto the in-port located near the bottom of the FTC. Then connect a 2- to 4-foot section of tubing onto the out port located near the top of the FTC to reach into the graduated bucket to collect the total purge volume.

- The YSI Series 600XL/XLM Sonde is typically operated while laying horizontally in its system case on a table or other stable, level surface off the ground. However, the unit can be used vertically if operated on a level and stable surface.

- Sampling then begins as described in field SOP B.7.

- The lengths of discharge tubing outside of the monitoring well should be limited. The tubing and FTC should be shaded from the sun to minimize change in ground water temperature prior to sampling.

- As described in field SOP B.7, the formation of bubbles should be limited during low flow purging and sampling. Bubbles should not be allowed to collect in discharge tubing or the FTC, particularly along the outside of the DO probe. If necessary, the YSI Series 600XL/XLM Sonde with attached FTC and the discharge tubing located outside the well head can be raised and/or rotated to promote the passage of bubbles through the system.

- Readings of pH, ORP, specific conductance, temperature and DO should be logged from the handheld display unit onto the Low Flow Sampling Summary form at the time intervals specified in the field SOP B.7. When groundwater parameters have stabilized, or the two hour time limit has been reached, a sample shall be collected in the manner described in SOP B.7.

- Once the groundwater sample is collected, the YSI Series 600XL/XLM Sonde and FTC can be disconnected from the discharge tubing and disassembled. It is not necessary to decontaminate the probes and FTC between sample locations because the groundwater sample does not come into contact with the FTC because it is collected from the discharge tubing upstream of the FTC and 3-way stopcock/valve. However, the probes and FTC should be rinsed periodically with distilled water to wash off sediment which may accumulate.

3.3 Measurement of Temperature, Specific Conductance, pH, Oxidation Reduction Potential (ORP) and Dissolved Oxygen (DO) in Surface Water Using A Sensor Guard

Surface water samples are collected prior to measuring field parameters.

Measurement of temperature, specific conductance, pH, ORP and DO using the YSI Series 600XL/XLM Sonde in surface water is described below:

- Attach sensor guard to end of sonde if not already attached.
- Calibrate instrument as indicated above for DO, pH, ORP and specific conductance using standards as indicated above.
- With the probe guard on the YSI instrument, rinse the probes in the surface water downstream of the sampling location.
- The probes should be placed at the same depth as the samples were collected. Refer to the SOP B.8.
- It is important that there are no air bubbles on/in the electrode. To dislodge any bubbles, gently move the electrode through the water before recording the measurement. If the sample location is not accessible, a pole and strapping may be used to hold the probes in place for stabilization and readings.
- Allow a minimum of two minutes for the readings to stabilize and record readings on the Surface Water Quality Sampling Summary Form.
- It is not necessary to decontaminate the probes between sample locations because the probes are rinsed in the surface water at each location prior to collecting readings and they do not come in contact with samples.

3.4 Cleaning/Decontamination and Care/Maintenance

Cleaning/Decontamination

If the probes or the FTC show signs of contamination not removed by a distilled water rinse, the following procedure should be followed for cleaning the FTC.

- Remove the sonde from the FTC. Be sure to store the sonde in a damp location during the cleaning if the DO and pH probes are installed.
- Clean all of the parts with a non-phosphatic detergent wash followed by a potable water rinse. Do not use harsh solvents to clean the FTC.
- Inspect O-rings and the O-ring seats for damage that may prevent sealing. If the O-rings are damaged, replace them.

- Reassemble the FTC being sure to properly install the O-rings to limit the potential for leaks.

- The User Guide also recommends care and maintenance for the DO, conductivity, and pH probes in Section 2.10.2 of the Operation Manual/User's Guide.

Care and Maintenance of Dissolved Oxygen Probe

For best results, it is recommended that the potassium chloride (KCl) solution and the Teflon® membrane at the tip of the DO probe be changed prior to each probe deployment. Replacement of the membrane and KCl solution is described in Section 2.3.1 of the Operation Manual/User's Guide. In addition, the KCl solution and membrane should be changed if:

- Bubbles are visible under the membrane

- Significant deposits of dried electrolyte are visible on the membrane or the O-ring;

- If the probe shows unstable readings or other malfunction.

- If the DO Charge is outside the acceptable range of 25-75.

Care and Maintenance of Conductivity/Temperature Probe

The openings which allow fluid access to the conductivity electrodes should be cleaned regularly. The small brush included in the maintenance kit can be used for this purpose. Dip the brush in clean water and insert it into each hole 15 to 20 times. In the event that deposits have formed on the electrodes, it may be necessary to use a non-phosphatic detergent with the brush. After cleaning, check the response and accuracy of the conductivity cell with a calibration standard. The temperature portion of the probe requires no maintenance.

Care and Maintenance of Combination pH/ORP Probe

- Cleaning is required whenever deposits or contaminants appear on the glass probes. To clean the probe use the following procedure:

- Remove the probe from the sonde.

- Use clean water and a clean cloth to remove all foreign material from the glass probe.

- Carefully remove any material which may be blocking the circular reference electrode junction of the sensor.

- Dry the probe port and probe connector with compressed air and apply a very thin coat of O-ring lubricant to all O-rings before re-installation.

- Reinstall the probe for use or place the probe in the storage container for storage.

- When being moved between sampling locations, the sonde should be stored attached to the FTC with a small amount of deionized water in order to keep probes moist.

- For storage overnight or up to one week, the manufacturer recommends leaving the probe in the sonde and storing the sonde in the FTC or storage cap containing either a wet sponge or approximately ¼-inch of water.

- For storage longer than one week, the manufacturer recommends removing the pH probe and storing it in a solution of pH 4 buffer solution. The storage bottle in which the pH probe arrived can be used for this purpose. Install a plug in the vacant probe port and place the sonde in the FTC containing approximately ½-inch of tap water.

4.0 YSI 556 MPS (MULTIPROBE SYSTEM)

In some instances, a YSI 556 MPS may be used in lieu of the YSI 600 XL/XLM unit. The meters have similar capabilities. A primary difference between the YSI 600 XL/XLM and 556 MPS units is that the DO probe on the 556 MPS consists of a removable membrane cap, as opposed to the o-ring/membrane on the 600 XL/XLM. The 556 MPS instrument includes a handheld meter with display, which includes a sonde unit with multiple sensors, a 250 ml or less transparent FTC for low flow sampling, and sensor guard for the end of the sonde for surface water field screening. This instrument will be used to screen groundwater during low flow sampling and to screen surface water during sampling and to assess stabilization of water quality parameters. The water quality parameters monitored include: temperature, specific conductance, pH, ORP, and DO. Prior to use, the instrument will be configured to display temperature in °C, pH in standard units, DO in mg/l, specific conductance in µS/cm, and ORP in mV.

The procedures outlined below are for YSI 556 MPS systems. If an equivalent system is used, refer to that system's Owner's Manual for appropriate procedures.

4.1 Calibration Procedure

The instrument and calibration standards will be allowed to equilibrate to ambient temperature prior to calibration. The specific conductivity, pH, ORP, and DO probes will be calibrated following the manufacturer's instructions described below.

New buffer solutions will be used daily. ORP, pH, specific conductivity, and DO standards will be purchased from commercial vendors.

<u>Calibration Acceptance Criteria</u>
All field instruments shall be calibrated, and have a calibration check, in the office prior to the field event (within one week) to evaluate that the equipment is working properly and meets the QA criteria.

For this project, once the equipment is calibrated, and checked, prior to the sampling event, it is not necessary to recalibrate the instruments at the beginning of each sampling day.

Instead, a calibration check shall be performed at the beginning of each sampling day to verify the instruments have remained in calibration.

If one or more parameters are not within the appropriate range during the beginning of the day calibration check, only those parameters shall be calibrated and the calibration shall be checked again, to verify the instrument was calibrated properly. If that calibration check is not within the acceptable range for any parameter, the instrument shall be recalibrated using all the standards for that parameter and the calibration shall be checked again. See individual parameters for specific instructions. If problems with the instrument continue, backup instruments shall be calibrated and used in place of the inoperable unit.

The calibration shall be checked again at the end of the day of use to verify that the instruments have remained in calibration throughout the day. In addition, should any erratic or illogical readings occur between calibrations, a calibration check should be performed on the instrument evaluate that representative measurements are obtained. All calibration and check values shall be documented on the calibration log maintained by each user (see attached log).

If a calibration check is not within the acceptable range for a parameter, the data collected since the last acceptable calibration or calibration check for that parameter shall be qualified in its use. This qualification shall be documented on the calibration log and the field sheets/logs for the appropriate sampling locations. For example: pH measurements are collected as part of the low flow sampling procedure. If a pH calibration check was not within the acceptable range, the pH data collected by that instrument since the last acceptable calibration or calibration check would be qualified as useful only for determining stabilization and not as representative pH measurements of the water being sampled. That qualification would then be documented on the calibration log and the sampling sheet for each of those locations. All calibration and check values shall be documented on the calibration log maintained by each user (see attached log).

<u>Specific Conductivity Probe</u>

- Specific conductance is the conductivity value corrected to 25°C. The specific conductivity probe will be calibrated following the procedure described below. A one-point calibration using a conductivity solution in the anticipated range of the samples to be screened that day will be used (e.g., 1,413 µS/cm, the minimum conductivity calibration standard value recommended by YSI).

- A calibration check will be completed on the probe immediately after calibration to check the calibration of the probe and operation of the instrument. A calibration check will be conducted using a second standard (e.g., 700 µS/cm), which will generally be used as a check on the linearity of the instrument. If the check is not within ±5% of the standard, recalibration is required.

- Another calibration check will completed once at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed.

Calibration checks will be completed using the 700 µS/cm calibration standard as a sample. If the check is not within ±5% of the standard, the specific conductance data collected since the last acceptable calibration or calibration check shall be qualified in its use.

Specific Conductivity Calibration

1. Allow the calibration standards to equilibrate to the ambient temperature.
2. Remove the probe from its storage container, rinse the probe with a small amount of the first (1,413 µS/cm) specific conductance standard (discard the rinseate), and place the probe into the standard. Be sure that the temperature sensor and the probe's vent hole are immersed in the standard. Gently move the sonde up and down to dislodge any air bubbles from the conductivity cell.
3. Allow at least one minute for temperature equilibrium before proceeding.
4. Select the calibration mode for specific conductance. Enter the calibration value of the standard being used (1,413 µS/cm). Allow the temperature and specific conductance to stabilize. If the reading does not change within 30 seconds, press enter to accept the calibration.
5. To check the calibration, select the monitoring/run mode (a run/measurement screen). Remove the probe from the higher standard, rinse the probe with distilled water and then a small amount of the second, lower standard (discard the rinseate), and place the probe into the second (700 µS/cm) standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument. Record the value on the calibration log, and compare the value to the standard. The value must be ±5%. (665-735 µS/cm for the 700 µS/cm standard). If not, recalibrate using new standards and check again. If the re-calibration does not correct the problem, clean the probe, consult the manufacturer/ vendor or replace the unit.
6. Remove probe from the specific conductance check standard, rinse with distilled water, and gently blot dry.

Dissolved Oxygen Probe

- Membrane caps and electrode solution on the dissolved oxygen probe will be replaced prior to initial equipment use. DO will be calibrated as described below. A one-point calibration will be completed using conditions of water-saturated air as the calibrating medium. A barometer will be used to input local atmospheric pressure.

- A calibration check will be completed on the probe immediately after calibration to check the calibration of the probe. The value for water-saturated air displayed on the 556 MPS will first be compared with Table 6-2 (theoretical values of DO for given temperatures and barometric pressures) using ambient barometric pressure and temperature. The instrument should read ±10% of the appropriate value on Table 6-2, if not the instrument should be recalibrated. Next, check the calibration of the probe with a measurement of a zero mg/l DO standard prepared according to Standard

Method 4500-OG or an equivalent purchased from a commercial vendor. The standard must be filled to the top of its container and the probe must fit tightly into the standard's container (no headspace). The instrument should read <0.5 mg/l and the value is not negative. If the instrument cannot reach this range, clean the probe and change the membrane cap and electrolyte solution and recalibrate the instrument.

- An additional calibration check will be completed at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed. To perform this check of the calibration of the DO probe, take a measurement of a zero mg/l DO standard. If the measured DO value is not within 0-0.5 mg/l, the DO data collected since the last acceptable calibration or calibration check shall be qualified in its use.

<u>DO Calibration/Calibration Check Procedure</u>

1. Gently dry the temperature sensor according to manufacturer's instructions and inspect the DO membrane for air bubbles and nicks.
2. Place a wet sponge or a small volume of clean water on the bottom of the DO calibration container to create a 100 percent water-saturated air environment.
3. Loosely fit the DO probe into the calibration container to prevent the escape of moisture evaporating from the sponge or paper towel while maintaining ambient pressure (see manufacturer's instructions on attaching the calibration container to the instrument). Do not allow the probe to come in contact with the wet sponge or paper towel.
4. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). During this time, turn on the instrument to allow the DO probe to warm-up according to the manufactures directions. Make sure that both the DO reading and the temperature have stabilized before starting the calibration sequence.
5. Select calibration mode; then select "DO %".
6. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument using an on-site hand held barometer, unless the instrument already has a temperature-compensated barometer.
7. Record the barometric pressure on the calibration log.
8. The instrument should indicate that the calibration is in progress. Observe the readings for percent dissolved oxygen and temperature. When they show no significant change for approximately 30 seconds, press enter. After calibration, the instrument should display dissolved oxygen in mg/L (% DO is only used for calibration).
9. Record the initial DO reading in mg/L and temperature reading in ˚C on the calibration log immediately after calibration.
10. To check the calibration in the run/measurement mode (on a run/measurement screen), remove the probe from the container and place it into a zero mg/L DO

standard. Do not put the DO probe back into the storage cup (w/sponge), prior to performing the zero check.

11. Wait until the "mg/L DO" and temperature readings have stabilized. Record the zero mg/L DO reading on the calibration log. The instrument must read 0 to 0.5 mg/L DO. If the instrument cannot reach this value, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this is unsuccessful, use a new zero mg/L DO standard. If these measures are still unsuccessful, consult the manufacturer/vendor or replace the unit.
12. Remove probe from the zero DO standard, rinse with distilled water, and gently blot dry.

<u>pH Probe</u>

- pH will be calibrated following a 3-point calibration procedure as described below. Buffer solutions with pH values of 4, 7, and 10 will be used.
- A calibration check will be completed after calibration to assess that the probe has maintained accuracy. If the check is not within ±5% for pH 7, recalibration of all three pH standards is required.
- A calibration check will be completed at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed. If a calibration check is not within ±5% for pH 7, the pH data collected since the last acceptable calibration or calibration check shall be qualified in its use.

<u>pH Calibration/Calibration Check Procedure</u>

1. Allow the buffered standards to equilibrate to the ambient temperature.
2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.
3. Remove probe from its storage container, rinse with distilled water, and gently shake excess water off or gently blot dry with a Kimwipe. Use caution during drying that the dissolved oxygen probe membrane is not disturbed.
4. Select the calibration mode for a three point pH calibration.
5. Immerse probe into the initial standard, pH 7. Enter the temperature-corrected buffered standard value (pH 7) into instrument (refer to Table B.6-4). Wait until temperature and pH readings stabilize. If the readings do not change within 30 seconds, press enter to accept the calibration.
6. Remove probe from the initial standard, rinse with distilled water, and gently shake excess water off or blot dry.
7. Immerse probe into the second standard (pH 4). Repeat step 5.
8. Remove probe from the second standard, rinse with distilled water, and gently shake excess water off or blot dry.

9. Immerse probe in third buffered standard (pH-10) and repeat step *5.*
10. Remove probe from the third standard, rinse with distilled water, and gently shake excess water off or blot dry.
11. To check the calibration in the run/measurement mode (on a run/measurement screen), immerse the probe into the pH 7 buffer solution. Wait for the temperature and pH readings to stabilize. Record the pH value on the calibration log. The value must be pH 7 ±5% (pH 6.65-7.35). If the calibration check failed re-calibrate the instrument using fresh standards for all three values and check it again. If re-calibration fails, clean the pH probe, consult the manufacture/vendor or replace the unit.
12. Remove probe from the pH 7 check standard, rinse with distilled water, and gently blot dry.

Oxidation Reduction Potential Probe

- ORP will be calibrated by placing the probe in a Zobell solution as outlined below.
- A calibration check will be completed immediately after calibration to determine whether the sensor is functioning correctly. This check will be completed by placing the sensor in a Zobell solution. The measured ORP must be within the range of ±5% mV at normal ambient temperature for use. If the reading is outside of the range, the probe can be calibrated to the correct value according to the temperature using the calibration procedure below.
    - Immerse probe in Zobell solution and allow temperature to stabilize, the read temperature.
    - Using Table 6-3 lookup the mV value for the stabilized temperature. Enter the temperature corrected to ORP value into the instrument.
    - A calibration should be performed to determine if probe is measuring within ±20 mV of the temperature corrected value.
- A calibration check will be completed at the end of the day to assess that the probe has maintained accuracy. A mid-day calibration check may also be performed. If a calibration check is not within ±5% mV at normal ambient temperature for use, the ORP data collected since the last acceptable calibration or calibration check shall be qualified in its use.

ORP Calibration/Calibration Check Procedure

1. Allow the Zobell solution calibration standard to equilibrate to ambient temperature.
2. Remove the probe from its storage container and rinse the probe with distilled water.
3. Select monitoring/run mode.
4. Wait for the probe temperature to stabilize, and then read the temperature. Record the temperature reading on the calibration log.

5. Look up the millivolt (mV) value at this temperature on Table 6-3. These values have been rounded to the nearest whole number. Record this value on the calibration log.
6. Select the calibration mode for ORP. Enter the temperature-corrected ORP value into the instrument. Once the temperature and ORP values stabilize, press enter to accept the calibration.
7. To check the calibration in the monitoring/run mode (on a run/measurement screen), immerse the probe in the Zobell solution, read the ORP on the instrument. Record the check value on the calibration log, and compare the value to the ORP value of the standard in step 5. The instrument value must be ±5% of the calibration value. See Table 6-3 for the check range. If it is not within ±5%, recalibrate using a new Zobell solution. If the re-calibration is not successful, consult the manufacture/vendor or replace the unit. For subsequent calibration checks, the instrument must be within ±5% of the mV value for the current temperature.
8. Remove the probe from the ORP check standard and rinse with distilled water.

4.2 Measurement of Temperature, Specific Conductance, pH, Oxidation Reduction Potential (ORP), and Dissolved Oxygen in Groundwater Using a Transparent Flow Through Cell (FTC)

Measurement of temperature, specific conductance, pH, ORP, and DO using the YSI 556 MPS in groundwater with FTC is described below:

- Remove sensor guard from end of sonde if not already removed.
- Calibrate instrument as indicated above for DO, pH, ORP and specific conductance.
- Slide FTC onto the end of the sonde unit.
- At sampling location, connect sample tubing leading from the discharge end of the pump (Note: there will be a 3-way stopcock/valve installed upstream of the FTC on this section of tubing if turbidity is to be measured) onto the in-port located near the bottom of the FTC. Then connect a 2- to 4-foot section of tubing onto the out port located near the top of the FTC to reach into the graduated bucket to collect the total purge volume.
- The YSI 556 MPS is typically operated vertically while connected to the FTC, but may be operated laying horizontally in its system case on a table or other stable, level surface off the ground.
- Sampling then begins as described in field SOP B.7.
- The lengths of discharge tubing outside of the monitoring well should be limited. The tubing and FTC should be shaded from the sun to minimize change in groundwater temperature prior to sampling.
- As described in field SOP B.7, the formation of bubbles should be limited during low flow purging and sampling. Bubbles should not be allowed to collect in discharge tubing or the FTC, particularly along the outside of the DO probe. If necessary, the YSI

556 MPS with attached FTC and the discharge tubing located outside the well head can be raised and/or rotated to promote the passage of bubbles through the system.

- Readings of pH, ORP, specific conductance, temperature and DO should be logged from the handheld display unit onto the Low Flow Sampling Summary form at the time intervals specified in the field SOP B.7. When groundwater parameters have stabilized, or the two hour time limit has been reached, a sample shall be collected in the manner described in SOP B.7.
- Once the groundwater sample is collected, the YSI 556 MPS and FTC can be disconnected from the discharge tubing and disassembled. It is not necessary to decontaminate the probes and FTC between sample locations because the groundwater sample does not come into contact with the FTC because it is collected from the discharge tubing upstream of the FTC and 3-way stopcock/valve. However, the probes and FTC should be rinsed periodically with distilled water to wash off sediment which may accumulate.

4.3 Measurement of Temperature, Specific Conductance, pH, Oxidation Reduction Potential (ORP) and Dissolved Oxygen (DO) in Surface Water Using A Sensor Guard

Surface water samples are collected prior to measuring field parameters.

Measurement of temperature, specific conductance, pH, ORP and DO using the YSI 556 MPS Sonde in surface water is described below:

- Attach sensor guard to end of sonde if not already attached.
- Calibrate instrument as indicated above for DO, pH, ORP and specific conductance using standards as indicated above.
- With the probe guard on the YSI instrument, rinse the probes in the surface water downstream of the sampling location.
- The probes should be placed at the same depth as the samples were collected. Refer to the SOP B.8.
- It is important that there are no air bubbles on/in the electrode. To dislodge any bubbles, gently move the electrode through the water before recording the measurement. If the sample location is not accessible, a pole and strapping may be used to hold the probes in place for stabilization and readings.
- Allow a minimum of two minutes for the readings to stabilize and record readings on the Surface Water Quality Sampling Summary Form.
- It is not necessary to decontaminate the probes between sample locations because the probes are rinsed in the surface water at each location prior to collecting readings and they do not come in contact with samples.

4.4 Cleaning/Decontamination and Care/Maintenance

Cleaning/Decontamination
If the probes or the FTC show signs of contamination not removed by a distilled water rinse, the following procedure should be followed for cleaning the FTC.

- Remove the sonde from the FTC. Be sure to store the sonde in a damp location during the cleaning if the DO and pH/ORP probes are installed.
- Clean all of the parts with a non-phosphatic detergent wash followed by a potable water rinse. Do not use harsh solvents to clean the FTC.
- Inspect O-rings and the O-ring seats for damage that may prevent sealing. If the O-rings are damaged, replace them.
- Reassemble the FTC being sure to properly install the O-rings to ensure there will be no leaks.
- The User's Guide also recommends care and maintenance for the DO, conductivity, and pH probes in Section 11.

Care and Maintenance of Dissolved Oxygen Probe
For best results, it is recommended that the potassium chloride (KCl) solution and the membrane cap be changed at least once every 30 days. Replacement of the membrane cap and KCl solution is described in Section 11.1.1 of the Operation Manual/User's Guide. In addition, the KCl solution and/or membrane should be re-installed/changed if:

- Bubbles are visible under the membrane
- Significant deposits of dried electrolyte are visible on the membrane or the O-ring;
- If the probe shows unstable readings or other malfunction.
- If the DO Charge (if equipped) is outside the acceptable range of 25-75.

Care and Maintenance of Conductivity/Temperature Probe
The openings which allow fluid access to the conductivity electrodes should be cleaned regularly. The small brush included in the maintenance kit can be used for this purpose. Dip the brush in clean water and insert it into each hole 15 to 20 times. In the event that deposits have formed on the electrodes, it may be necessary to use a non-phosphatic detergent with the brush. After cleaning, check the response and accuracy of the conductivity cell with a calibration standard. The temperature portion of the probe requires no maintenance.

Care and Maintenance of Combination pH/ORP Probe
- Cleaning is required whenever deposits or contaminants appear on the glass probes. To clean the probe use the following procedure:
- Remove the probe from the sonde.
- Use clean water and a clean cloth to remove all foreign material from the glass probe.

- Carefully remove any material which may be blocking the circular reference electrode junction of the sensor.
- Dry the probe port and probe connector with compressed air and apply a very thin coat of O-ring lubricant to all O-rings before re-installation.
- Reinstall the probe for use or place the probe in the storage container for storage.
- When being moved between sampling locations, the sonde should be stored attached to the FTC with a small amount of distilled or deionized water in order to keep probes moist.
- For storage overnight or up to one week, the manufacturer recommends leaving the probe in the sonde and storing the sonde in the FTC or storage cup containing either a wet sponge or approximately ¼-inch of water.
- For storage longer than one week, the manufacturer recommends removing the pH/ORP probe and storing it in a solution of pH 4 buffer solution. The storage bottle in which the pH probe arrived can be used for this purpose. Install a plug in the vacant probe port and place the sonde in the FTC or storage cup containing approximately ¼-inch of tap water.

5.0 DATA AND RECORDS MANAGEMENT

All calibration information must be documented on the attached calibration log, including the instrument manufacturer, model number and identification number; standards used to calibrate the instruments (including source, lot numbers and expiration dates); date; personnel; the instrument readings, barometer reading, DO membrane inspection, changed DO membrane and solution, etc. Each daily calibration log shall be dated and signed by the user. All calibration information/forms shall be included in the data reports.

6.0 HEALTH AND SAFETY WARNINGS

Refer to the Health and Safety Plan for all task-specific health and safety warnings.

TABLE B.6-1
Field Equipment Calibration Schedule
Mohawk Tannery – Southern Parcel
Sampling and Analysis Plan
Nashua, New Hampshire

Instrument	Activity	Minimum Calibration & Calibration Check Frequency	Calibration Check Acceptance Criteria	Corrective Action
YSI Series 600XL/XLM Sonde and YSI 556 MPS	Groundwater Sampling by Low Flow Procedure and Field Screening, and Surface Water Field Screening	N/A	N/A	N/A
Dissolved Oxygen Probe		Daily Calibration Check at the beginning of each day Calibration of any parameter not within range during the calibration check Calibration Check at the end of the day	±10% of water-saturated air and 0-0.5 mg/l (zero DO)	**Morning Calibration Check** -If outside the criteria during the morning check, calibrate only the parameter(s) that was out of range. If still out of range replace the appropriate calibration standards and recalibrate/check. If recalibration is unsuccessful, replace the unit. **Mid-Day and End of Day Calibration Checks –** If outside the criteria, the data collected since last acceptable calibration or calibration check will be qualified by Sanborn Head. Recalibrate the parameter(s) that was out of range. If still out of range, replace the appropriate calibration standards and recalibrate/check. If recalibration is unsuccessful, replace the unit.
pH Probe			±5% for pH 7	
Specific Conductivity Probe			±5%	
ORP Probe			±5%	
Hatch 2100P Turbidity Meter			±5% for 20 NTU with StablCal™ standards	

N/A = Not applicable

TABLE B.6-2
Dissolved Oxygen Concentration Variance With Temperature and Barometric Pressure
Mohawk Tannery – Southern Parcel
Sampling and Analysis Plan
Nashua, New Hampshire

BAROMETRIC PRESSURE

TEMP, °C	DISSOLVED OXYGEN CONCENTRATION, mg/L									
	BAROMETRIC PRESSURE, MILLIMETERS OF MERCURY									
	735	740	745	750	755	760	765	770	775	780
0	14.12	14.22	14.31	14.41	14.51	14.60	14.70	14.80	14.89	14.99
1	13.73	13.82	13.92	14.01	14.10	14.20	14.29	14.39	14.48	14.57
2	13.36	13.45	13.54	13.63	13.72	13.81	13.90	14.00	14.09	14.18
3	13.00	13.09	13.18	13.27	13.36	13.45	13.53	13.62	13.71	13.80
4	12.66	12.75	12.83	12.92	13.01	13.09	13.18	13.27	13.35	13.44
5	12.33	12.42	12.50	12.59	12.67	12.76	12.84	12.93	13.01	13.10
6	12.02	12.11	12.19	12.27	12.35	12.44	12.52	12.60	12.68	12.77
7	11.72	11.80	11.89	11.97	12.05	12.13	12.21	12.29	12.37	12.45
8	11.44	11.52	11.60	11.67	11.75	11.83	11.91	11.99	12.07	12.15
9	11.16	11.24	11.32	11.40	11.47	11.55	11.63	11.70	11.78	11.86
10	10.90	10.98	11.05	11.13	11.20	11.28	11.35	11.43	11.50	11.58
11	10.65	10.72	10.80	10.87	10.94	11.02	11.09	11.16	11.24	11.31
12	10.41	10.48	10.55	10.62	10.69	10.77	10.84	10.91	10.98	11.05
13	10.17	10.24	10.31	10.38	10.46	10.53	10.60	10.67	10.74	10.81
14	9.95	10.02	10.09	10.16	10.23	10.29	10.36	10.43	10.50	10.57
15	9.73	9.80	9.87	9.94	10.00	10.07	10.14	10.21	10.27	10.34
16	9.53	9.59	9.66	9.73	9.79	9.86	9.92	9.99	10.06	10.12
17	9.33	9.39	9.46	9.52	9.59	9.65	9.72	9.78	9.85	9.91
18	9.14	9.20	9.26	9.33	9.39	9.45	9.52	9.58	9.64	9.71
19	8.95	9.01	9.07	9.14	9.20	9.26	9.32	9.39	9.45	9.51
20	8.77	8.83	8.89	8.95	9.02	9.08	9.14	9.20	9.26	9.32
21	8.60	8.66	8.72	8.78	8.84	8.90	8.96	9.02	9.08	9.14
22	8.43	8.49	8.55	8.61	8.67	8.73	8.79	8.84	8.90	8.96
23	8.27	8.33	8.39	8.44	8.50	8.56	8.62	8.68	8.73	8.79
24	8.11	8.17	8.23	8.29	8.34	8.40	8.46	8.51	8.57	8.63
25	7.96	8.02	8.08	8.13	8.19	8.24	8.30	8.36	8.41	8.47
26	7.82	7.87	7.93	7.98	8.04	8.09	8.15	8.20	8.26	8.31
27	7.68	7.73	7.79	7.84	7.89	7.95	8.00	8.06	8.11	8.17
28	7.54	7.59	7.65	7.70	7.75	7.81	7.86	7.91	7.97	8.02
29	7.41	7.46	7.51	7.57	7.62	7.67	7.72	7.78	7.83	7.88
30	7.28	7.33	7.38	7.44	7.49	7.54	7.59	7.64	7.69	7.75
31	7.16	7.21	7.26	7.31	7.36	7.41	7.46	7.51	7.46	7.62
32	7.04	7.09	7.14	7.19	7.24	7.29	7.34	7.39	7.44	7.49
33	6.92	6.97	7.02	7.07	7.12	7.17	7.22	7.27	7.31	7.36
34	6.80	6.85	6.90	6.95	7.00	7.05	7.10	7.15	7.20	7.24
35	6.69	6.74	6.79	6.84	6.89	6.93	6.98	7.03	7.08	7.13
36	6.59	6.63	6.68	6.73	6.78	6.82	6.87	6.92	6.97	7.01
37	6.48	6.53	6.57	6.62	6.67	6.72	6.76	6.81	6.86	6.90
38	6.38	6.43	6.47	6.52	6.56	6.61	6.66	6.70	6.75	6.80
39	6.28	6.33	6.37	6.42	6.46	6.51	6.56	6.60	6.65	6.69
40	6.18	6.23	6.27	6.32	6.36	6.41	6.46	6.50	6.55	6.59

*Source: J. Colt, Department of Civil Engineering, University of California, Davis.

TABLE B.6-3
Concentration of Zobell Solution at Various Temperatures
Mohawk Tannery – Southern Parcel
Sampling and Analysis Plan
Nashua, New Hampshire

Zobell Solution mV Values Based on Temperature for ORP Calibration
Calibration Check Range Values (±5%)

Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values ±5%	Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values ±5%	Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values ±5%
-3	267	254-280	10	251	238-264	23	234	222-246
-2	266	253-279	11	249	237-261	24	232	220-244
-1	265	252-278	12	248	236-260	25	231	219-243
0	264	251-277	13	247	235-259	26	230	219-242
1	262	249-275	14	245	233-257	27	228	217-239
2	261	248-274	15	244	232-256	28	227	216-238
3	260	247-273	16	243	231-255	29	226	215-237
4	258	245-271	17	241	229-253	30	225	214-236
5	257	244-270	18	240	228-252	31	223	212-234
6	256	243-269	19	239	227-251	32	222	211-233
7	254	241-267	20	238	226-250	33	221	210-232
8	253	240-266	21	236	224-248	34	219	208-230
9	252	239-265	22	235	223-247	35	218	207-229

TABLE B.6-4
Concentration of pH Buffers at Various Temperatures
Mohawk Tannery – Southern Parcel Sampling and Analysis Plan
Nashua, New Hampshire

Temp. °C	Buffer Value					
	pH 4.01	**Calibration Check Range Values ±5%**	**pH 7.01**	**Calibration Check Range Values ±5%**	**pH 10.01**	**Calibration Check Range Values ±5%**
0	4.01	3.81 - 4.21	7.13	6.77 - 7.49	10.32	9.80 - 10.84
1	4.01	3.81 - 4.21	7.12	6.77 - 7.48	10.30	9.79 - 10.82
2	4.01	3.81 - 4.21	7.12	6.76 - 7.47	10.29	9.77 - 10.80
3	4.00	3.80 - 4.20	7.11	6.76 - 7.47	10.27	9.76 - 10.79
4	4.00	3.80 - 4.20	7.11	6.75 - 7.46	10.26	9.74 - 10.77
5	4.00	3.80 - 4.20	7.10	6.75 - 7.46	10.24	9.73 - 10.75
6	4.00	3.80 - 4.20	7.09	6.74 - 7.45	10.23	9.72 - 10.74
7	4.00	3.80 - 4.20	7.09	6.73 - 7.44	10.22	9.71 - 10.73
8	4.00	3.80 - 4.20	7.08	6.73 - 7.44	10.20	9.69 - 10.71
9	4.00	3.80 - 4.20	7.08	6.72 - 7.43	10.19	9.68 - 10.70
10	4.00	3.80 - 4.20	7.07	6.72 - 7.42	10.18	9.67 - 10.69
11	4.00	3.80 - 4.20	7.06	6.71 - 7.42	10.17	9.66 - 10.68
12	4.00	3.80 - 4.20	7.06	6.71 - 7.41	10.16	9.65 - 10.66
13	4.00	3.80 - 4.20	7.05	6.70 - 7.40	10.14	9.64 - 10.65
14	4.00	3.80 - 4.20	7.05	6.69 - 7.40	10.13	9.63 - 10.64
15	4.00	3.80 - 4.20	7.04	6.69 - 7.39	10.12	9.61 - 10.63
16	4.00	3.80 - 4.20	7.04	6.69 - 7.39	10.11	9.60 - 10.61
17	4.00	3.80 - 4.20	7.04	6.68 - 7.39	10.10	9.59 - 10.60
18	4.00	3.80 - 4.20	7.03	6.68 - 7.39	10.08	9.58 - 10.59
19	4.00	3.80 - 4.20	7.03	6.68 - 7.38	10.07	9.57 - 10.58
20	4.00	3.80 - 4.20	7.03	6.68 - 7.38	10.06	9.56 - 10.56
21	4.00	3.80 - 4.20	7.03	6.67 - 7.38	10.05	9.55 - 10.55
22	4.00	3.80 - 4.20	7.02	6.67 - 7.37	10.04	9.54 - 10.54
23	4.01	3.81 - 4.21	7.02	6.67 - 7.37	10.03	9.53 - 10.53
24	4.01	3.81 - 4.21	7.01	6.66 - 7.36	10.02	9.52 - 10.52
25	4.01	3.81 - 4.21	7.01	6.66 - 7.36	10.01	9.51 - 10.51
26	4.01	3.81 - 4.21	7.01	6.66 - 7.36	10.00	9.50 - 10.50
27	4.01	3.81 - 4.21	7.01	6.66 - 7.36	9.99	9.49 - 10.49
28	4.02	3.82 - 4.22	7.00	6.65 - 7.35	9.98	9.48 - 10.48
29	4.02	3.82 - 4.22	7.00	6.65 - 7.35	9.97	9.47 - 10.47
30	4.02	3.82 - 4.22	7.00	6.65 - 7.35	9.96	9.46 - 10.46
31	4.02	3.82 - 4.22	7.00	6.65 - 7.35	9.95	9.45 - 10.45
32	4.02	3.82 - 4.23	7.00	6.65 - 7.35	9.94	9.45 - 10.44
33	4.03	3.82 - 4.23	6.99	6.64 - 7.34	9.94	9.44 - 10.43
34	4.03	3.83 - 4.23	6.99	6.64 - 7.34	9.93	9.43 - 10.42
35	4.03	3.83 - 4.23	6.99	6.64 - 7.34	9.92	9.42 - 10.42
36	4.03	3.83 - 4.23	6.99	6.64 - 7.34	9.90	9.40 - 10.39
37	4.03	3.83 - 4.24	6.99	6.64 - 7.34	9.87	9.38 - 10.37
38	4.04	3.83 - 4.24	6.98	6.63 - 7.33	9.85	9.36 - 10.34
39	4.04	3.84 - 4.24	6.98	6.63 - 7.33	9.82	9.33 - 10.32
40	4.04	3.84 - 4.24	6.98	6.63 - 7.33	9.80	9.31 - 10.29

Notes:
1. Based on information provided by Hanna Instruments, Inc. of Woonsocket, Rhode Island.
2. Values were provided for temperatures in increments of 5 °C. Values for all other temperatures were linearly interpolated.

Equipment Calibration/Calibration Check Data Sheet
(circle one)

____
Sanborn Head Rep Signature

SANBORN HEAD

Project No.: ________________ Date: _______________________

Location: ________________ Time: ______________________

Sanborn Head Rep: _________ Weather: _____________________

YSI 600 / 556 Sonde with Flow Through Cell, Serial number: ____________________________________

YSI 650 MDS / 556 MPS Display, Serial number: ____

Date and Time Dissolved Oxygen Filter membrane last changed: ________________________________

Local Barometric Pressure: ______

Ambient Air Temperature (measured with YSI temperature probe): ________ °C

Calibration of Dissolved Oxygen (DO) Probe by water-saturated air: Yes ☐ No ☐

Value read back from instrument:_______ mg/l

Theoretrical DO concentration in water-saturated air: ____ mg/l

Calibration check of DO Probe with zero mg/l DO standard: Yes ☐ No ☐

Standard manufacturer, lot number and expiration date: ______________________________________

Value read back from instrument: ___________ mg/l

DO Charge: ___________

First pH Standard: _______s.u. Calibration check: ______s.u. @_____ °C

Standard manufacturer, lot number and expiration date: ______________________________________

Second pH Standard: _________s.u Calibration check:______s.u. @_____ °C

Standard manufacturer, lot number and expiration date: ______________________________________

Third pH Standard: _______s.u. Calibration check: ______s.u. @_____ °C

Standard manufacturer, lot number and expiration date: ______________________________________

Primary Specific Conductance Standard: 1,413 µS/cm Value read back from instrument: _____µS/cm @__ °C

Primary Standard (1,413 µS/cm) manufacturer, lot number and expiration date: ______________________

Secondary Specific Conductance Standard: 700 µS/cm Calibration check___________µS/cm @____ °C

Secondary Standard (700 µS/cm) manufacturer, lot number and expiration date: _____________________

Oxidation Reduction Potential Standard: ________mV Calibration check: ________mV @____ °C

Standard manufacturer, lot number and expiration date: ______________________________________

Hach 2100P Portable Turbidimeter, serial number:____

Date & Time Turbidity Meter last calibrated with Primary Standards:__________________________________

Hach StablCal® Standards:

Std No 1: <0.1 NTU Calibration Check: _________ Lot No. & Expiration Date: _______________________

Std No 2: 20 NTU Calibration Check: _________ Lot No. & Expiration Date: _______________________

Std No 3: 100 NTU Calibration Check: _________ Lot No. & Expiration Date: _______________________

Std No 4: 800 NTU Calibration Check: _________ Lot No. & Expiration Date: _______________________

Low Flow Purge and Sample Data Sheet

Sampler's Signature:

SANBORN HEAD	Project No.:	Well Diameter:	Water Level:	Well No.:
	Location:	Reference Point: TPVC	Total Depth:	Date:
	Sanborn Head Rep.:	Intake Depth:	Screen Interval:	Weather:

Instrumentation	**Pumping Equipment and Materials**
DO, Conductivity, Temperature, pH, ORP: YSI 556 MPS S/N: __________________	Bladder Pump Make, Model & S/N: ____________________________
YSI 600 XLM Probe S/N: ____________________ Meter S/N: ____________________	Bladder Material: Teflon Bladder Pump Diameter: 1¾" ¾"
Water Level Make, Model & S/N: ____________________________	Water Tubing Diameter (in): ID ______ OD ______ Air Tubing Diameter (in): ID ____ OD ____
Turbidity: Hach 2100P S/N: ______________________	Water Tubing Material: Teflon-Lined Poly Air Tubing Material: Poly
Compressor Make, Model & S/N: ____________________________	Flow Cell Volume (mL): ___________________________
Controller Make, Model & S/N: ____________________________	Other:

Time	Pump Settings			Water Level (ft)	Flow (ml/min)	Temperature (°C)	Specific Conductance (µS/cm)	DO (mg/l)	pH (s.u.)	ORP (mV)	Turbidity (NTU)	Comments
	Compressor Pressure (psi)	Recharge (sec)	Discharge (sec)									
Equilibrium Goals (3 consecutive readings 5 min apart)				**<0.3 ft total drawdown**	**50 - 400 ml/min**	**± 3%** (may not equilibrate)	**± 3%**	**± 10%** (if >0.5 mg/l; if ≤0.5, three consecutive readings is stabilized)	**± 0.1**	**± 10 mV**	**± 10%** (for > 5 NTU; if ≤5 NTU, three consecutive readings is stabilized)	

Indicator Parameters Stabilized? Yes No

2 Hour Time Limit Reached? Yes No

Laboratory Sample	Sample ID:	Collection Time:

Purge Water Volume (gal):

Groundwater Quality Field Sampling Summary

Sampler's Signature:

SANBORN HEAD	Project Number:	Date:
	Project Name:	
	Project Location:	

pH, Conductivity, Temperature Meter:	Project Manager:
Water Level Meter:	Collector(s):
Other:	Weather:

Field Measurements

Sampling Location							
Reference Point							
Reference Point Elevation (feet)							
Depth to Floating Product (feet)							
Depth to Water (feet)							
Water Table Elevation (feet)							
Depth to Bottom (feet bgs)							
pH (standard units)							
Specific Conductance (µS/cm)							
Temperature (°C)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potential (mV)							
Turbidity (NTU)							
Date of Sample							
Sample Time							
Gallons Purged							
Purge/Sample Device							
Comment Reference Number							

Comments

1.

2.

3.

4.

5.

6.

7.

8.

Surface Water Quality Field Sampling Summary

Sampler's Signature:

SANBORN HEAD	Project Number:	Date:
	Project Name:	
	Project Location:	
Weather:	Project Manager:	
Measurement Device:		

Field Measurements

Sampling Location				
Collector(s)				
Reference Point				
Depth to Floating Product (feet)				
Depth to Water (feet)				
Depth to Stream Bed (feet)				
Depth of Flow (DTSB-DTW)				
pH (standard units)				
Specific Conductance (µS/cm)				
Temperature (°C)				
Dissolved Oxygen (mg/L)				
Oxidation Reduction Potential (mV)				
Turbidity (NTU)				
Date of Sample				
Sample Time				
Comment Reference Number				

Comments

1.
2.
3.
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SOP B.7

MONITORING WELL GROUNDWATER SAMPLING

TABLE OF CONTENTS

ATTACHMENTS

Low Flow Purge and Sample Data Sheet

Groundwater Quality Field Sampling Summary

USEPA's "Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells," SOP No.: EQASOP-GW 0001, Revision No. 3, dated January 19, 2010

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) is generally applicable to collection of groundwater samples from monitoring wells using low-flow sampling techniques with bladder pumps on the Southern Parcel of the Mohawk Tannery Site in Nashua, New Hampshire. This SOP is intended to cover sampling of wells with both fully and partially saturated well screens. This SOP does not address the collection of samples from wells containing free phase non-aqueous phase liquid (NAPL). If NAPL is encountered, modifications to the Sampling and Analysis Plan (SAP) will be necessary.

2.0 GROUNDWATER SAMPLING USING LOW-FLOW TECHNIQUES

Low-flow groundwater samples will be collected in general accordance with United States Environmental Protection Agency (USEPA) guidance on low-flow sampling techniques as set forth in the USEPA document entitled, “Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells,” SOP No.: EQASOP-GW 0001, Revision No. 3, dated January 19, 2010. The initial phase of sampling at the site using this SOP includes monitoring wells SH-13, SH-19, GZ-10, GZ-11, and GZ-13 (refer to Table 4). Deviations from these procedures will be documented.

Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.’s (Sanborn Head’s) Project Manager or Principal-in-Charge (PIC). In addition to the USEPA Guidance and NHDES’ QAPP, the procedures included herein were selected based on our understanding of site conditions based on historical conditions encountered at monitoring wells SH-13, SH-19, and GZ-10. The following modifications and specific protocols will augment/supersede the USEPA low-flow SOP.[1]

Sample collection procedures are established to limit introduction of contaminants to the sample, or contaminant loss from the sampled medium (groundwater) during collection. This will be accomplished by the selection and handling of sampling equipment and, the care of the individual performing the sampling. Reusable sampling equipment (e.g., water level meter, field screening equipment, pumps) will be decontaminated prior to reuse. Field personnel will limit sampling equipment contact with the ground surface. Sampling personnel will wear disposable protective gloves during sampling to limit possible contamination of samples, and for health and safety considerations. To reduce potential loss of contaminants during collection, field personnel will inspect sampling equipment to check that fouling problems do not alter collection efficiency or cause reintroduction of sample to media.

Low flow indicator parameters include: pH, turbidity, specific conductance, temperature, dissolved oxygen (DO) and oxidation/reduction potential (ORP). All measurements must be obtained using a transparent “flow-through-cell”, except for turbidity. Turbidity is measured before (i.e., “upstream of”) the flow-through-cell, and from an instrument

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[1] SOP No.: EQASOP-GW 0001 applies to only wells with fully saturated screens, Sanborn Head intends to apply to the same general low-flow techniques to partially saturated screens.

separate from the flow-through-cell apparatus as indicated below. A three-way stop cock attached to the tubing before the flow-through-cell will be used for this purpose. Transparent flow-through-cells with a cell capacity of 250 ml or less are required. The transparency allows field personnel to watch for air bubbles and particulate build-up within the cell, which may affect indicator field parameter values measured within the cell. The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off water in the cell must not drain out. Monitoring probes must be submerged in water at all times.

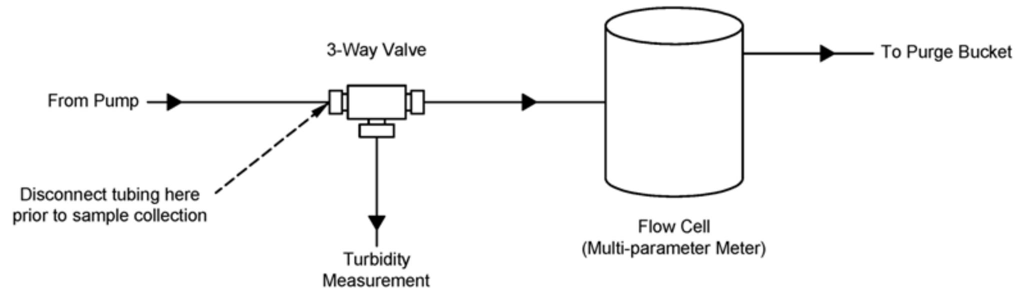

Figure 1 – Equipment Set-up Diagram

A small volume cell (250 ml or less) facilitates rapid turnover of water in the cell between measurements of the indicator field parameters. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 milliliters per minute [ml/min], the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell at the same flow rate, it would be every ten minutes). If the cell volume cannot be replaced in the proper interval, (e.g. five minute for a 250 mL flow through cell) then the time between measurements must be increased accordingly, hence, cell volume of 250 ml or less is required for this project.

Prior to conducting the sampling event, information regarding well construction, development, and water level records for each well to be sampled should be obtained and reviewed to determine the appropriate pump to be used, the location of the intake, and the potential groundwater recharge rate of the well. If this installation data or well history (construction and sampling) is not available for the wells to be sampled, efforts to build a sampling history should begin with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point, or the lowest historical mid-point of the saturated screen length, is often used as the location of the pump intake.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, shade the equipment and sample containers from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be limited to avoid the sun light or ambient air from heating up the groundwater.

Cold weather considerations must be factored into a low-flow sampling plan. It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell is required to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times for cleaning and give a brief description of cleaning activities.

The use of dedicated sampling equipment is recommended as it promotes consistency in the sampling; may reduce sampling bias by having the pump's intake at a constant depth; and can streamline sampling activities, significantly reducing the time needed to complete each sampling event, thereby reducing the overall field costs.

3.0 PRELIMINARY PROCEDURES

1. Field instruments used will be calibrated, as appropriate, in general accordance with the instrument manufacturer's recommendations and as described in field SOP B.6 within one week prior to the sampling event. A calibration check will be performed at the beginning of each day and following the day's sampling. A calibration check may also be performed mid-day. Records of daily calibration will be maintained on a calibration form which will be referenced in the daily entry in the field book. Field personnel will limit contact of sampling equipment and field instruments with the ground surface.

2. Set up equipment according to the Low-Flow Setup Diagram in the attached USEPA Low Stress (low flow) Purging and Sampling Procedure.

3. Measure and record the water level (to 0.01 feet) in the well by slowly lowering the probe to a water level indicator to the top of groundwater. Care should be taken to limit suspension of any particulates attached to the inside of the well.

4. Pumps will be slowly lowered into each well to minimize agitation and mixing of the water column. For low-flow sampling, pump intakes for shallow (water table) monitoring wells will be placed at the mid-point of the saturated screened interval, determined at the time of the sampling round. Pump intakes for wells screened below the water table (i.e., fully saturated screen) will coincide with the mid-point of the screened interval.

   In general, the pump intake needs to be kept at least one to two feet above the bottom of the well to avoid disturbing any sediment on the bottom. The exceptions to this include wells with 2-foot screen lengths or less, and those wells that typically have less than 2 feet of saturated thickness and are not flowing under artesian conditions. For these wells, the intake will be adjusted during each sampling round to be in the middle of the saturated screen based on the current water level, and needs to be at least ½-foot off the bottom of the well. If there is less than ½-foot of water, a sample will not be collected.

4.0 PURGING AND SAMPLING PROCEDURES

4.1 Bladder Pump Purging Procedure

1. Lay out sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, bucket, etc.).

2. Lower the water level meter to the top of the water table and measure and record the water level.

3. Care must be taken during pump installation and sampling to minimize the disturbance of particulates that can greatly extend the purge time by increasing turbidity.

4. Before starting the pump, lower the water level meter to the top of the water table and measure and record the water level again with the tubing and pump in the well.

5. Activate the gas source (e.g., battery-powered oil-less air compressor), which activates the pneumatic controller (MP-10).

6. From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. Record drawdown and total volume purged on the Low Flow Purge and Sample Data Sheet.

7. Select the appropriate pressure (pounds per square inch [PSI]) setting for the MP-10 controller. The pressure setting should be close to the pressure needed to lift water the depth of the pump intake, plus 10-20 feet, to maximize the discharge volume from the bladder. However, be careful not to set the pressure too high

which may result in a sample stream that shoots out of the tubing during sampling and/or damage to the bladder. Record the PSI on the worksheet.

8. If air bubbles are observed they can usually be removed by elevating the discharge tube and pump to allow the air to continue rising until discharged with the water. Prevent sample and air tubing from crimping and avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

9. Start with a cycle setting of one cycle per minute, a discharge setting of 20 seconds and a refill setting of 40 seconds unless otherwise indicated on the historical flow sheets. The purge rate should be close to the well recharge rate so that the water level in the well doesn't decrease during purging.

10. If excessive turbidity or floc is anticipated or encountered with the pump startup, divert the water through the three way stopcock, as if you were measuring turbidity, until it clears in order to minimize particulate buildup in the cell. Make sure that the discharge water is going into the graduated bucket as part of the final purge volume.

11. Adjust pump discharge and refill rates (followed by changes to the pressure setting if required) until there is little or no water level drawdown.

12. During pump start-up, drawdown may exceed the 0.3-foot target and then "recover" somewhat as pump flow adjustments are made. If the drawdown has exceeded 0.3 foot and stabilizes, continue purging until the indicator parameters stabilize.

13. Initially monitor and record the water level (during discharge cycle of the bladder pump), draw down, pressure, pumping rate (discharge/refill of pump), any adjustments, and the indicator parameters (pH, turbidity, specific conductance, temperature, dissolved oxygen and oxidation-reduction potential) approximately every five minutes (or as appropriate; not less than 5 minutes apart) until the indicator parameters begin to stabilize. Once it appears that the indicator parameters have begun to stabilize, record the data at a minimum of every five minutes, or at a greater interval that allows the flow rate to "turn over" at least one FTC volume. Field measurements will be recorded on Sanborn Head's Low-flow Purge and Sample Data Sheet and Groundwater Quality Sampling Summary Form (final readings) provided at the end of this SOP.

14. If the water level continues to drop with the MP-10 controller settings at one cycle per minute and a discharge setting of one second, or if the flow rate for a stabilized groundwater level is below 50 ml per minute, the well will be considered to have insufficient recharge for low flow sampling. Discontinue sampling at that location and return once the well has sufficiently recharged and there is ample water to purge one tubing volume of water and collect all samples. Refer to the "Monitoring

Wells That Have Insufficient Recharge" section below for instructions as to how to sample the well.

15. After the water level appears stabilized, if the normal discharge volume from a pump cycle is less than 70 ml, place the controller in the "pause-hold-sample mode" to confirm that a discharge volume of 70 ml or greater can be collected. The "pause-hold-sample mode" will empty the bladder. Note that if the discharge volume is 70 ml or greater, there is no need to perform this check as you will be sampling directly from the pump cycle. In the event the "pause-hold-sample mode" volume is less than 70 ml, attempt to change operating conditions to increase the "pause sample mode" volume. NHDES requires that VOAs are filled with one discharge volume of water.

16. In the event that flow from the bladder pump appears to be a water/air mixture during purging/sampling operations, pull the bladder pump and check and tighten the tubing and fitting connections. If the flow from the bladder pump still appears to be a water/air mixture, pumping should be discontinued without taking a sample. This may signal that turbulent flow is occurring, the water level in the well is at the pump intake level, or the bladder has been damaged. If possible, lower the pump further into the water so the pump unit is fully submerged (if it is not fully submerged) and continue stabilization step operations. If the pump is lowered, the sampler needs to record the reason for lowering the pump and the pump's new depth on the field form(s). This new depth should be maintained as the fixed pumping depth for all subsequent monitoring events.

4.2 Field Parameter Stabilization and Sample Collection Procedure

Measured readings will be recorded until all water quality indicator parameters have stabilized or two hours of purge time has elapsed, at which time, a groundwater sample will be collected. The stabilization guidelines include three consecutive readings of no less than five minutes apart for the parameters within the following range:

Indicator Field Parameter	Stabilization Guideline
Temperature	±3% (values in degrees Celsius; stabilized temperature readings may not be possible)
pH	±0.1 standard units
Specific Conductance	±3%
Oxygen Reduction Potential	±10 millivolts (mV)
Dissolved Oxygen	±10% for values >0.5 milligrams per liter (mg/l); three consecutive readings <0.5 mg/l is considered stabilized
Turbidity	±10% for values >5 Nephelometric Turbidity Units (NTU); three consecutive readings <5 NTU are considered stabilized

If the water level reaches approximately the top of the screen before parameter stabilization or the end of two hours, purging will be stopped and the water level allowed to recover before samples are collected. The duration of water level recovery will be selected by the sampler and recorded in the field notes. Once the well has sufficiently recovered, one tubing volume of water shall be removed before samples are collected. If the water quality indicator parameters have not stabilized after two hours of pumping, a sample will be collected and an explanation of the attempt to achieve stabilization will be noted. Full documentation of attempts to achieve stabilization should be included in the field documentation; note that the analytical data obtained, particularly for metals and strongly hydrophobic organic analytes, may reflect a sampling bias and may not meet project data quality objectives.

The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If parameter stabilization has been achieved but the purge volume criteria has not been met, pumping must be continued until the combined volume (stabilized drawdown plus tubing volume) has been purged from the well or the two hour limit has been reached.

Purge volume calculations should utilize the stabilized drawdown value, not the initial drawdown. Calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well before samples are collected. Purge volume calculations must be documented on the field form.

Samples for laboratory analyses must be collected before the flow cell and three way stop cock. This will be done by disconnecting the flow cell and three-way stop cock after reaching stabilization. Collection of the sample is directly from the tubing.

When collecting VOCs, if the discharge water volume is 70 ml per discharge or greater, the sampler may sample directly from the pump discharge. In the event the discharge water volume is less than 70 ml per discharge, the water samples will need to be collected through the "pause-hold-sample" function of the QED MP-10 controller.

Samples for metals and SVOC analyses will be collected as total (unfiltered) if the turbidity is less than or equal to 20 nephelometric turbidity units (NTU). If the turbidity is greater than 20 NTU, both total (unfiltered) and dissolved (filtered) samples will be collected for metals, and only dissolved (filtered) samples will be collected for SVOCs. Samples for dissolved metals and SVOCs will be field-filtered using a single-use, in-line, 0.45 micron filter.

The addition of groundwater to sample containers will be conducted in a controlled manner to limit aeration, overflow of bottles, or loss of preservative. Pre-preserved sample containers provided by the laboratories will be used when required for the selected analyses. Field SOP B.10 also provides additional information on sample handling.

If turbidity is less than or equal to 20 NTU, samples will be collected and containerized in the following order:

i. Non-filtered Hexavalent Chromium
ii. Volatile Organic Compounds (VOCs)
iii. 1,4-Dioxane
iv. Non-filtered Semi-Volatile Organic Compounds (SVOCs)
v. Non-filtered Metals (using appropriate container(s) for each lab)

If turbidity is greater than 20 NTU, samples will be collected and containerized in the following order:

i. Non-filtered Hexavalent Chromium
ii. Filtered Hexavalent Chromium
iii. Volatile Organic Compounds (VOCs)
iv. 1,4-Dioxane
v. Non-filtered Metals (using appropriate container(s) for each lab)
vi. Filtered Semi-Volatile Organic Compounds (SVOCs)
vii. Filtered Metals (using appropriate container(s) for each lab)

Samples to be submitted for chemical analysis will be stored in re-sealable plastic bags on ice in a cooler. Sample handling is discussed in field SOP B.10.

Field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples should be collected by filling a separate container for each analysis immediately following the actual field sample collection for that parameter. Field duplicate samples will be blind to the laboratories and will be designated **OW-[laboratory matrix series #]**, where “laboratory matrix series #” corresponds to the sample deliverable group (SDG) number (e.g., the first soil field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named “OW-101”). Refer to SOP B.10 for additional information on sample naming and SDGs. Refer to **Table 5** in the SAP for specific QC sampling requirements.

4.3 Monitoring wells that have insufficient recharge

This procedure is to be used if the well has insufficient recharge and stabilized drawdown cannot be achieved. Check that the well has recharged sufficiently and there is ample water to remove one tubing volume of water and collect all the samples before continuing with this procedure. When samples are being collected, the water level must not drop below the top of the screen. If the water drops below the top of the screen during sample collection, stop pumping to allow the well to recover until there is sufficient water to collect the remaining samples. For wells with a partially unsaturated screen (e.g., SH-13), the water level should be monitored to maintain submergence of the pump intake prior to and during sample collection. If the water level is approaching the pump intake (i.e., is within approximately 0.5 feet of the pump intake), stop pumping to allow the well to recover until there is sufficient water to collect the remaining samples. Apply the last control settings used before purging was discontinued or sample at a rate of 50 ml/min.

Measure the water level. Carefully lower a water level indicator to the top of groundwater, measure and record the water level (to 0.01 feet) before any disturbance to the well. Care should be taken to minimize suspension of any particulates attached to the sides of the well.

1. Prior to sample collection, purge one discharge line volume. The discharge line purge volume (V_{DL}) is equal to:

$$V_{DL} = \boldsymbol{h} \times f$$

h = length of tubing (ft)
f = the tubing volume (specify units – gallons or milliliters; see table below)

Tubing Diameter (inches)	¼ - inch (0.25) OD **(0.17-inch ID)**	3/8 - inch (0.375) OD **(0.25-inch ID)**	1/2 - inch (0.50) OD **(0.375-inch ID)**	5/8 - inch (0.625) OD **(0.50-inch ID)**
Volume (gal/foot)	0.0012	0.0026	0.0057	0.0102
Volume (ml/foot)	4.5	9.7	21.7	38.6

2. Remove the cap from the sample container and place it on the plastic sheet or in a location where it won't become contaminated.

3. All sample containers should be filled by allowing the discharge to flow gently down the inside of the container with minimal turbulence. Cap sample containers securely after filling each bottle. Samples shall be collected in the same order as previously indicated.

5.0 EQUIPMENT DECONTAMINATION

Disposable down-hole sampling equipment (i.e., tubing, etc.) will be discarded after sample collection. Bladder pumps will be disassembled between monitoring wells. Components which are expendable (e.g., bladder, o-rings, check balls, grab plates, intake screen) will be removed from the pump and discarded.

The remaining portions of the bladder pump which are manufactured from stainless steel and other non-dedicated equipment (water level meter) will be decontaminated between each well location following field SOP B.11.

Disposition of wash and rinse water will be handled as investigation-derived waste (IDW) as discussed in field SOP B.12.

An equipment rinseate blank of the non-dedicated equipment used shall be collected after decontamination. Refer to Table 5 in the SAP for specific QC sampling requirements and analysis.

6.0 EQUIPMENT/SUPPLIES

- Laboratory-supplied sample containers
- Sample coolers with ice; re-sealable plastic bags and packing materials
- Site and well keys
- YSI 600 XL/XLM multi-parameter sonde with a 250 milliliter or less transparent flow cell (or equivalent)
- Hach 2100P turbidity meter (or equivalent)
- Slope (or equivalent) Water Level Meter
- Calibration solutions and supplies for the YSI and Hach meters according to SOP B.6.
- 3-way stopcock/valve
- Lint-free cloth (e.g., Kimwipes® or equivalent)
- QED Sample Pro® Portable MicroPurge® Bladder Pump with expendable Teflon bladders, o-rings, Teflon® check balls, stainless steel intake screens and grab plates
- Stainless steel wire to hang bladder pump
- Teflon® lined polyethylene tubing (water line for bladder pump)
- Polyethylene tubing for air line
- Stainless steel hose clamps
- QED bladder pump controller (Model MP-10) capable of adjusting flow to 50 ml/minute, with a manual control option and operation manual.
- Flow measurement supplies/graduated cylinder (appropriately sized for flow rates)
- Air compressor, pump control box, and 12 volt deep cycle marine battery(s)
- Stop watch
- Graduated bucket for purge water
- Clean plastic storage bags
- Plastic ground cloth
- 0.45 micron in-line filters for dissolved analyses (as applicable)
- Decontamination buckets, brushes, and non-phosphatic detergent, potable water, de-ionized water, decontamination solvent (if necessary)
- Sturdy field table
- Groundwater Field Sampling Forms
- Low-flow Purge and Sample Data Sheets
- Field book
- Personal protective equipment (PPE)
- Umbrella, tent (or equivalent) to protect equipment and sample containers from the sunlight.
- Mohawk SAP

7.0 SPECIAL NOTES

If site conditions result in a modification of standard operating procedures, the modifications shall be recorded in the daily logbook of Sanborn Head's field representative.

8.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

9.0 REFERENCES

Low Flow Groundwater Purging and Sampling Procedure included in the current Hazardous Waste Remediation Bureau Master QAPP, EPA RFA#08036.

Low Flow Purge and Sample Data Sheet

Sampler's Signature:

SANBORN HEAD	Project No.:	Well Diameter:	Water Level:	Well No.:
	Location:	Reference Point: TPVC	Total Depth:	Date:
	Sanborn Head Rep.:	Intake Depth:	Screen Interval:	Weather:

Instrumentation

DO, Conductivity, Temperature, pH, ORP: YSI 556 MPS S/N: ________________

YSI 600 XLM Probe S/N: __________________ Meter S/N: __________________

Water Level Make, Model & S/N: ____

Turbidity: Hach 2100P S/N: ____________________

Compressor Make, Model & S/N: ____

Controller Make, Model & S/N: ____

Pumping Equipment and Materials

Bladder Pump Make, Model & S/N: ____

Bladder Material: Teflon	Bladder Pump Diameter: 1¾" ¾"
Water Tubing Diameter (in): ID _____ OD _____	Air Tubing Diameter (in): ID ____ OD ____
Water Tubing Material: Teflon-Lined Poly	Air Tubing Material: Poly

Flow Cell Volume (mL): ________________________

Other:

Time	Pump Settings			Water Level (ft)	Flow (ml/min)	Temperature (°C)	Specific Conductance (µS/cm)	DO (mg/l)	pH (s.u.)	ORP (mV)	Turbidity (NTU)	Comments
	Compressor Pressure (psi)	Recharge (sec)	Discharge (sec)									
Equilibrium Goals (3 consecutive readings 5 min apart)				**<0.3 ft total drawdown**	**50 - 400 ml/min**	**± 3%** (may not equilibrate)	**± 3%**	**± 10%** (if >0.5 mg/l; if 0-0.5, three consecutive readings is stabilized)	**± 0.1**	**± 10 mV**	**± 10%** (for > 5 NTU; if ≤5 NTU, three consecutive readings is stabilized)	

Indicator Parameters Stabilized? Yes No

2 Hour Time Limit Reached? Yes No

Laboratory Sample	Sample ID:	Collection Time:

Purge Water Volume (gal):

Groundwater Quality Field Sampling Summary

Sampler's Signature:

SANBORN HEAD	Project Number:	Date:
	Project Name:	
	Project Location:	

pH, Conductivity, Temperature Meter:	Project Manager:
Water Level Meter:	Collector(s):
Other:	Weather:

Field Measurements

Sampling Location							
Reference Point							
Reference Point Elevation (feet)							
Depth to Floating Product (feet)							
Depth to Water (feet)							
Water Table Elevation (feet)							
Depth to Bottom (feet bgs)							
pH (standard units)							
Specific Conductance (µS/cm)							
Temperature (°C)							
Dissolved Oxygen (mg/L)							
Oxidation Reduction Potential (mV)							
Turbidity (NTU)							
Date of Sample							
Sample Time							
Gallons Purged							
Purge/Sample Device							
Comment Reference Number							

Comments

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U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
11 Technology Drive
North Chelmsford, MA 01863

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Approved by: Gerard Sotolongo 1-19-10
(Gerard Sotolongo, Quality Assurance Unit) Date

Revision Page

Date	**Rev #**	**Summary of changes**	**Sections**
7/30/96	2	Finalized	
01/19/10	3	Updated	All sections

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USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Poteniometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convention cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or Teflon are preferred. Note: if extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

Teflon or Teflon-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. Note: if tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic "tape", pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* January 19, 2010, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed lay out sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). All during the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods (e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 μm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and then following sampling of each well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

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APPENDIX A
PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could effect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or colored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or colored water is usually from the well being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take awhile (pump maybe removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note,

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

> **Turbidity** (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
> **Dissolved Oxygen** (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
> **Specific Conductance** (3%),
> **Temperature** (3%),
> **pH** (± 0.1 unit),
> **Oxidation/Reduction Potential** (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record that the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

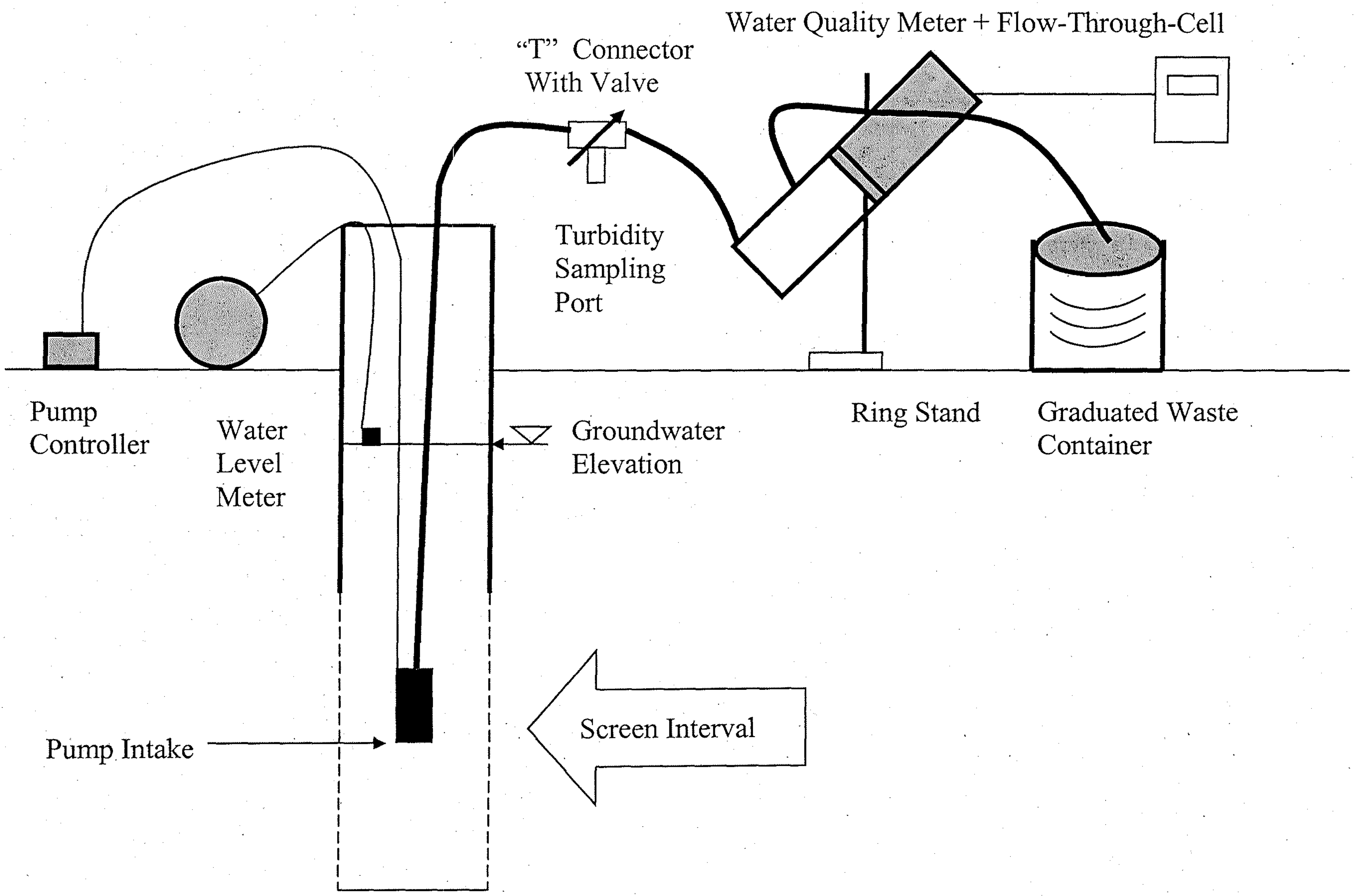
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C
EXAMPLE (Minimum Requirements)
WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)______________________________
Well Number________________Date__________________
Field Personnel______________________________
Sampling Organization______________________________
Identify MP______________________________

Depth to ________/________ of screen
(below MP) top bottom
Pump Intake at (ft. below MP)__________
Purging Device; (pump type)__________
Total Volume Purged ______________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Turb-idity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	± 10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

SOP B.8

SURFACE WATER SAMPLING

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ATTACHMENT

1.0 SCOPE AND APPLICABILITY

The scope of this Standard Operating Procedure (SOP) encompasses surface water sampling in shallow water on the Southern Parcel of the Mohawk Tannery Site in Nashua, New Hampshire. Wooden grade stakes (or equivalent) will generally be driven at the planned surface water sampling locations.

Surface water sampling procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 SURFACE WATER SAMPLING

2.1 Sample Locations

Sampling locations shall be established, prior to sampling and as described in the Sampling and Analysis Plan (SAP) on Table 2, using a global positioning system (GPS) unit. The top of the wooden grade stake will be surveyed (refer to SOP B.4 regarding procedures).

2.2 Preliminary Surface Water Sampling Procedures

Surface water samples will be collected in accordance with the following procedures. Sample handling shall be in accordance with SOP B.10. Alternative sampling methods may be considered if it is deemed that the procedures outlined herein are not appropriate for the conditions encountered (e.g., depth of water requires using a boat/raft).

1. We have assumed that sampling can be conducted either from the shore, or by a sampler standing in the water wearing boots or waders.

2. The sampling location should be approached from downstream, where practicable. The depth of the surface water should be recorded on a Surface Water Quality Sampling Summary Form.

3. If hands/arms are significantly submersed in water during sample collection, elbow- or shoulder-length gloves should be worn to limit the potential for skin/clothing contact with surface water. Gloves should be discarded between sampling locations, if they become contaminated, or if contamination is suspected prior to sampling.

4. If no safe access is available, attach the sample collection container to a pole with strapping and collect the sample. Alternatively a peristaltic pump with single-use tubing may be used to limit the need to submerge hands/arms in surface water during sample collection or where the depth of water or flow makes it impracticable to perform the sampling using boots or waders. A boat may be used to access sampling locations.

5. The laboratory will provide bottles used for analyses in coolers secured with custody seals or in factory-sealed cartons. The coolers should remain closed except when removing empty bottles or replacing full bottles. Clean gloves should be worn when removing/replacing bottles into the coolers. Coolers will be secured with custody seals prior to shipment back to the laboratory.

6. In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, tested, and inspected according to the manufacturer's instructions. The manufacturer's instruction manuals for field equipment shall be kept on-site with the equipment.

7. The field instruments used during the investigations will be calibrated and checked in accordance with the manufacturer's instructions and as described in field SOP B.6. A calibration check will be performed at the beginning of the day and following the day's investigations. Mid-day calibration checks may also be performed. Records of calibration will be maintained on a calibration form which will be referenced in the daily entry in the field book. Field personnel will limit contact of sampling equipment and field instruments with the ground surface.

8. Surface water sampling will occur congruent to the groundwater sampling event. Based on weather reports, the sampling team will select the driest period during the Site sampling events to collect the surface water samples, unless otherwise directed by the project manager.

9. Surface water sampling locations will be marked in the field with a grade stake/fence post or be located adjacent to a mini-piezometer such that the sampling location will be consistent between rounds.

10. Additional information to be recorded includes the following:
    - Past 7 days of local meteorological data showing a minimum of daily precipitation totals and barometric pressure;
    - General physical description of the samples and sampling locations; and
    - Descriptions/ID's of digital photographs

11. Laboratory-provided bottles/jars with lids will be used for collection. Prior to sample collection, the bottle should be stored in a plastic bag (re-closable, zipper-type is acceptable) to prevent contamination of the exterior of the bottle surface before immersion into the water.

12. Laboratory samples are collected first, followed by in-situ field screening parameters using the YSI meter and turbidity using the Hach meter.

2.3 Surface Water Sampling Procedures

1. Sampling occurs sequentially from downstream to upstream. Each location is sampled from the downgradient side. Where feasible, surface water samples and field

parameters are collected from the shore. If the field representative must enter the water to collect a sample, or where no discernible flow direction is observed, samples will be collected in a manner that minimizes disruption of water column/sediment.

2. Collect the sample approximately midway in the water column between the surface and the bottom, to limit the turbidity in, and aeration of the sample. Collect the samples upstream of where the depth to water was measured to limit sampling in areas that may have been disturbed.

3. Field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples should be collected by filling the required additional container(s) for each analysis immediately following the actual field sample collection for that parameter and should be in the same priority order as indicated below. Field duplicate samples will be blind to the laboratories and will be designated **OW-[laboratory matrix series #]**, where "laboratory matrix series #" corresponds to the sample deliverable group (SDG) number (e.g., the first soil field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named "OW-101"). Refer to SOP B.10 for additional information on sample naming and SDGs. Refer to **Table 5** in the SAP for specific QC sampling requirements.

4. For samples being collected using sample container submersion:
   a. For analyses requiring preservation:
      - Remove the disposable syringe/tubing from the plastic bag and immediately immerse approximately midway into the water column, upgradient, as far as possible from a potentially source of interference (i.e., body, etc.).
      - Draw back the plunger of the syringe to fill it with water, and remove the syringe/tubing from the water. For preserved samples, gently discharge the syringe directly into the appropriate laboratory provided pre-preserved container.
      - Repeat as necessary until sufficient sample volume is obtained. Re-cap the bottle, and place the filled bottle back in the plastic bag and return to cooler.
      - Collect the VOC sample first, filling the bottles for the primary sample and then the bottles for any required QC (e.g., field duplicate, MS/MSD), as necessary. Next collect the sample for metals and hardness, filling the bottle for the primary sample and then the bottles for any required QC (e.g., field duplicate, MS/MSD), as necessary. Last, collect the sample for total chromium, filling the bottle for the primary sample and then the bottles for any required QC (e.g., field duplicate, MS/MSD), as necessary.
      - Return the filled sample bottles to the plastic bag, and place in the cooler on ice.

   b. For analyses which do not require preservation:
      - Remove the laboratory-provided unpreserved sampling container for the

analysis from the plastic bag and immediately immerse into the water, upgradient, as far as possible from a potentially contaminating surface (i.e., body, etc.) while still capped (to prevent contamination from the surface micro-layer), and remove the cap, while immersed.

- Allow a small portion of water into the bottle and replace the cap. Remove the bottle from the water, rinse thoroughly, and discard the rinseate away from the sampling area. Repeat this procedure two to three times, if possible.
- After rinsing the bottle, immerse it in the water while still capped (to prevent contamination from the surface micro-layer), remove the cap, fill the bottle, and re-cap (all while immersed). Place the filled bottle back in the plastic bag.
- Collect the SVOC sample first, filling the bottles for the primary sample and then the bottles for any required QC (e.g., field duplicate, MS/MSD), as necessary. Then collect the hexavalent chromium sample, filling the bottle for the primary sample and then the bottles for any required QC (e.g., field duplicate, MS/MSD), as necessary.
- Return the filled sample bottles to the plastic bag, and place in the cooler on ice.

5. For samples were a peristaltic pump is to be used to collect the sample, submerge the tubing approximately midway into the water column, and commence pumping at a flow rate between 100 and 400 milliliters per minute (mL/min) to fill the sample containers. Fill all the bottles for the primary sample for a given analysis and then all the bottles for any required QC (e.g., field duplicate, MS/MSD) for that analysis before continuing on to fill the bottles for the next analysis. Fill the bottles in the following order:
   a. VOCs
   b. SVOCs
   c. Hexavalent chromium
   d. Metals and hardness.
6. Samples to be submitted for chemical analysis will be stored on ice in a cooler.
7. Following collection of samples for analysis, surface water will be screened in the field for field parameters (e.g., temperature, pH, specific conductance, dissolved oxygen [DO], oxidation reduction potential [ORP], and turbidity) in accordance with SOP B.6. The probes should be placed approximately midway in the water column between the stream surface and stream bottom. If stream depth is not sufficient to completely submerge the probes, a sample of surface water should be collected in a clean plastic or glass container. The container should be of sufficient capacity to completely submerge the probes. Field screening of surface water will be completed with an YSI 600 XLM multi-parameter sonde (or equivalent). Results will be logged in a field book or on a Surface Water Quality Sampling Summary Form.

8. Following sampling, the depth to water level surface will be measured from the top of the wooden grade stake (or other reference point), and the water depth will also be measured.
9. Digital photographs shall be taken at each sampling location, upstream and downstream, or in the general vicinity of the sampling location if no discernible flow direction is observed.
10. Additional information to be recorded includes the following:
    a. Previous 7 days of local meteorological data showing a minimum of daily precipitation totals and barometric pressure;
    b. General physical description of the samples and sampling locations; and
    c. Descriptions/ID's of digital photographs.
11. The field instruments used during the investigations will be calibrated prior to the day's sampling activities in accordance with the manufacturer's instructions and as described in field SOP B.6. A calibration check will be performed following the day's investigations. Records of daily calibration will be maintained on a calibration form which will be referenced in the daily entry in the field book. Field personnel will limit contact of sampling equipment and field instruments with the ground surface.

2.4 Equipment Cleaning/Decontamination Procedures

At this time, use of reusable equipment is not anticipated. Decontamination of non-dedicated equipment will be completed in accordance with field SOP B.11. Surface water and decontamination water generated from surface water sampling activities will be discharged to the ground surface near the point of generation.

3.0 EQUIPMENT/SUPPLIES

- Laboratory-supplied sample containers, pre-preserved as necessary, for surface water sampling
- Cooler, ice, chain-of-custody forms and seals
- Re-sealable plastic bags to protect and store samples
- Pre-cleaned wide-mouth glass sample containers (jar) with lids for each sampling location, plus extra, to use as intermediary containers to fill pre-preserved sampling containers
- Disposable syringes (where applicable)
- Peristaltic pump and tubing (where applicable)
- YSI Series 600XL Sonde and YSI 650 MDS with appropriate calibration solutions(or equivalent)
- Pole and strapping as necessary to collect samples from locations with limited access
- Staff gauge for measuring depth of water
- Digital camera
- Decontamination buckets, brushes, and non-phosphatic detergent, paper towels, potable water, de-ionized water, decontamination solvent (if necessary)
- Tape measure

- Flagging
- Boots or waders (i.e., chest or hip)
- Boat (if needed)
- Mini-sledge hammer
- Grade stakes (or equivalent)
- Mohawk SAP
- Surface Water Sampling Summary Forms
- Field book
- Personal protective equipment (PPE)

4.0 HEALTH AND SAFETY WARNINGS

This sampling procedure requires two field personnel if the surface water sample is being collected from a water body (e.g., Nashua River) where there is any potential for accidental drowning. If a sample cannot be obtained safely, the sample should not be taken and the conditions documented in the sampler's field book. Necessary precautionary measures should be heeded when performing these sampling techniques. Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

5.0 REFERENCES

The Surface Water Sampling Procedure found in the current version of the Hazardous Waste Remediation Bureau Master Quality Assurance Project Plan (HWRB Master QAPP), EQA RFA# 08036.

Surface Water Quality Field Sampling Summary

Sampler's Signature:

SANBORN HEAD

Project Number:

Date:

Project Name:

Project Location:

Weather:

Project Manager:

Measurement Device:

Field Measurements

Sampling Location				
Collector(s)				
Reference Point				
Depth to Floating Product (feet)				
Depth to Water (feet)				
Depth to Stream Bed (feet)				
Depth of Flow (DTSB-DTW)				
pH (standard units)				
Specific Conductance (µS/cm)				
Temperature (°C)				
Dissolved Oxygen (mg/L)				
Oxidation Reduction Potential (mV)				
Turbidity (NTU)				
Date of Sample				
Sample Time				
Comment Reference Number				

Comments

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SOP B.9

SEDIMENT SAMPLING

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ATTACHMENT

1.0 SCOPE AND APPLICABILITY

Sediment samples will be collected according to the guidelines discussed in this SOP at the Mohawk Tannery Site in Nashua, New Hampshire. Samples will be classified and logged on-site by the field representative using a modified Burmister Soil Classification System; a Description and Classification of Soil (and sediment) "key" is included as an attachment. Sampling locations shall be established, prior to sampling and as described in the Sampling and Analysis Plan (SAP), using a global positioning system (GPS) unit.

VOC sample collection will be conducted in accordance with the New Hampshire Department of Environmental Services (NHDES) SOP "Preservation of VOCs in Soil Samples" included in the current NHDES Hazardous Waste Remediation Bureau Master Quality Assurance Project Plan (HWRB Master QAPP).

Sample collection and decontamination procedures are discussed below. Sample handling shall be in accordance with Standard Operating Procedure (SOP) B.10. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 SAMPLE COLLECTION

In general, sediment samples will be collected from the designated locations from the water-sediment interface to a depth of approximately 2 to 4 inches. Digital photographs shall be taken at each sampling location, upstream and downstream.

We have assumed that sampling can be conducted either from the shore, or by a sampler standing in the water wearing boots or waders. Alternative sampling methods may be considered if it is deemed that the procedures outlined herein are not appropriate for the conditions encountered (e.g., depth of water requires using a boat/raft).

2.1 Sediment Sampling in Locations without Standing or Running Water

This section applies to collection of sediment samples from locations without standing or running water (i.e., non-submerged locations).

A stainless steel spade/shovel, spoon/scoop/spatula, or hand auger, or similar hand tool will be used to collect sediment samples from locations without standing or running water. The following procedures will be used.

1. It is anticipated that most locations may be sampled using a stainless steel spade/shovel or spoon/scoop/spatula. However, if a hand auger is used, attach the auger bit to the drill rod extension, and attach the "T" handle to the drill rod.
2. Clear the sample location of any surface debris and spread out plastic sheeting adjacent to the sampling location for staging equipment.

3. Advance the hand tool or auger to the required depth and place the recovered sediment into a stainless steel mixing bowl (placed on the plastic sheeting).
4. Upon completion of the shallow excavation, collect the VOC sample. In order to limit exposure to air and potential loss of volatile contaminants, the VOC sample shall be collected from the side wall of the excavation at the approximate midpoint of the depth interval using a graduated disposable syringe. The proper volume of sediment is then added to the methanol preserved VOA vials until the volume in the VOA vial (approximately 10 grams of sediment in each vial). Close tightly with the screw-on cap, label, and place in ice for delivery to the laboratory. A separate dry weight sample will not be necessary as long as the dry weight analysis is added to the analysis for the SVOC container.
5. Collect a discrete sediment sample from the side wall of the boring for field-screening with a photoionization detector (PID). PID screening will be performed in accordance with SOP B.2.
6. Using a stainless steel tool, transfer additional sediment from the excavation to the stainless steel mixing bowl. Continue to collect additional sediment until there is sufficient material to fill the remaining sample containers. Mix the sample volume thoroughly to obtain a homogeneous sample using a stainless steel tool in a manner which limits the introduction of air into the sample as much as is practicable (i.e., “stirred” not “whipped”). Fill the containers provided by the laboratory appropriate for the intended chemical analyses, close tightly with the screw-on cap, label, and place on ice for delivery to the laboratory.
7. After the VOCs are collected, the sample containers should be filled in the following order:
    - SVOCs,
    - Metals (using the appropriate containers for each lab)
    - PCB Congeners
    - Dioxins/Furans
    - Asbestos
    - Grain Size
8. Collect field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples by filling a separate container for each analysis immediately following the actual field sample collection and it should be in the same priority order as indicated above (VOCs are collected first). Field duplicate samples will be blind to the laboratories and will be designated **OW-[laboratory matrix series #]**, where “laboratory matrix series #” corresponds to the sample deliverable group (SDG) number (e.g., the first soil field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named “OW-101”). Refer to SOP B.10 for additional information on sample naming and SDGs. Refer to **Table 5** included in the SAP for specific quality control (QC) sampling requirements.

9. Classify samples using a modified Burmister Soil Classification System and record on the Sediment Sampling Summary Form.
10. Once samples are collected, digital photographs shall be taken at each sampling location, upstream and downstream, or in general vicinity of sampling location if no discernible flow direction is observed.
11. Between each sampling location, hand sampling equipment will be cleaned with a brush and decontaminated following the procedures described in field SOP B.11.
12. Equipment blanks are required for sediment sampling equipment. Following sample collection and after equipment decontamination, gently pour DI water over the equipment used to collect the sediment samples (e.g. stainless steel tools, bowl, and mixing spoon). Collect the rinseate that flows off the equipment into the appropriate sample containers. Refer to Table 5 included in the SAP for specific QC sampling requirements and analysis.
13. Field observations will be recorded on a Sanborn Head Sediment Sampling Summary Form, or in a tabular format.

2.2 Sediment Sampling in Locations with Standing or Running Water

This section applies to collection of sediment samples below standing or running water (i.e., submerged locations).

If a sediment sample is to be collected at the same location as a surface water sample, the sediment sample should be collected after collection of the surface water sample.

2.2.1 Sample Collection with a Scoop

If sampling puddles, or other features with standing water, a stainless steel spade/shovel, spoon/scoop/spatula, or similar hand tool may be used. If the location is reachable by hand, and the standing water will not overtop the sampler's glove, a spoon/scoop/spatula may be used. If the location is unreachable by hand, or the standing water will overtop the sampler's glove, a stainless steel spade/shovel, or a stainless steel scoop attached to a long handle may be used. Alternatively, if sediments are of sufficient thickness, an Ekman sampler may be used (see Section 2.2.2 below).

1. Using the appropriate sampling device, as determined above, scoop up sediment, allowing standing water to drain.
2. Collect a VOC sample directly from the from the central/interior portion of the sampling device as described above. A separate dry weight sample will not be necessary as long as the dry weight analysis is added to the analysis for the SVOC container.
3. Collect a discrete sediment sample from the central/interior portion of the sampling device for field-screening with a photoionization detector (PID). PID screening will be performed in accordance with SOP B.2.

4. Place the remaining sediment into a stainless steel bowl. Repeat Step 1 until sufficient sample volume is accumulated to fill the containers provided by the analytical laboratory.
5. Mix the sample volume thoroughly in the stainless steel bowl using a stainless steel tool in a manner which limits the introduction of air into the sample as much as is practicable (i.e., "stirred" not "whipped"). Larger roots, twigs, leaves, gravel clasts, etc. should be removed from the sample prior to placement in laboratory containers.
6. Place sediment into the appropriate sample containers provided by the analytical laboratory in the same order noted above. All sample containers should be containerized and labeled and placed in a cooler with ice in accordance with site sample handling procedures.
7. Collect field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples as described above.
8. Classify samples using a modified Burmister Soil Classification System and record on the Sediment Sampling Summary Form.
9. Once samples are collected, digital photographs shall be taken at each sampling location, upstream and downstream, or in general vicinity of sampling location if no discernible flow direction is observed.
10. Between each sampling location, hand sampling equipment will be cleaned with a brush and decontaminated following the procedures described in field SOP B.11.
11. Collect an equipment rinseate blank as described above.

Field observations will be recorded on Sanborn Head Sediment Sampling Summary Forms, or in a tabular format.

2.2.2 Sample Collection with an Ekman Sampler

If sampling stream and/or pond sediments below water, an Ekman grab/dredge sampler (or similar) with an approximate 200 cubic inch (equivalent to three liters) capacity will be used. This type of sampler does not collect samples in a manner which is consistent with sampling discrete layers in the sediment. As such, the samples collected will be more consistent with composite samples. Depending on sample recovery, multiple grab samples of sediment may be required from a planned sampling location to obtain sufficient volume of sediment for the required analyses. If multiple grab samples are required, the aliquots for volatile analyses (e.g., VOC analyses and PID headspace screening) will be taken from the first grab sample. Field-screening procedures are outlined in field SOP B.2.

1. Using the Ekman sampler (or equivalent), push the sampler into the bottom sediment at the selected location after approaching the location from downstream, and positioning the Ekman sampler upstream of the person doing the sampling.
2. Deploy sampler so as to fill, but not overfill, the sampler.
3. Remove sampler, allow standing water to drain. Containerize the sediment for

volatile analyses from the central/interior portion of the first sample (preferably from an undisturbed area) as soon as possible after collection of the sample.

4. Open the dredge and using a syringe, siphon off, to the extent possible while minimizing the disturbance of any fines, any existing standing water in the dredge.
5. Collect a VOC sample right from the dredge (using the methanol preserved VOA vials and disposable syringe). Using the laboratory provided graduated disposable syringe, the proper volume of sediment is added to the methanol preserved VOA vials (approximately 10 grams of sediment in each vial). A separate dry weight sample will not be necessary as long as the dry weight analysis is added to the analysis for the SVOC container.

   Using the syringe method to extract the VOC sample assumes that the water content does not prevent sample collection. If the water content and/or sediment characteristics are such that a sample can't be obtained using a syringe, a stainless steel tool will be used to transfer sediment from the dredge to the VOC sample vials, and a digital field scale will be used to verify appropriate volumes of sediment added to the vials.
6. Collect a discrete sediment sample right from the dredge for field-screening with a photoionization detector (PID). PID screening will be performed in accordance with SOP B.2.
7. Following collection of the samples for volatile analyses, empty the remaining sediment into stainless steel mixing bowl.
8. If sampler did not fully close, and thus did not retain a sediment sample due to roots or other obstructions, or if insufficient sample volume was retained for the remaining analyses, repeat Steps 1 through 4 until sufficient sample volume is collected.
9. Mix the sample volume thoroughly in the stainless steel bowl using a stainless steel spoon/scoop/spatula in a manner which limits the introduction of air into the sample as much as is practicable (i.e., "stirred" not "whipped"). Larger roots, twigs, leaves, gravel clasts, etc. should be removed from the sample prior to placement in laboratory sample containers.
10. Place sediment into the appropriate sample containers provided by the analytical laboratory in the same order noted above. All sample containers should be containerized and labeled and placed in a cooler with ice in accordance with site sample handling procedures.
11. Collect field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples as described above.
12. Classify samples using a modified Burmister Soil Classification System and record on the Sediment Sampling Summary Form.
13. Once samples are collected, digital photographs shall be taken at each sampling location, upstream and downstream, or in general vicinity of sampling location if no discernible flow direction is observed.

14. Between each sampling location, hand sampling equipment will be cleaned with a brush and decontaminated following the procedures described in field SOP B.11.
15. Collect an equipment rinseate blank as described above.

Field observations will be recorded on Sanborn Head Sediment Sampling Summary Forms, or in a tabular format.

2.2.3 Sediment Vertical Profile Sample Collection

Vertical profile sediment samples can be collected using a multi-stage, hand driven coring device manufactured by Art's Manufacturing & Supply, Inc. (AMS; or similar). The maximum coring depth using this equipment is approximately 4 feet below the sediment / water interface. The core contains a removable plastic liner that holds the sediment sample in place during core advancement and removal. The coring device is hand driven using a slide hammer and extension rods. Cores are driven to the desired depth and subsequently removed. The plastic liner is then removed from the stainless steel housing and cut open with a cutting tool for sample collection and inspection.

Depending on sample recovery, multiple cores of sediment may be required from a planned sampling location to obtain sufficient volume of sediment for the required analyses. If multiple grab samples are required, the aliquots for volatile analyses (e.g., VOC analyses and PID headspace screening) will be taken from the first grab sample. Field-screening procedures are outlined in field SOP B.2.

Collect the samples for volatile analyses directly from the sampling device as described above. A separate dry weight sample will not be necessary as long as the dry weight analysis is added to the analysis for the SVOC container. Collect a discrete sediment sample right from the sampling device for field-screening with a photoionization detector (PID). PID screening will be performed in accordance with SOP B.2. The remaining sediment is emptied into a stainless steel mixing bowl. Mix the sample volume thoroughly in the stainless steel bowl using a stainless steel tool in a manner which limits the introduction of air into the sample as much as is practicable (i.e., “stirred” not “whipped”).

Place sediment into the appropriate sample containers provided by the analytical laboratory in the same order as described above. All sample containers should be containerized and labeled and placed in a cooler with ice in accordance with site sample handling procedures (Refer to field SOP B.10).

Collect field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples as described above.

Classify samples using a modified Burmister Soil Classification System and record on the Sediment Sampling Summary Form.

Once samples are collected, digital photographs shall be taken at each sampling location, upstream and downstream, or in general vicinity of sampling location if no discernible flow direction is observed.

Between each sampling location, hand sampling equipment will be cleaned with a brush and decontaminated following the procedures described in field SOP B.11.

Collect an equipment rinseate blank as described above.

Field observations including the distance driven versus recovery of sample will be recorded on Sanborn Head Sediment Sampling Summary Forms, or in a tabular format.

3.0 PID FIELD-SCREENING

Will be performed in accordance with field SOP B.2.

4.0 FIELD EQUIPMENT CLEANING/DECONTAMINATION PROCEDURES

Sediment sampling (i.e., dredge sampler, hand auger, spades/shovels) and mixing (i.e., mixing bowl, spoon/scoop/spatula) equipment will be decontaminated between each sample collection as described in SOP B.11.

5.0 EQUIPMENT/SUPPLIES

- Ekman sampler (or similar)
- AMS Multi-Stage Core Sampler (or similar) with disposable plastic liners, requisite extension rods, slide hammer, and cutting tool
- Stainless steel spade/shovel
- Stainless steel hand auger
- Hand driven stainless steel split spoon or Geoprobe sampler
- Stainless steel spoon/scoop/spatula
- Stainless steel mixing bowl
- Implement enabling extended reach (e.g., piece of PVC pipe, broomstick, etc.)
- Laboratory provided sample containers and sediment transfer tools (e.g., plastic syringes)
- Cooler, ice, chain-of-custody forms and seals
- Digital camera
- Digital field scale (if not using pre-weighed soil transfer tools)
- GPS
- PID
- Aluminum foil
- Re-closable plastic bags
- Plastic sheeting
- Measurement tape
- Decontamination buckets, brushes, and non-phosphatic detergent, potable water, Deionized Water (DI) / distilled water
- Sediment Sampling Summary forms

- Field notebook
- Mohawk SAP
- Personal protective equipment (PPE)

Whenever standard operating procedures are varied, variations shall be recorded by Sanborn Head's field representative.

6.0 HEALTH AND SAFETY WARNINGS

This sampling procedure requires two field personnel if the sediment sample is being collected from a water body (e.g., Nashua River) where there is any potential for accidental drowning. If a sample cannot be obtained safely, the sample should not be taken and the conditions documented in the sampler's field book. Necessary precautionary measures should be heeded when performing these sampling techniques. Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

7.0 REFERENCES

The Sediment Sampling Procedure found in the current version of the Hazardous Waste Remediation Bureau Master Quality Assurance Project Plan (HWRB Master QAPP), EQA RFA# 08036.

Description and Classification of Soil

1. Density or Consistency: The density or consistency of a soil sample is based on the Standard Penetration Test N-value according to the following table:

Density of Granular Soil	SPT N-Value		Consistency of Cohesive Soil
Very Loose	0-4	<2	Very Soft
Loose	4-10	2-4	Soft
Medium Dense	10-30	4-8	Medium Stiff
Dense	30-50	8-15	Stiff
Very Dense	>50	15-30	Very Stiff
		>30	Hard

The Standard Penetration Resistance, or N-value in blows per foot, is the sum of the blows recorded over the second and third 6-inch interval.

A number followed by "/3" indicates the distance that the sampler advanced. For example "100/4" indicates that 100 blows of a 140 pound hammer falling 30 inches advanced the sampler 4 inches. "WOR/24" indicates the weight of the drilling rods without the hammer caused the sampler to advance 24 inches.

“WOH” indicates the static weight of the 140 pound hammer and the drilling rods attached to the split spoon sampler were sufficient to cause the sampler to advance.

“WOR” indicates the static weight of the drilling rods attached to the split spoon sampler was sufficient to cause the sampler to advance.

2. Color: The color of a soil sample is based on visual observation.

3. Soil Components

   A. Description: The components of a soil sample are described by visually estimating the percentage of each component by weight of the total sample using a Modified Burmister System.

      i. Major Component: The major soil component is written with upper case letters for granular soil (e.g., SAND, GRAVEL) and a combination of upper and lower case letters for fine grained soil (e.g., Silty CLAY, Clayey SILT).

      ii. Minor Component: The minor soil components are written with the first letter of each soil type in upper case, and the remaining letters in lower case (e.g., Gravel, Silt). The minor components are identified and prefaced in the description based on the following percentages:

Preface	Percentage
and	35-50
some	20-35
little	10-20
trace	0-10

      iii. Note: The actual percentages of gravel soil may differ from that measured when sampling with a standard split spoon sampler because of the relatively small sampler diameter. Also, it is not possible to identify the presence of boulders and cobbles using a standard split spoon sampler.

   B. Definitions

      i. Granular Soil: A granular soil sample is defined by the following particle sizes as referenced to a standard sieve:

Material	Description	Standard Sieve Limit	
		Upper	Lower
Boulders	C-sized	--	36 inch
	B-sized	36 inch	24 inch
	A-sized	24 inch	12 inch
Cobbles	--	12 inch	3 inch
Gravel	coarse	3 inch	3/4 inch
	fine	3/4 inch	No. 4
Sand	coarse	No. 4	No. 10
	medium	No. 10	No. 40
	fine	No. 40	No. 200

      ii. Fine Grained Soil: The degree of plasticity of fine-grained soils is defined as follows:

Material	Degree of Plasticity	Plasticity Index (PI)	Smallest Thread Diameter (in.)
SILT	Non-Plastic	0	None
Clayey SILT	Slight	1 to 5	1/4
SILT & CLAY	Low	5 to 10	1/8
CLAY & SILT	Medium	10 to 20	1/16
Silty CLAY	High	20 to 40	1/32
CLAY	Very High	40+	1/64

      iii. Organic Soil: An organic soil sample is classified by observation of the sample structure as follows:

Material	Description
TOPSOIL	Surficial soils that support plant life and which contain organic matter.
SUBSOIL	Soil underlying the topsoil which may contain roots or plant fibers.
PEAT	Deposits of plant remains in which the original plant fibers or root structure are visible.
ORGANIC SILT	Deposit of plant remains in which the original plant fibers or root structure have decomposed.

      iv. Non-Soil Constituents: Non-soil constituents (artificial or anthropogenic material, organic materials, cobbles and boulders) are described as follows:

      The following terminology is used to denote size ranges of non-soil constituents such as man-made objects or fill material:

Descriptive Term	Size Range	Comparative Term
Specks	< No. 200 Sieve	Silt and Clay fines
Particles	No. 200 Sieve to No. 4 Sieve	Sand
Fragments	No. 4 Sieve to 3 in.	Gravel
Pieces	3 in. to 12 in.	Cobbles
Blocks	> 12 in.	Boulders

      The following terminology is used to describe the frequency that a non-soil constituent is observed by estimating the percentage of the constituent by weight of the total sample:

Descriptor	Percentage
very few	0-5
few	5-10
common	10-20
frequent	20-35
numerous	35-50

4. Moisture Content: The moisture content of a soil sample is based on the observable presence of water according to the following table:

Dry	Moisture is not apparent, dusty.
Moist	No visible water.
Wet	Visible free water.

5. Other Pertinent Characteristics: Pertinent characteristics observed in a soil sample should be noted according to the following table:

Soil Structure Produced by Deposition of Sediments	
Stratified	Random soil deposits of varying components of color.
Varved	Alternating soil deposits of varying thickness (i.e., clays or silts).
Stratum	Soil deposit > 12 inches thick.
Layer	Soil deposit 3 inches to 12 inches thick.
Seam	Soil deposit 1/8 inch to 3 inches thick.
Parting/Lens	Soil deposit <1/8 inch thick.

Sediment Field Sampling Summary

Sampler's Signature:

SANBORN HEAD	Project Number:	Date:
	Project Name:	
	Project Location:	

PID Meter:	Project Manager:
Other:	Collector(s):
	Weather:

Field Measurements

Sampling Location					
Reference Point					
Reference Point Elevation (feet)					
Depth to Surface Water (feet below reference point)					
Surface Water Elevation (feet)					
Depth to Sediment (feet below reference point)					
Depth of Sample (inches below sediment surface; e.g., __ to __)					
PID (ppm)					
Sample Color					
Burmeister Sediment Description					
Date of Sample					
Sample Time					
Comment Reference Number					

Comments

1.
2.
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SOP B.10

SAMPLE HANDLING

CHAIN-OF-CUSTODY, SAMPLE PACKAGING AND SHIPMENT PROCEDURES

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1.0 SCOPE AND APPLICABILITY

Samples intended for chemical analysis will be handled during and after collection as discussed below at the Southern Parcel of the Mohawk Tannery Site in Nashua, New Hampshire. Samples will be collected in new, clean containers provided by the laboratory. Containers for samples requiring preservation will typically be provided pre-preserved by the laboratory. In instances where the laboratory does not provide containers, Sanborn Head will obtain suitable containers from an outside vendor.

Sample handling procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 SAMPLE COLLECTION AND DOCUMENTATION

Sample collection activities performed at the site will be appropriately documented, as described below. Copies of all field logbooks, sampling records and field forms shall be included in the final report prepared by Sanborn Head.

2.1 Field Notes

Field records will be maintained to provide a permanent record of activities conducted.

2.1.1 Logbooks

Field operations will be documented on an on-going basis by Sanborn Head. Documentation will be made in indelible ink in the primary logbook for the site. This primary logbook will be a bound notebook with water-resistant, sequentially numbered pages. Each page of the logbook will be initialed and dated by the field staff making the entry; the final page of each daily entry will include a signature.

Information recorded in daily entries in the primary logbook for the site will include:

- Site name and location;
- Project identification number;
- The date, times of personnel entries and exits from the site, and general notes regarding observations at and in the vicinity of the site;
- Temperature/weather conditions;
- Names of project personnel on-site (including contractors and subcontractors), organizational affiliations, activities they were engaged in, and reference to the bound field notebook they maintained (if applicable);
- General descriptions of site activities performed and general method(s) used;
- References to field sampling summary forms used by site personnel;

- Records of photographs taken; and
- Site sketches and diagrams made on-site.

Errors/changes in the bound notebook will be corrected/noted by making a single line through the entry such that it is still legible, and will be initialed and dated by the responsible person.

Field information recorded for each medium/matrix and type of sampling procedure will be documented on individual field forms such as Test Boring/Monitoring Well Logs or Soil or Groundwater Field Sampling Summary Forms. When field forms are used, they will be referenced in the primary field logbook on a daily basis. The forms will be retained in project files and included in project reports.

2.1.2 Sampling Records and Field Forms

Details of sample collection, including the NHDES Site #198404002, sample number; sample matrix; date, time, and sampling personnel; sample depth; method of collection (and sampling devices used); sample preservation and analysis information; location description including maps or diagrams, as necessary; and sample-specific observations such as color, odor, sheen, and/or field instrumentation response will be documented on the appropriate field form and/or chain-of-custody (COC) documentation. Each sample will be identified by a unique sample number written in indelible ink on an adhesive label on the sample container, on the container lid, and on the COC documentation.

As indicated above, to standardize the recording of information relevant to sampling of environmental media and completion of subsurface explorations, individual field forms will be completed as appropriate, including, but not limited to:

- Water Level/NAPL Summary Form;
- Calibration Forms
- Groundwater Quality Field Sampling Summary Form;
- Surficial Soil Field Sampling Summary Form;
- Sediment Field Sampling Form; and
- Surface Water Field Sampling Summary Form

The information contained on the forms will not be repeated in the field logbooks; however, the use of these field forms will be indicated in the daily entry in the primary field logbook. Field quality control samples, such as field duplicates and equipment rinseate blanks, will also be documented on field forms.

Field forms may be typed for legible presentation in the final report; handwritten original field forms will be retained in the project files for reference and included in project reports.

2.1.3 Chain-of-Custody Records

A COC is a legal document designed to track persons who are responsible for sample collection, sample delivery, sample storage, and sample analysis. COC records will be maintained for samples destined for laboratory analysis, to allow each sample to be tracked from its collection time and location, to the laboratory, through to its ultimate disposal. These records will include the NHDES Site #198404002, a project identifier, sample number, matrix, date and time of collection, analyses requested, preservation, and the signatures of the sampler(s) and the individuals who had custody of the samples at each point during sample handling. The COC should also include any QA/QC samples and associated information (i.e., duplicate, trip blank, temperature blank, and equipment blanks).

2.2 Field Documentation Management System

As indicated above, one primary, bound field logbook will be in use at any given time to record field activities. All pages of the primary logbook will be used, before another book is started, or remaining sheets clearly and irreversibly marked as unused. Each logbook will be tracked and archived with other project records in accordance with the project data management system. Secondary field logbooks assigned to individual field samplers may be in use concurrently. Each secondary field logbook will be uniquely numbered and referenced in the primary field logbook. Copies of all field logbooks, shall be included in the final report prepared by Sanborn Head.

3.0 SAMPLE HANDLING AND TRACKING SYSTEM

The term “sample” as used herein shall mean any sample collected from any matrix (e.g., soil, groundwater, sediment, and surface water) from the site and aliquotted into containers for field measurements and/or fixed laboratory analyses.

3.1 Sample Numbering System

In order to properly transfer groundwater sample results into the NHDES Environmental Monitoring Database (EMD) samples must be identified using the designated NHDES station identification. Samples results for other media may be uploaded to the NHDES EMD in the future.

- Sample names will include “MHK_” as a prefix. This includes samples going to the USEPA and New Hampshire Department of Health and Human Services (NHDPHS) labs, as well as outside labs so that later this data may be uploaded into the NHDES EMD;
- Sample names will be 15 characters or less, including the “MHK_”;
- Equipment Blanks will be labeled “EQUIP BLANK.” The equipment from which the equipment blank was collected will be documented in the field log book and indicated in the comments section of the COC form;
- Trip Blanks will be labeled “Trip Blank” without any other designation. If more than one Trip Blank is delivered with any group of samples, it will be clearly noted on the

COCs which samples are associated with each Trip Blank (example: Trip Blank, sample a, sample b, sample c, Trip Blank, sample x, sample y, sample z, etc.);

- Field duplicate samples will be blind to the laboratories and will be designated **OW-[laboratory matrix series #]**, where "laboratory matrix series #" corresponds to the sample deliverable group (SDG) number (e.g., the first soil field duplicate sample for SDG MT2-101 being submitted to the NHDPHS Lab will be named "OW-101"); and
- New sample location names will be approved by the NHDES Project Manager and the QA Coordinator in advance, following concurrence with USEPA.

Containers for samples intended for laboratory analysis will be labeled with the sample name, as indicated above, which will be used consistently during sampling rounds and on documents associated with the project. The sample name will be used to track samples through subsequent handling, analysis and data reduction procedures.

At a minimum, the sample container label will contain the following information:

- Sanborn Head Job Number (2158.01)
- Sample Location (e.g., MHK_SH-13)
- Sampling date (mm/dd/yy)
- Time of Collection (e.g., 1330)
- Sample analysis and Preservation
- Collector's Initials (e.g., MTS)

In addition to the sample container labels, the sample information will be logged on the applicable Sanborn Head field form.

3.2 Sample Delivery Groups

In general terms, a sample delivery group (SDG) is defined as a group of samples, of the same matrix, collected by the same sampling team, consisting of 20 field samples or less, which in terms of QA/QC procedures and deliverables are dealt with as a single group. Note: The QA/QC procedures described below do not apply to samples submitted to Geotesting Express for grain size analysis.

SDGs will include:

- 1 equipment blank (if applicable);
- 1 field duplicate sample; and
- 20 (or fewer) field samples.

In addition to the above-listed samples included in each SDG, each group will also include other necessary QA/QC samples that are not accounted for in the 20 field samples, but are required to be collected and analyzed with each SDG, nonetheless. These samples include:

- 1 site-specific MS/MSD sample (i.e., a field sample collected in triplicate, if extra sample volume is required by the laboratory). MS/MSD samples are not performed for PCB congener and dioxin/furan analyses;
- 1 trip blank per cooler (for SDGs containing samples to be submitted for VOC and 1,4-dioxane analyses only); and
- 1 performance evaluation (PE) sample, included with the first SDG for each matrix and each analysis as defined for this program in the project Sampling and Analysis Plan (SAP).

The laboratories will measure the cooler temperature upon receipt either by use of an infrared thermometer or by measuring the temperature of the temperature blank included in the cooler.

Samples collected for a given SDG will be collected over as short a time span as possible. If possible, for a given SDG, samples will be collected over a span of three working days or less. If the SDG stretches over a longer period of time, issues with regard to variations in instrument calibration and other variations in laboratory conditions may occur which may make the documentation, deliverables, and validation a more complicated process. Hence, Sanborn Head will plan to collect the SDGs in a time span of three working days or less.

In addition, holding times are a concern if samples are held in the laboratory to be batched as a single SDG. Therefore, for samples which include analyses with short holding times (e.g., groundwater samples submitted for hexavalent chromium [which has a holding time of 24 hours]), samples will be submitted to the laboratories to allow analyses to be completed within hold times. Samples with longer hold time analyses may be held by the laboratories until the SDG is closed and analyzed together.

SDG numbers will be designated MT2-[laboratory matrix series #]. Each laboratory and matrix has a designated series, as follows:

Series	Laboratory	Matrix
100	NHDPHS	Soil
110		Sediment
120		Groundwater from Monitoring Wells
130		Groundwater from Mini-Piezometers
140		Surface Water
200	USEPA	Soil
210		Sediment
220		Groundwater from Monitoring Wells
230		Groundwater from Mini-Piezometers
240		Surface Water
300	Alpha	Soil
310		Sediment
320		Groundwater from Monitoring Wells
330		Groundwater from Mini-Piezometers
340		Surface Water
400	USEPA Contract Lab	Soil
410		Sediment
520	EAI	Groundwater from Monitoring Wells
530		Groundwater from Mini-Piezometers
610	Geotesting[1]	Sediment

Each SDG will be numbered sequentially within each laboratory matrix series (e.g., the first SDG of soil samples submitted to the NHDPHS lab will be MT2-101, the second will be MT2-102, etc.). The SDG number will be noted on the laboratory COC.

3.2 Sample Packing Procedures

Sample containers are generally packaged in insulated coolers for transport, shipment, or pickup by the laboratory courier. Appropriate packing materials may include bubble wrap and air cushions. Sample containers are typically packed tightly to minimize movement during shipment that may cause breakage.

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[1] Geotesting Express does not provide COCs, so Alpha COCs will be used when transmitting samples for grain size analysis.

- To reduce the potential for breakage during shipment via a commercial shipper (e.g., FedEx, UPS, etc.), inert material should be placed, as appropriate, in the bottom of the cooler.
- Place each sample container, or set of sample containers that have been bubble wrapped tightly, inside a re-sealable plastic bag and seal, as a precaution against cross-contamination due to leakage or breakage.
- Place containers in an upright position in the cooler with ice and place glass containers in such a way that they do not come into contact with each other during shipment.
- After samples have been packed, additional ice will be added to the cooler so as to provide temperature preservative (temperature 4 ±2 degrees Celsius).
- Coolers being shipped via a commercial shipper (e.g., Federal Express, UPS, etc.) will be sealed with at least two signed and dated custody seals, placed on opposite sides of the lid and covered with clear packing tape such that one or more of the seals would be broken if the cooler were opened. The COC(s) will be placed in a sealed re-sealable plastic bag within each cooler being shipped to the laboratory.
- Coolers being transported via laboratory courier will be sealed with at least two signed and dated custody seals, placed on opposite sides of the lid and covered with clear packing tape such that one or more of the seals would be broken if the cooler were opened. The COC(s) will be placed in a sealed re-sealable plastic bag and taped to the outside of the cooler such that the courier may sign it when taking custody of the cooler.

3.3 Sample Pickup/Shipping Procedures

Samples will be properly packaged for shipment, and a separate signed COC record will be enclosed in each sample cooler if more than one is used. Samples will be transported to the laboratory via laboratory currier in such a manner as to preserve their integrity and will be delivered at least every other day if possible, every three days at maximum; no samples should be held over the weekend.

If Friday sampling is unavoidable and Saturday delivery is not possible, samples shall be properly stored (custody and sample preservation must be maintained) over the weekend.

A commercial shipper (i.e., Federal Express, UPS, etc.) may be used for sample shipment. The individual relinquishing custody will sign and date the COC form and enter the airbill number in the "Received By" section, and the tracking number recorded. The airbill will be maintained in Sanborn Head's files and considered part of the COC. When using a commercial shipper the sample cooler will be secured with at least two signed and dated custody seals, placed on opposite sides of the lid and covered with clear packing tape such that one or more of the seals would be broken if the cooler were opened for shipment to the laboratory.

4.0 SAMPLE CUSTODY

The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched (e.g., prepared for shipment). As few people as possible should handle the samples. A sample including empty sample containers, samples and coolers are under a person's custody if it meets the following requirements:

- It is in the person’s possession;
- It is in the person’s view, after being in the person’s possession;
- It was in the person’s possession and it was placed in a secured location; or it is in a designated secure area.

******Never leave samples, including un-used sample containers, unattended unless they are secured in a locked vehicle or building.******

COC forms will be maintained from the time of collection to the time of disposal for samples submitted for laboratory analysis. If samples are relinquished to a commercial shipper rather than to a laboratory representative or other project staff, the individual relinquishing custody will sign and date the form and enter the carrier name and airbill number in the “Received By” section. The sample cooler will be sealed with at least two signed and dated custody seals, placed on opposite sides of the lid and covered with clear packing tape such that one or more of the seals would be broken if the cooler were opened.

- The field sampler will review the Sampling and Analysis Plan (SAP) provided by the project manager for specific COC record-keeping requirements. Note the following key COC related items:
  - Quality Assurance/Quality Control (QA/QC) data package requirements (i.e., level A, B, or C) for project-specific data validation needs.
  - Laboratory reporting options required (i.e., preliminary results requested or electronic deliverable options needed).
  - Standard or rush turn-around-time required.
  - Special laboratory requirements needed (i.e., lower detection limits).
  - Short hold time issues.
  - Sample volume issues.
- The field sampler will label sample bottles with the following: sample name, sampler initials, date and time sample was collected, laboratory analyses and test methods requested, preservative used, and project number. Sample labels should be filled out using indelible ink for each sample.

  Note: If soil VOA samples are collected, no additional labels or tape should be used as these are pre-weighed by the laboratory.

- Prior to leaving the site, the field sampler will verify that pertinent data is on both the sample label and the COC form. Check for errors on the label and COC form.

- The COC will be filled out and include the following: NHDES Site number, sample name, time and date of collection, matrix type (e.g., soil, groundwater, surface water), laboratory tests and methods requested, the preservative used, the number of containers, project contact information, specific requirements such as specific Reporting Detection Limits and any special notes. The COC should also include any QA/QC samples and associated information (i.e., duplicates, trip blanks, and equipment rinseate blanks).

  Either one of the field samplers or the onsite QA Officer will prepare the COC forms. The names and phone numbers of the field samplers and/or the QA Officer must be listed on the COC.

- When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to a fixed laboratory, or to/from a secure storage area.

  One of the field samplers will sign the first "relinquished by" line. The person who receives the samples at the laboratory signs the COC last in the "received by" line. In case there are additional steps in the process requiring another person or persons to take custody of the sample, the form has additional lines for signatures. Signatures must be in ballpoint pen and followed by the date and time that the COC was signed. The line at the bottom of the page is provided for personnel from the laboratory to sign for receiving the sample.

  Note: Any errors must be lined out and initialed/dated, and the correction written in.

5.0 EQUIPMENT/SUPPLIES

The following is a list of equipment and material commonly used for labeling, packaging and shipping samples:

- COC forms/custody seals
- Bubble wrap or air cushions
- Re-sealable plastic bags
- Ballpoint / indelible ink pen
- Ice
- Shipping coolers
- Sample labels
- Packing tape
- Personal protective equipment (PPE)

6.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for task-specific health and safety warnings.

7.0 REFERENCES

The Chain of Custody Sample Handling and Shipping guidance found in the current version of the Hazardous Waste Remediation Bureau Master Quality Assurance Project Plan (HWRB Master QAPP), EQA RFA# 08036.

Shipping Group:1

Chain-of-Custody

SANBORN HEAD

20 Foundry Street
Concord, NH 03301
P (603) 229-1900
F (603) 229-1919

To:

USEPA Region 1
New England Regional Laboratory
11 Technology Drive
North Chelmsford, MA 01863-2431

Relinquished By:	***Date / Time***	***Received By:***	***Date / Time***

Project Information

Name: Mohawk Tannery Southern Parcel
Number: 2158.01
Location: Nashua, New Hampshire
Manager: T. White
Account #:
Quote #:

Deliverable Information

TAT: Standard
Delivery Method: Alpha Courier
Email To: kdubois@sanbornhead.com
Data Package Option:
EDD Type:

Other Information

SGD Complete? MT2-201 - Not Complete
Internal COC Required?
Site Specific QA/QC? Yes

Lab ID (Lab Use Only)	Sample Name	Collection		Matrix	Top Depth	Bottom Depth	Filtered? (Field / Lab)	VOCs/HCl	SVOCs					Remarks:
		Date	Time											
	MHK_GZ-10	9/19/2012	0920	GW	–	–	No	4	2					

NHDPHS LABORATORY SERVICES LOGIN AND CUSTODY SHEET

(Laboratory Policy: Samples not meeting method requirements will be analyzed at the discretion of the NHDPHS, PHL Laboratory.)

Samples must be delivered in a cooler with loose ice.

LAB ACCOUNT (Billing) **#04-0007207**
One Stop (PROJECT) ID# **HWR/ORCB**
DES Site Number **198404002**
Temp. ^{0}C. ____

Description: **Mohawk Tannery Site**
Town: **Nashua, NH**

NHDES Contact: Robin Mongeon (603) 271- 7378, Sharon Perkins (603) 271- 6805 (Sharon's cell 419-9209)

Comments:

SHA Contacts: Tim White (603) 415-6139, Kelly Dubois (603) 415-6135; Charles Crocetti, (603) 415-6121

Collected By & Phone#: Matthew Stein, (603) 415- 6161/cell: (603) 496-0275

Sample Location / ID	Date/Time Sampled	# of Containers	Matrix	Total Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V	Dissolved Sb, As, Ba, Cd, Pb, Mn, Hg, Tl, V							Comments	Lab ID # (For Lab Use Only)
			AQ										
			AQ										
			AQ										
			AQ										
			AQ										
			AQ										
			AQ										
			AQ										
			AQ										
			AQ										
			AQ										

Preservation: Aqueous Metals = HNO_3 Solid Metals = 4°C +/-2°C

☐ Temperature Blank Included in Cooler

Relinquished By____________________ Date and Time__________ Received By____________

Matrix: A= Air, S= Soil, SED=Sediments, AQ=Aqueous, Other=____

Relinquished By____________________ Date and Time__________ Received By____________

Relinquished By____________________ Date and Time__________ **Received For Laboratory By________**

Page ______ of _______

Data Reviewed By________________ Date________

Section No.: 22.0
Revision No.: 6 (HWRB)
Date: July 2011

CHAIN OF CUSTODY

PAGE_______ OF _______

Date Rec'd in Lab:

ALPHA Job #:

ALPHA ANALYTICAL

WESTBORO, MA
TEL: 508-898-9220
FAX: 508-898-9193

MANSFIELD, MA
TEL: 508-822-9300
FAX: 508-822-3288

Client Information

Client:

Address:

Phone:

Fax:

Email:

☐ These samples have been previously analyzed by Alpha

Project Information

Project Name:

Project Location:

Project #:

Project Manager:

ALPHA Quote #:

Turn-Around Time

☐ Standard ☐ RUSH *(only confirmed if pre-approved!)*

Date Due: **Time:**

Report Information - Data Deliverables

☐ FAX ☐ EMAIL
☐ ADEx ☐ Add'l Deliverables

Billing Information

☐ Same as Client info PO #:

Regulatory Requirements/Report Limits

State /Fed Program	*Criteria*

Other Project Specific Requirements/Comments/Detection Limits:

SAMPLE HANDLING

*Filtration*_________
☐ Done
☐ Not needed
☐ Lab to do
Preservation
☐ Lab to do
(Please specify below)

ALPHA Lab ID (Lab Use Only)	Sample ID	Collection Date	Collection Time	Sample Matrix	Sampler's Initials	ANALYSIS												Sample Specific Comments	TOTAL # BOTTLES

Container Type												
Preservative												

Relinquished By:	Date/Time	Received By:	Date/Time

Please print clearly, legibly and completely. Samples can not be logged in and turnaround time clock will not start until any ambiguities are resolved. All samples submitted are subject to Alpha's Terms and Conditions.
See reverse side.

FORM NO: 01-01 (rev. 14-OCT-07)

Page ________ of ________

Chain-of-Custody Record

Bold Fields Required. Please Circle Requested Analysis.

For Lab Use Only

				VOC				SVOC					TCLP	Metals		Inorganics								Micro		Other				
Sample I.D.	**Sampling Date/Time** *If Composite, Indicate Both Start & Finish Date/Time	**Matrix (see below)**	**Grab/*Composite**	524.2 524.2 BTEX 524.2 MTBE only	8260B 624 VTICs 1, 4 Dioxane	8021B BTEX HALOS	8015B GRO MAVPH	8270D 625 SVTICs EDB DBCP ABN A BN PAH	TPH8100 L1 L2	8015B DRO MAEPH	PEST 608 PCB 608 PEST 8081A PCB 8082	Oil & Grease 1664 TPH 1664	TCLP 1311 ABN Metals VOC Pest Herb	Dissolved Metals (List Below)	Total Metals (List Below)	TS TSS TDS Spec. Con.	Br Cl F SO_4 NO_2 NO_3 NO_3NO_2	BOD CBOD T. Alk.	TKN NH_3 T. Phos. O. Phos.	pH T. Res. Chlorine	COD Phenols TOC DOC	Total Cyanide Total Sulfide	Reactive Cyanide Reactive Sulfide Flashpoint Ignitability	Total Coliform E. Coli Fecal Coliform	Enterococci Heterotrophic Plate Count				# of Containers	**Notes** MeOH Vial #

Matrix: A-Air; S-Soil; GW-Ground Water; SW-Surface Water; DW-Drinking Water; WW-Waste water

Preservative: H-HCL; N-HNO_3; S-H_2SO_4; Na-NaOH; M-MEOH

Project Manager: ______________________________

Company: ______________________________

Address: ______________________________

City: ____________________ State: __________ Zip: __________

Phone: ____________________ Ext.: __________

Fax: ______________________________

E-Mail: ______________________________

Site Name: ______________________________

Project #: ______________________________

State: NH MA ME VT Other: __________

Regulatory Program: NPDES: RGP POTW Stormwater or GWP, Oil Fund, Brownfield or Other: __________

Quote #: ____________________ PO #: ____________________

Date Needed: ______________________________

QA/QC Reporting Level

A B C

OR

Presumptive Certainty

Reporting Options

Prelims: Yes or No

If Yes: Fax or PDF

Electronic Options

No Fax E-Mail PDF Equis

Temp. __________ °C

ICE? Yes No

Sampler(s): ______________________________

Relinquished By:	Date:	Time:	Received By:
Relinquished By:	Date:	Time:	Received By:
Relinquished By:	Date:	Time:	Received By:

Metals: 8 RCRA 13 PP Fe, Mn Pb, Cu

Other Metals: ______________________________

Samples Field Filtered? ☐ **Yes** ☐ **No**

Notes: (ie: Special Detection Limits, Billing Info, If Different)

Site History: ______________________________

Suspected Contamination: ______________________________

Field Readings: ______________________________

Eastern Analytical, Inc.
professional laboratory & drilling services

25 Chenell Drive | Concord, NH 03301 | Tel: 603.228.0525 | 1.800.287.0525 | Fax: 603.228.4591 | E-Mail: customerservice@eailabs.com | www.eailabs.com

(**WHITE:** Original **GREEN:** Project Manager)

EPA

USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

1. Case No.:
DAS No.:

R

2. Region:
Project Code:
Account Code:
CERCLIS ID:
Spill ID:
Site Name/State:
Project Leader:
Action:
Sampling Co.:

3. Date Shipped:
Carrier Name:
Airbill:
Shipped To:

4. Chain of Custody Record

Sampler Signature:

Relinquished By: **(Date/Time)**	**Received By:** **(Date/Time)**
1)	
2)	
3)	
4)	

5. ORGANIC SAMPLE No.	6. MATRIX/ SAMPLER	7. TYPE	8. ANALYSIS/ TURNAROUND	9. TAG No./ PRESERVATIVE/Bottles	10. STATION LOCATION	11. SAMPLE COLLECT DATE/TIME	12. INORGANIC SAMPLE No.	13. QC Type

14. Shipment for Case Complete?

15. Sample(s) to be used for laboratory QC:

16. Additional Sampler Signature(s):

17. Chain of Custody Seal Number:

18. Analysis Key:

Type: Comp, Grab (from Box 7)

19. Shipment Iced? ____________

20. TR Number:

REGION COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.
Send Copy to: Sample Management Office, Attn: Heather Bauer, 15000 Conference Center Dr., Chantilly, VA 20151 Phone 703/818-4200 Fax 703/995-4415

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EPA

USEPA Contract Laboratory Program
Organic Traffic Report & Chain of Custody Record

1. Case No.:

DAS No.:

SDG No.:

L

2. Date Shipped:	**3. Chain of Custody Record**	**Sampler Signature:**	
Carrier Name:	**Relinquished By: (Date/Time)**	**Received By: (Date/Time)**	
Airbill:	1)		
Shipped To:	2)		
	3)		
	4)		

4. For Lab Use Only

Lab Contract No: ____

Unit Price: ____

Transfer To: ____

Lab Contract No: ____

Unit Price: ____

5. ORGANIC SAMPLE No.	6. MATRIX/ SAMPLER	7. TYPE	8. ANALYSIS/ TURNAROUND	9. TAG No./ PRESERVATIVE/Bottles	10. STATION LOCATION	11. SAMPLE COLLECT DATE/TIME	12. INORGANIC SAMPLE No.	13. FOR LAB USE ONLY Sample Condition On Receipt

14. Shipment for Case Complete?	**15. Sample(s) to be used for laboratory QC:**	**16. Additional Sampler Signature(s):**	**17. Cooler Temperature Upon Receipt:**	**18. Chain of Custody Seal Number:**
19. Analysis Key:	**Type:** Comp, Grab (from Box 7)		**20. Custody Seal Intact?** ____	**21. Shipment Iced?** ____

22. TR Number:

LABORATORY COPY

PR provides preliminary results. Requests for preliminary results will increase analytical costs.

Send Copy to: Sample Management Office, Attn: Heather Bauer, 15000 Conference Center Dr., Chantilly, VA 20151 Phone 703/818-4200 Fax 703/995-4415

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05/04

SOP B.11

SAMPLING EQUIPMENT DECONTAMINATION

TABLE OF CONTENTS

1.0 SCOPE AND APPLICABILITY

This Standard Operating Procedure (SOP) is designed to provide a procedure for preventing, or limiting cross-contamination of environmental samples at the Mohawk Tannery Site in Nashua, New Hampshire. Removing or neutralizing contaminants from equipment not only minimizes the likelihood of sample cross contamination, but reduces or eliminates transfer of contaminants to clean areas and limits the mixing of incompatible substances. In addition, decontamination reduces health hazards and prevents the spread of contaminants off-site.

Decontamination procedures are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURE

The procedure will be followed for decontaminating sampling equipment (e.g., manual Geoprobe®, hand augers, water level meters, sediment sampling tools, etc.). The decontamination procedure is summarized as follows:

1. Set up a decontamination line. The decontamination line should progress from "dirty" to "clean", with an area for drying decontaminated equipment. The decontamination line should be set up on plastic sheeting.
2. Flush and rinse the equipment with potable water. If equipment includes pumps, make sure that rinse water is mechanically run through the pump system (see Special Conditions).
3. Wash the item thoroughly in a bucket, wash basin, or tub of a non-phosphate detergent and potable water. Use a stiff-bristle brush to dislodge any clinging dirt. Disassemble any items that might trap contaminants internally before washing. Do not reassemble until decontamination is complete.
4. Rinse the item in a basin containing potable water. Rinse water should be replaced as needed.
5. Flush and rinse with distilled or deionized water.
6. Allow to air dry.
7. Document that decontamination was performed in the appropriate logbook or sample sheet.
8. Decontamination water will be managed in accordance with the field SOP B.12.
9. Secure clean equipment.

If the soils are anticipated to be or are found to be highly contaminated, a solvent wash (e.g., isopropyl alcohol) may be used following the non-phosphate detergent wash. If a solvent wash is used, the final step in the decontamination procedure (following a potable water rinse) will be a rinse with distilled/deionized water to remove remaining traces of solvent.

2.1 Sensitive Equipment

Sensitive equipment which is not waterproof should be wiped down with a damp cloth.

2.2 Water Level Meter

Water level indicator probes will be decontaminated after each monitoring well and, at a minimum, the length of tape used in that well in accordance with the above described methods.

2.3 Sampling Pumps (Bladder)

If decontaminating a QED Sample Pro (or similar) Bladder Pump: the pump is disassembled after each sample is collected and the disposable one-time use only internal components (Teflon bladder, the metal screen and top plate, and the o-rings) are discarded. Using a bottle brush, scrub the external and internal body of the pump with distilled water and then rinse with distilled water. Replace the internal components including the Teflon bladder, the metal screen and top plate, and the o-rings that come in new pre-packaged, sealed replacement bladder kits.

3.0 QUALITY ASSURANCE/QUALITY CONTROL

Equipment blanks shall be collected and analyzed throughout the program to determine the effectiveness of decontamination procedures. If an equipment blank is analyzed and found to contain a contaminant, possible sources of error will have to be investigated to determine whether or not the decontamination procedures were properly followed. Possible sources of error include: inadequate scrubbing/washing/rinsing of equipment; inadequate choice of chemical rinses; use of contaminated detergents or rinse waters; contact with contaminants after decontamination but prior to sampling, and/or, laboratory error. Refer to **Table 5** in the Sampling and Analysis Plan (SAP) regarding collection of equipment blanks.

4.0 EQUIPMENT/SUPPLIES

The following is a list of equipment and materials commonly used for decontamination:

- Distilled/Deionized water
- Potable water
- Isopropyl Alcohol, as required
- Plastic buckets/wash basins/tubs
- Plastic sheeting
- Brushes

- Non-phosphatic detergent
- Spray bottles
- Paper towels
- Re-sealable plastic bags
- Appropriate personal protective equipment [PPE] (i.e., safety glasses appropriate gloves, boots)
- Mohawk SAP

5.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

SOP B.12

HANDLING OF INVESTIGATION DERIVED WASTE

TABLE OF CONTENTS

1.0 SCOPE AND APPLICABILITY

This Standard Operation Procedure (SOP) describes the procedures to be followed in the handling and disposition of investigation derived waste (IDW) on the Southern Parcel of the Mohawk Tannery Site in Nashua, New Hampshire. IDW includes soils and other environmental material that is retrieved from the subsurface, used decontamination water, as well as used disposable personal protective and sampling equipment (e.g., gloves, tubing).

Procedures related to IDW are discussed below. Where conditions warrant, these procedures may be altered with the approval of Sanborn, Head & Associates, Inc.'s (Sanborn Head's) Project Manager or Principal-in-Charge (PIC). Deviations from these procedures will be documented.

2.0 PROCEDURES

The following procedures for handling/disposing investigation derived waste will be implemented during the course of this project.

Soils – Soil removed from explorations (shallow borings, etc.) will be placed back into the originating explorations when space allows. In the event soil cannot be placed back into the originating explorations, it will be handled one of two ways.

- Soils exhibiting evidence of contamination (i.e., based on visual, olfactory, or PID indicators) will be placed in a pile on-site that is secured/covered with tarpaulins.
- Soil that does not appear contaminated will be spread on the ground surface near the point of origin.

Groundwater – Groundwater evacuated from monitoring wells or mini-piezometers/well points as part of development or sampling will be allowed to infiltrate into the soils in the area of the well following sample collection. If a measureable layer of floating product (i.e., >0.01 feet) is present in the evacuated water, the product-containing water will be placed in drums, dated, and labeled accordingly. Drums will be stored on-site pending characterization and disposal.

Sediment – If excess sediment is obtained during sample collection it will be placed back into the originating explorations. In the event sediment cannot be placed back into the originating explorations it will be handled one of two ways.

- Sediment exhibiting evidence of contamination (i.e., based on visual, olfactory, or PID indicators) will be placed in a pile on-site that is secured/covered with tarpaulins.
- Sediment that does not appear contaminated will be spread on the ground surface near the point of origin.

Solid Waste – Based on previous investigations performed at the site, used disposable personal protective equipment (PPE) and disposable sampling equipment will be handled as solid waste and disposed of in a dumpster or similar receptacle for off-site disposal.

Used Decontamination Water – Based on previous investigations performed at the site, we anticipate that water used for decontamination and cleaning of field equipment will be allowed to infiltrate into the soils in the area of the decontamination activities.

3.0 HEALTH AND SAFETY WARNINGS

Refer to the Site-Specific Health and Safety Plan for all task-specific health and safety warnings.

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