

MASTER
QUALITY ASSURANCE PROJECT PLAN
of the
Oil Remediation and Compliance Bureau
Waste Management Division
New Hampshire Department of Environmental Services

This document serves as the quality assurance project plan for all of the USEPA regulated leaking underground storage tank and petroleum brownfield sites being investigated and/or remediated through contracts administered by the Oil Remediation and Compliance Bureau and any sampling at federally regulated leaking underground storage tank sites by Oil Remediation and Compliance Bureau staff.

EQA RFA #18060



Prepared By:
Margaret Bastien, P.E.
QA Coordinator
Oil Remediation and Compliance Bureau
Waste Management Division
New Hampshire Department of Environmental Services
29 Hazen Drive
Concord, N.H. 03302-0095
Phone: (603) 271-7372
E-mail: Margaret.Bastien@des.nh.gov

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This document serves as the Quality Assurance Project Plan for all USEPA regulated leaking underground storage tank and petroleum brownfield sites being investigated and/or remediated through federally funded contracts administered by the Oil Remediation and Compliance Bureau and any federally funded sampling by Oil Remediation and Compliance Bureau staff.

Margaret Bastien, P.E.
NHDES ORCB Quality Assurance Coordinator and Oil Remediation Program Manager

Signature:  Date: May 8, 2018

Sarah Yuhas Kirn, P.G.
NHDES ORCB Administrator

Signature:  Date: May 8, 2018

Vincent R. Perelli
NHDES QA Manager

Signature: p.p.  Date: May 9, 2018

Susan Hanamoto
NH UST/LUST Coordinator, USEPA Region 1

Signature:  Date: May 11, 2018

Robert Reinhart
QA Officer, EPA Region 1

Signature:  Date: May 17, 2018

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(Found only in the original QAPP that is maintained by the Quality Assurance QA Coordinator)

DISTRIBUTION LIST

Upon approval and implementation of this Master Quality Assurance Project Plan (QAPP) for the Oil Remediation and Compliance Bureau (ORCB), the ORCB Quality Assurance (QA) Coordinator shall:

1. Retain a hardcopy of the current QAPP.
2. Provide an electronic copy of the QAPP to the New Hampshire Department of Environmental Services (NHDES) QA Manager.
3. Ensure that the current QAPP, and all subsequent yearly updates of the QAPP, are uploaded on the NHDES website.
4. Notify the following people of the location of the official (most current) version of the ORCB Master QAPP by email; including a link to the QAPP on the website:
 - a. All ORCB Personnel
 - b. The contact person for each contractor approved by NHDES to perform work for the ORCB
 - c. Others, as required/requested

The control version of this document is the electronic version viewed on-line only. If this is a printed copy of the document or any part of the document (e.g., text, standard operating procedures), then it is an uncontrolled version and may or may not be the version currently in use.

The current official version of the ORCB Master QAPP is available on the NHDES website. Other links may be provided as appropriate.

LIST OF ACRONYMS

AGQS	Ambient Groundwater Quality Standards
COC	Contaminant of Concern
DQO	Data Quality Objective
FID	Flame Ionization Detector
GMZ	Groundwater Management Zone
MDL	Method Detection Limit
NHDES	New Hampshire Department of Environmental Services
NHDHHS	New Hampshire Department of Health and Human Services
NHDPHS Lab	NHDHHS Public Health Services Laboratory Services Unit
NHELAP	New Hampshire Environmental Laboratory Accreditation Program
MtBE	Methyl tertiary-Butyl Ether
ORCB	Oil Remediation and Compliance Bureau
OSHA	Occupational Safety and Health Administration
PEHB	Permitting and Environmental Health Bureau
PID	Photoionization Detector
RP	Responsible Party
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
RDL	Reporting Detection Limit
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
SRCIS	Spill Response and Compliant Investigation Section
USEPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile Organic Compound

1.0 INTRODUCTION

The United States Environmental Protection Agency (USEPA) requires that all organizations conducting environmental programs funded by USEPA establish and implement a quality system. USEPA also requires that all environmental data used in decision making be supported by an approved QAPP. This generic QAPP meets this requirement by establishing criteria for all USEPA funded sample collection and data generation activities associated with the leaking underground storage tank and petroleum brownfields programs of the ORCB ensuring data are of adequate quality for their intended use. This QAPP does not cover:

- projects which are administered by the Hazardous Waste Remediation Bureau,
- sites that are being managed under a contractor's QAPP or QA program, or
- analyses covered by a laboratory's quality assurance programs other than in general terms.

This QAPP is composed of standardized elements covering routine aspects of a corrective action project from planning through implementation. More detailed site specific requirements not covered in this QAPP will be included in a site-specific Sampling and Analysis Plan (SAP) or QAPPs, which will be written as needed. See Appendix E for an example of a SAP outline. Site specific SAPs and QAPPs will be approved by the appropriate Project Manager, USEPA (in the case of petroleum brownfields SAPs and QAPPs), with a copy provided to the NHDES QA Manager.

All procedures must be in accordance with applicable professional technical standards, USEPA requirements, the NHDES Administrative Rules, other applicable government regulations or guidelines, and specific project goals and requirements.

This document replaces the Master Quality Assurance Project Plan of the ORCB (Quality Assurance Project Plan for the ORCB, January 2011).

1.1 Overview of the Leaking Underground Storage Tank Program

Sites regulated under the Leaking Underground Storage Tank Program in New Hampshire proceed through the following phases of activities: 1) notification, 2) emergency and initial response, 3) site investigation, 4) remediation, 5) groundwater monitoring, and 6) site closure, as described below.

When a petroleum release occurs, the facility owner/operator has a legal duty to notify and must undertake corrective action to meet state and federal requirements. Notification and corrective action requirements are detailed in New Hampshire Administrative Rules Env-Or 600.

Typically, the initial response to releases and reported spills is completed by the Spill Response and Complaint Investigation Section (SRCIS). SRCIS turns over the cleanup and day to day oversight of sites to the remediation section once the initial response activities are complete. New releases also enter the system during the removal of underground storage tanks (UST). In the case of UST removals, NHDES sends a representative of our Petroleum Remediation Section to visit the site during the tank pull. Their presence onsite allows NHDES to make timely

decisions on the removal of source area contamination and the proper collection of samples for the tank closure report.

Corrective actions include consultants/contractors performing an investigation determining the extent and magnitude of the release and developing a remediation plan detailing cleanup implementation. NHDES is responsible for ensuring that surface waters, groundwater, and public health are protected. The NHDES project managers work with site owners to ensure that investigation and remediation are conducted as necessary.

Corrective actions are primarily conducted by contractors and consultants hired by the responsible party (ies). Sample analysis is conducted by laboratories certified by the USEPA or New Hampshire Environmental Laboratory Accreditation Program (NHELAP) pursuant to Env-C 300. The requirement for laboratory certification is a key component of NHDES' QA program for the samples collected by third parties.

Occasionally, a NHDES staff collects samples from sites without a responsible party, orphan site, under enforcement or at USEPA's request for Office of Research and Development related research. Samples collected by NHDES staff are analyzed at the New Hampshire Department of Health and Human Services (NHDHHS), Division of Public Health Services Laboratory Services Unit (NHDPHS Lab) or through a NHDPHS Lab chain of custody at a contract laboratory. Our sampling efforts are generally limited to split samples and grab samples of surface water, drinking water supplies or groundwater found in excavations. This QAPP does not include groundwater monitoring well sampling protocols since typically NHDES staff does not sample monitoring wells. If monitoring well sampling is required, a monitoring well sampling standard operating procedure (SOP) will be included in the site's sampling and analysis plan.

NHDES operates a separate program addressing residential drinking water contamination when a responsible party has not been identified or is unable or unwilling to address the contamination. As part of this program, NHDES administers a contract for the delivery of bottled water and the design and installation of point of entry treatment systems. NHDES project managers are responsible for evaluating the data collected by contractors/consultants and analyzed by either the NHDPHS Lab or by other private labs certified by NHELAP or USEPA.

NHDES uses its contractors to complete corrective action work at petroleum brownfields sites or at sites where the responsible party is unable or unwilling to perform corrective action work. These sites are known as State lead sites. Contractors for State lead sites are procured through State of New Hampshire standard practices as outlined in RSA 21-I:22. Sites are assigned to contractors on a rotating basis to distribute work evenly. Program Managers provide input on contractor selection taking into account contractor availability, skills related to the issues found at the site and previous work experiences. The contractors prepare Work Scopes to complete tasks in accordance with NHDES requirements, and they incorporate the NHDES project managers' input into these documents. SAPs may be written by the contractor or the ORCB Quality Assurance Coordinator, and they describe the methods the contractor will use to accomplish tasks in the Work Scopes. SAPs are written prior to any sample collection in the field and when

- 1) an extensive sampling effort is required, or
- 2) data quality objectives (DQOs) are particularly stringent.

At the discretion of the project manager and the Quality Assurance Coordinator, a SAP may not be written for sampling efforts where timeliness is essential to protecting human health and the environment such as assessing water supplies potentially impacted by a recent spill or a newly-discovered release. In these cases, contractors must rely on this QAPP and established practices to meet the DQOs

The NHDES project manager approves Work-Scopes and SAPs, with input from the Quality Assurance Coordinator. See Appendix E for an example of a SAP outline.

After sufficient characterization of groundwater plumes and remedial measures implemented, sites are managed under a groundwater management permit. If groundwater samples from all onsite monitoring wells meet ambient groundwater quality for two rounds of monitoring and the site meets soil standards, the site is closed.

1.2 Program Organization, Responsibilities and Communication Pathways

A graphic illustration of the project organization and communication pathways can be found in **Appendix A**. These are considered to be general pathways of communication and do not restrict communication between all parties, as necessary. The roles and responsibilities are described in greater detail in **Appendix A**.

- The Quality Assurance Manager (QA) Manager is the key NHDES individual responsible for QA. The QA Manager reports to the Commissioner's Office and communicates directly with the ORCB QA Coordinator.
- The QA Coordinator reports to the ORCB Administrator and is the liaison between the QA Manager and all other ORCB personnel. When the NHDPHS Lab or the current NHDES Contract Lab is used, the QA Coordinator is the liaison between each lab and the Project Manager. The QA Coordinator periodically reviews sampling reports received from the NHDPHS Lab for QC.
- The section supervisors report to the ORCB Administrator and interact directly with the Project Managers, the QA Coordinator, the contractor and USEPA.
- The Project Managers report to subsection supervisors and coordinate activities with the QA Coordinator, contractor, NHDES Contracts Supervisor, NHDPHS Lab, the NHDES Contract Lab, the Permitting and Environmental Health Bureau in the NHDES Air Division for their assessment of possible health effects, and USEPA.
- The NHDES Contracts Supervisor issues work scope approvals, tracks budgets and provides contractor performance feedback and reviews.
- The contractor coordinates activities directly with their staff, the Project Manager, the QA Coordinator, NHDES Contracts Supervisor and the appropriate laboratory.
- When the NHDPHS Lab is used, the lab typically reports the analytical results to the Project Manager, after having audited the results in accordance with their SOPs.

- When the current NHDES Contract Lab is used, the lab typically reports the analytical results to the QA Coordinator, Project Manager, and the contractor, after having reviewed the results in accordance with their SOPs. Refer to the SAP for specific requirements.
- The PEHB reports risk assessment determinations to the appropriate Project Manager and may communicate with QA personnel or the contractor as necessary.
- USEPA communicates with the QA personnel, the ORCB Administrator, the section supervisors and the Project Managers.

1.3 Project Description

There are two classes of activities covered by this QAPP: 1) NHDES contractor led activities, under NHDES supervision, at sites using USEPA funding, and 2) NHDES staff collecting samples related to corrective actions at a site

For the NHDES contractor lead activities, NHDES relies on the QA protocols and contractor's SOPs. For example, for the petroleum brownfields assessment grant, NHDES contractors prepare QAPPs and SAPs for USEPA and NHDES concurrence. Each site-specific SAP shall include a description of the anticipated tasks based on the NHDES approved Work-Scope for that project. See **Appendix E** for an example of a SAP outline. In general, the contaminants of concern are VOCs, semi-volatiles and metals. Other contaminants shall be investigated as appropriate.

In the cases where federal funds are used for NHDES staff to collect samples and to pay for the sample analysis, sample collection activities are typically limited to surface water, soil and drinking water sampling. As a result, the SOPs in **Appendix C** are limited to this subset of activities. Samples collected by NHDES are either analyzed by the NHDPHS lab or contact lab or by USEPA's lab in the case of research projects. The labs follow their respective protocols, which are not included as part of this document.

1.4 Quality Assurance Objectives

The primary QA objective for all projects is to assure that: a) all measurements are representative of actual site conditions, b) all data resulting from field, sampling, and analytical activities are comparable, reproducible and generated in a scientifically valid and legally defensible manner, and c) appropriate judgments can be made against the clean-up standards in Env-Or 600 and other applicable regulations (e.g., Surface Water Quality Regulations). It is important that the collected data are of known and documented quality. Any party generating data under this program has the responsibility to implement minimum procedures assuring the precision, accuracy, completeness, and representativeness of its data are known and documented.

The use of accepted, published sampling and analysis methods, as well as using standardized units, aids in ensuring data comparability. The SOPs, as included in **Appendix C** of this project plan, were developed to meet this objective.

Qualitative or quantitative statements or DQOs are developed by the data user to specify data quality needs for a particular activity to support specific decisions. The DQOs are the starting

point in designing a sampling program. Developed DQOs match sampling and analytical capabilities to the specific data needs and ensure that the quality of the data meets project requirements. Specific DQOs will be discussed in the site-specific SAPs unique to each project.

Minimum DQOs include the following:

- Evaluation of the risk to human health and the environment, (i.e., detection limits must be sufficiently low to compare to the regulation or statute governing the sampled media),
- Establishment of short and long-term trends in contaminant levels to support future site management decisions (i.e., data must be reproducible for meaningful trend analysis), and
- Evaluation of the effectiveness of a treatment system or other remedial strategy.

The objective of all site characterization and remedial reports is to either: 1) describe the occurrence and movement of groundwater and contaminants at the site including transport mechanisms, migration, and degradation pathways or 2) evaluate the feasibility or implementation of a remedial action. Such reports are required to be prepared by, or under the direct supervision of, a professional engineer or a professional geologist licensed under NH RSA 310-A and shall bear the seal of the professional responsible for preparing the document. NHDES professional staff review and routinely provide comment to these reports in consultation with the report's authors.

Long-term groundwater monitoring is a component of the remedial alternatives selected for a site. The project quality objectives for long-term groundwater monitoring are to evaluate contaminant of concern (COC) concentration trends and natural attenuation processes in groundwater to:

- Verify that groundwater containing COCs in excess of the ambient groundwater quality standards (AGQS) do not migrate past the Groundwater Management Zone (GMZ) compliance boundaries,
- Verify reductions in COC concentrations, natural attenuation processes, and plume attenuation rates,
- Determine if implemented remedial alternatives are operating properly and successfully, and
- Determine when groundwater concentrations meet the AGQS.

The ORCB will accept the limits of precision and accuracy for analytes that have been established by the QA Officer of the NHDPHS Lab. The NHDPHS Lab's Limits of Precision and Accuracy is a support document found in the Lab's Quality Systems Manual. In general, the ORCB will accept the Method Detection Limits (MDLs) and the Reporting Detection Limits (RDLs) established by the NHDPHS Lab, however, the Project Managers may request alternate limits to meet their quality objectives. Alternate limits requested by Project Managers will be documented in the SAP.

DES delivers all samples that staff collects to the NHDPHS laboratory or a contract laboratory, however, the NHDPHS laboratory will use outside laboratories for analyses that they are not able to do in-house. The NHDPHS laboratory will make sure that the laboratory is a New Hampshire

certified lab and will verify that the outside lab contains precision and accuracy information consistent with the NHDPHS laboratory QA plan.

Each SAP shall contain a summary table of analytical test methods, laboratory RDLs/MDLs and regulatory action limits for the compounds tested on site. See **Appendix F: Example Table – Site Analytes, Regulatory Standards and Lab Criteria**.

1.5 Training, Personal Protection and Safety

Personnel involved in site assessment and remedial activities shall have received training in accordance with Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120 (e) including annual refresher courses. All training shall be documented. Training records shall be maintained by NHDES and be available upon request. Standard safety practices shall be employed, and appropriate protective clothing shall be worn during all site visits.

Appropriate and effective health and safety practices shall be integrated into all daily operations to promote safe and healthful working conditions. Procedures shall comply with OSHA and other applicable local, State, and federal laws and regulations

1.6 Documentation and Records

Upon approval and implementation of this Master QAPP, the original shall be kept with the ORCB QA Coordinator and a copy shall be provided to the NHDES QA Manager. Paper copies generated for use on a particular job are not considered official copies.

Please note that this is a dynamic document and subject to revision. This QAPP will be reviewed and updated if necessary, but at least annually, as part of the NHDES Quality Assurance Program, <http://des.nh.gov/organization/commissioner/p2au/pis/qap/index.htm>. This document shall be valid for a period of up to five years from the official date of approval. The QA Coordinator will notify all ORCB personnel and the contact person for each contractor of any revisions to this QAPP by email. Additionally, the USEPA QA Unit will be notified of updates and revisions.

ORCB Project Managers, prior to work on projects subject to this QAPP, will be required to review this QAPP and sign the “QAPP Project Personnel Log Sheet” which documents that they have reviewed this QAPP and will follow the procedures as described. The contact person for each contractor that will use this QAPP will be required to review this QAPP and sign the “QAPP Project Personnel Log Sheet” which documents that they have reviewed this QAPP and that their company will follow the procedures as described.

The “QAPP Project Personnel Log Sheet” is found in **Appendix J** of the original QAPP kept with the ORCB QA Coordinator.

1.6.1 Field Activities

Field Data Collection QA

It is important that good quality data is collected in the field. Remedial decisions rely on an accurate description of site stratigraphy and contaminant distribution. Remedial methods using extraction or injection are highly susceptible to short-circuiting, creating preferential pathways and not working properly if designed around inaccurate or incomplete site characterization. Accurate soil descriptions, field screening information and boring/test pit logs all depend on high quality field activities. To ensure that high quality field work is conducted, NHDES will conduct periodic field audits using a checklist of best practices. NHDES will concentrate on improving field procedures for characterizing contaminant source areas and for developing site stratigraphic characterizations. NHDES will use the audits to raise awareness that that soil textural classifications must be done using the Unified Soil Classification System or Modified Burmister. A copy of the current field audit checklist is included in **Appendix C** following the SOPs.

Documentation

Field personnel shall use field logbooks and/or pre-printed field work sheets to accurately document when NHDES staff is engaged in performing field activities: on-site conditions, field measurements, sample collection information, field instrument, and calibration information and other pertinent site-related information during monitoring activities. All information shall be recorded in permanent ink.

The field notes shall include a description of field conditions that includes, at a minimum:

- Site location,
- Date, start, and finish times of the work and weather conditions,
- Name and initials of person making entry,
- Names of other personnel present, if any,
- Names of visitors, if any,
- Purpose and summary of proposed work effort,
- Details of any deviation from the field operations plan or standard operating procedures, including who authorized the deviation,
- Field observations,
- Sampling equipment used (including make model and serial number) and equipment calibration documentation,
- Field screening methods, if used, and a description of screening locations,
- Field screening results, and identification of samples with both field and fixed lab analyses,
- Fixed laboratory sample identification number, sample type (composite, grab), time of sampling, sample analysis, and sample locations shown on a near-scale map relative to a fixed landmark,
- Sample handling, packaging, labeling, and shipping information (including destination);
- Location, description and unique identifier for all photographs taken in association with the field activity, and
- Other pertinent information.

Information recorded in other site documents, *e.g.*, sampling logs, will not be repeated in logbooks except in summary form. All corrections in the logbook shall be shown as a single line through the original, initialed and dated.

1.6.2 Technical Reports

Hydrogeologic investigations will be conducted in accordance with standard industry practice and shall be prepared under the direction of a professional geologist or engineer licensed in the state of New Hampshire. Groundwater contour maps shall include text explicitly stating the method used to prepare the contour map. NHDES will also focus on improving the quality of geologic cross sections and other key conceptual model components as specified in NH Admin. Rule Env-Or 606. Reports summarizing the hydrogeologic investigation activities must include the information and data required by Env-Or 600. NHDES project managers will evaluate consultants' hydrogeologic interpretations and conceptual model on a site-specific basis. The report should summarize anything unusual that will affect the quality or usability of the data. NHDES will comment on QA problems identified during our review and will require corrections to the report, as necessary. Discrepancies between NHDES's interpretations and the consultants' interpretations will be documented in writing.

1.6.3 Document Handling and Retention Times

All project plans, associated analytical data, laboratory reports, tabulation of results and copies of field logbooks and field data forms, shall be maintained in the ORCB files and reviewed by the appropriate Project Manager to evaluate the usability of the data and assure compliance with the elements of this QAPP. Upon request, copies of the Lab reports and pertinent information shall be provided to the USEPA Project Manager.

Information collected for enforcement or litigation purposes shall be held in a separate confidential file unless specifically released to the open file by the New Hampshire Department of Justice.

Electronic project files shall be located on the NHDES computer network server which is backed up on a regular basis by the New Hampshire Department of Information Technology (additional information is provided in Chapter 7 of the NHDES Quality Management Plan (QMP)).

Retention of records is done in accordance with specific statutory or regulatory requirements (additional guidance is provided in Chapter 6 of the NHDES QMP). All records shall be maintained according to the Record Retention Schedule. See summary below.

ORCB Records Retention Policy

Record Description	Retention in Years
Reimbursement records	100 years after facility closure
Site Remediation Files	100 years after closure of file
Confidential Files	100 years after closure of file

ORCB emergency response contractor records shall be maintained for seven years following completion of an assigned project. At the end of the retention period, the contractor shall offer

the project records to the State. If the State declines to accept the records, the records become the property of the contractor.

1.7 Data Assessment

All data generated subject to the provisions of this QAPP shall be reviewed by the contractor and the Project Manager to ensure that the data meets the objectives and requirements of this QAPP and that the results are technically valid, reliable and usable. Sampling and analytical results shall be reviewed to determine if:

- Corrective action is necessary,
- Sampling plan revisions are needed, or
- Additional soil or groundwater samples are appropriate.

To ensure that the data meet the objectives and requirements of this QAPP and the results are technically valid, reliable and usable, data shall be reviewed and compared with relevant documentation including:

- Available historical data,
- Laboratory MDL and RDL,
- Standards and methods established in the current New Hampshire Administrative Rules, including but not limited to, the Contaminated Sites Management Rules (Env-Or 600), which contain the AGQS and the Soil Remediation Standards, Drinking Water Quality Standards (Env-Dw 700), Surface Water Quality Regulations (Env-Wq 1700), and Ambient Air Quality Standards (Env-A 300),
- Current NHDES requirements, such as the requirements for VOC analysis specified in the updated “Full list of Analytes for Volatile Organics,”
- Current NHDES policies, including but not limited to, the Risk Characterization and Management Policy, and
- Other pertinent documents as needed.

If data of questionable quality is reported or other QC issues are discovered, the ORCB Project Manager shall report the issues to the QA Coordinator and/or QA Manager. The Project Manager, with input from quality assurance personnel, shall determine the usefulness of data in question and, at minimum, shall summarize the data concerns in the project file. Data of questionable quality that is identified in work performed by NHDES contractors will be reported to the contractor and the QA Coordinator.

The need for corrective action, including the collection of new or additional samples, shall be determined based on the data quality objectives for the project and with input from quality assurance and other appropriate personnel. If additional corrective action is necessary, it will be carried out as described in Section 1.8 - Corrective Action.

The NHDPHS Lab performs validation of test data in accordance with their procedures. USEPA and/or NHDES quality assurance personnel may periodically conduct field audits, review field methods, analytical procedures and/or document tracking and record keeping practices to assure compliance with the elements of this QAPP. The laboratory analytical report needs to include information that demonstrates that the data was reviewed against the lab's precision and accuracy criteria and the additional criteria contained in this QAPP.

1.8 Corrective Action

Corrective actions must be taken as soon as possible when data or field procedures are found to be of questionable quality. Any suspected problems shall be brought to the attention of the ORCB Project Manager and the QA Coordinator. Problems with data collected by NHDES contractors shall be reported to the NHDES Contracts Supervisor in addition to the QA Coordinator. The Contracts Supervisor meets with NHDES contractors periodically to review their performance. During these periodic meetings concerns with the quality of any data produced during their work for NHDES would be discussed.

Identification of the need for corrective action occurs through, but is not limited to, the following steps:

- Identify and define the problem,
- Investigate the problem,
- Determine the cause of the problem and appropriate corrective action,
- Implement the corrective action,
- Verify that the problem has been corrected,
- Modify procedures, as necessary, to prevent recurrence, and
- Document the events.

2.0 MONITORING AND SAMPLING PROCEDURES

This section describes the overall design of the field program and includes the specific information necessary to conduct the monitoring and sampling components of the program. The monitoring and sampling procedures, sample handling and custody requirements, analytical method requirements, and the QC requirements are presented in this section and the associated appendices.

2.1 Generic Sampling Strategies and Procedures

Sampling situations for the leaking underground storage tank program that are conducted by NHDES staff are relatively simple in nature. NHDES staff will occasionally collect drinking water, surface water and soil samples. In the vast majority of cases, NHDES collects one or two samples on an emergency basis to determine whether there is a completed pathway for contamination to reach a receptor (drinking water wells, surface water runoff, etc). In these cases NHDES will follow all relevant SOPs and chain of custody procedures. Rarely and only at the request of USEPA's Office of Research and Development, NHDES has obtained groundwater

samples by splitting samples with a RP. In this case, groundwater sampling is conducted by the RP under their consultant's protocols.

Sampling personnel shall be responsible for collecting representative samples of impacted, or potentially impacted, media at sampling site locations and for ensuring the samples are obtained in accordance with sampling procedures/methods found herein, in the SAP, and other approved reference documents. Copies of policies for sampling soil for VOC analysis can be found in **Appendix C**.

The Project Manager is responsible for determining the number of samples and the method of sample collection in accordance with standard operating procedures, site conditions, and project requirements. Economic/financial resources/constraints, time allocation, availability of personnel, equipment, site conditions and sample variability are all factors the Project Manager shall consider and review in the development of a site specific SAP. For state lead sites, the contractor determines the number of samples and sampling protocols and the Project Manager approves the approach.

Depending on circumstances and needs, it may not be possible or appropriate to follow the SOPs exactly in all situations due to site conditions, equipment limitations, and limitations of the standard procedures. When necessary to perform an activity that does not have a specific SOP, or when the SOP cannot be followed, existing SOPs may be used as general guidance or SOPs similar to those found in this QAPP may be adopted if they meet the DQO of the project. All modifications or adoptions shall be approved by the Project Manager and QC Coordinator, and documented in the SAP and/or the final project report, as appropriate.

2.2 Sampling Equipment and Decontamination

The choice of sampling equipment and sample containers will depend upon the media being sampled and site considerations. The sampling equipment shall be selected to ensure that a representative sample is collected. **Appendix B** Sampling Equipment / Field Equipment has a list of equipment that is available for use, however, additional equipment may also be used as needed. Sampling equipment shall be clean before use to minimize the potential for cross-contamination and whenever possible, new/unused sampling equipment shall be utilized.

Pertinent information, including the make, and model on all equipment necessary for field sampling and health and safety purposes shall be part of the SAP and available to field personnel. Copies of the operating instruction manuals and calibration procedures shall be kept with the equipment and in the contractor/ORCB files (in the case of dedicated pumps and other permanently installed equipment, the operating manuals shall be kept as an appendix to the SAP).

See **Appendix C** for the decontamination standard operation procedure. Lab personnel can assist in determining an appropriate solvent. Disposable sampling equipment shall be discarded after completing the sampling task and not reused.

Decontamination of equipment generates contaminated rinse liquids, sludges, etc., that may need to be containerized onsite until proper disposal arrangements are made. Identification of situations where levels of contamination are sufficiently low, so disposal at a hazardous waste

facility is not necessary, shall be made by the Project Manager in consultation with field personnel.

2.3 Instrument Calibration and Maintenance

Refer to the Field Instruments Calibration SOP (ORCB-10) in **Appendix C** for specific calibration procedures. In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, calibrated, tested and inspected according to the manufacturer's instructions. All of these instruments shall be calibrated at the beginning of each sampling day at the Site. The calibration shall then be checked to ensure the instrument was calibrated properly. The calibration shall be checked again at the end of the day of use to ensure that the instruments have remained in calibration throughout the day. Should any erratic or illogical readings occur between calibrations, the instrument shall be recalibrated in order to ensure representative measurements. All calibration, confirmation and maintenance activities shall be documented in a manner that is traceable to the equipment. Equipment maintenance requirements and schedules will be maintained in accordance with manufacturer's recommendations for each piece of equipment.

2.4 Field Screening Instruments

Although highly unlikely, at some sites sampling personnel may be required to use field instruments such as an organic vapor photoionization detector (PID) meter or a combustible gas and oxygen detector to evaluate the safety of the site or sampling areas prior to initiating sampling. The PID or flame ionization detector (FID) is also sometimes used for soil screening using the jar headspace method (see **Appendix C**, ORCB-6 Jar Headspace Technique – Field Screening Soil Samples). All field instruments shall be calibrated prior to use in accordance with the manufacturer's instructions and copies of the operating instruction manuals and calibration procedures shall be kept with the equipment as well as in the contractor/ORCB files. All instrument readings shall be recorded in the sampler's field notebook/worksheet.

2.5 Laboratory Services

Analytical services shall be provided by laboratories which are currently certified by the USEPA² or accredited by the New Hampshire Environmental Laboratory Accreditation Program, Env-C 300³. The ORCB also accepts analytical results from the Region 1 USEPA Laboratory in Chelmsford, Massachusetts. The laboratories providing the services should, wherever possible, be accredited for the specific matrix / method / analytes for the required testing. In some cases, this may not be practical; then a laboratory that is accredited for the equivalent technology (i.e. GC-MS, ICP-MS, etc.) shall be used, subject to ORCB Project Manager approval. Additional information on accredited laboratories and the laboratory accreditation program may be found on the NHDES Website at <https://www.des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>

Each laboratory shall have their own quality assurance manual and SOPs which are not covered in this QAPP. For projects which use a field laboratory, the Project Manager and QA Coordinator will work with the specific laboratory to assure that QC measures meet the DQOs of

² <http://water.epa.gov/scitech/drinkingwater/labcert/index.cfm>

³ <http://des.nh.gov/organization/divisions/water/dwgb/nhelap/categories/rules.htm>

the particular project or event. Additionally, confirmatory samples will be submitted to an accredited lab for analysis.

Each SAP shall contain a summary table of analytes, analytical test methods, regulatory action limits and the laboratory reporting limits (detection limits as needed) for all compounds tested on site. See **Appendix F: Example Table (SAP Table 1) – Site Analytes, Regulatory Standards and Lab Criteria**.

The WMD has established specific analytical requirements for VOCs, including “Full List of Analytes for Volatile Organics” (Full List). For more information, refer to the NHDES website⁴. The NHDPHS Laboratory’s 8260B list is the same as the Full List; however the limits for the compounds with the asterisk are not as low as on the Full List. If there is a need to reach those limits, different methods are required. Other laboratories’ 8260B method may not include the Full List.

2.6 Sample Volume, Containers and Labeling

Containers used for collecting samples shall be compatible with the media being sampled and analysis to be performed. Containers shall be obtained from the analytical lab and shall be clean, free of contamination, and, if required, contain the proper preservative. Care shall be taken during sampling to ensure that material is not spilled onto the outer surface of containers, and that lids are placed on tightly after sampling. The volume sampled shall be in accordance with the analytical lab’s requirements. Containers shall be labeled with the date and time sampled, sample location, collectors initials, sample number, project name or number, preservative and any other pertinent information. Information shall be documented in field notebooks/worksheets and chain of custody form, where applicable.

2.7 Sample Preservation and Holding Times

Holding times and sample preservation shall be in accordance with the analytical method, and/or the analytical lab's requirements whichever are more stringent. When sampling containers contain preservatives, care shall be taken during sampling process to ensure the preservative is not spilled or diluted by overfilling. Preservation, storage conditions and sampling time shall be recorded in all applicable field notebooks/worksheets and chain of custody forms, where applicable.

Each SAP shall contain a summary table of the media, analysis, test methods, containers, sample volumes, preservation and hold times. See **Appendix G: Example Table (SAP Table 2) - Media and Laboratory Requirements**.

2.8 Chain of Custody Procedures and Sample Delivery Procedures

See **Appendix C** for the *Chain-of-Custody, Sample Handling and Shipping* SOP (ORCB-11). Samples and unused sample containers shall remain in the sample collector's view at all times, unless locked in a vehicle or other secure place. It is the sampler's responsibility to ensure that the samples are not tampered with prior to their delivery to the analytical lab. The chain of custody form shall be completed to provide documentation tracing sample possession and handling from

⁴ https://www.des.nh.gov/organization/divisions/waste/hwrb/documents/voc_changes.pdf

the time of collection through delivery to the analytical lab, and shall accompany the samples at all times. The chain of custody form is a legal document that may become instrumental in litigation.

Analytical laboratories often require the use of a specific chain of custody form. The NHDPHS Laboratory chain of custody form is attached as **Appendix D**. If other chain of custody forms are required, this shall be specified in the SAP. Labeling the chain of custody form shall be consistent with the sample container labeling described in Section 2.6 (above). The sampler shall record the following information on the form:

- The site name,
- Town site is located in,
- NHDES site number,
- Name of samplers including phone numbers,
- Project contact person including phone numbers,
- Sample numbers,
- Sample identifier,
- Date and time of sampling,
- Number and type of containers,
- Analyses required,
- Preservatives,
- Specific requirements such as specific RDLs, and
- Additional pertinent information and information as required by a particular lab (e.g. the lab account number, One Stop (Project) ID#, etc).

The completed original chain of custody form shall be attached to the analytical report submitted to the ORCB Project Manager for review, and becomes part of the permanent project record.

Samples shall be properly packaged in a cooler for shipment to maintain sample integrity and delivered to the analytical laboratory along with a separate signed chain of custody enclosed in each sample cooler. Samples must be delivered in a manner consistent with the requirements of the analytical laboratory with respect to preservation, temperature and holding times for the particular analytes to be tested. The ORCB requires that all samples requiring cooling be placed into loose ice within a cooler; the use of block ice, bagged ice and ice packs is not acceptable. Custody seals shall be used when the cooler is sent to the laboratory by independent courier, unless otherwise specified in the Site SAP.

2.9 Laboratory Sample Management

Lab personnel shall log the samples into their computer in accordance with their standard operating procedure. The samples shall be inspected by the Laboratory Sample Controller, or other qualified laboratory personnel. A Sample Receipt Checklist shall be used to document the receipt of the samples and shall include checks for breakage, correct container and preservative,

temperature of the cooler, holding times, and for other factors affecting sample quality. The samples shall be compared to their description on the chain of custody form, and discrepancies in the number or the designations of the samples shall be noted on the form and shall be brought to the attention of the person who relinquished the samples to the lab. If necessary, the contact person on the chain of custody may be contacted for further instruction. Since samples are held in the lab until discrepancies are resolved, there could be an impact on sample holding times.

The chain of custody form shall be signed and the date and time shall be recorded to formally accept the samples into laboratory custody. The analytical laboratory shall assign laboratory numbers to the samples, and these numbers shall be recorded on the chain of custody forms.

2.10 Sample Delivery

Samples shall be packed into a cooler and delivered to the analytical laboratory along with the chain of custody form(s). Samples must be delivered in a manner consistent with the requirements of the analytical laboratory with respect to preservation, temperature, and holding times for the particular analytes to be tested. Custody seals shall be used when the cooler is sent to the laboratory by independent courier.

2.11 Sample Quality Control

The following are field QC samples.

- **Trip Blanks**

Trip blanks for VOC samples shall be prepared by the laboratory prior to the sampling event using analyte-free water. The trip blanks shall accompany the sample containers to the field, during collection and transportation and shall be submitted with the other samples for analysis. There shall be one set of trip blanks per VOC sample cooler. The analysis of this blank will provide a baseline measurement of VOC contamination that the samples may have been exposed to in the field and during transport.

There shall be only one trip blank per chain of custody form per sample cooler, except when trip blanks require different preservatives for different methods. Consult with the specific laboratory for their requirements. The following is a list of examples where multiple trip blanks may be present in the same cooler:

- Aqueous VOC analysis, which requires hydrochloric acid (HCL) and 4 °C +/- 2 °C as the preservative. One VOC trip blank consists of two full volatile organic analysis vials and is added to each sample cooler that contains VOC samples.
- Sediment/Soil VOC analysis, which typically requires methanol and 4 °C +/- 2 °C as the preservative. One VOC trip blank consists of one full volatile organic analysis vial and is added to each sample cooler that contains VOC samples.

- **Equipment Blanks**

Equipment blanks consist of a sample of deionized (analyte-free) water which has been poured around and through sample collection equipment to determine if contamination has occurred due to improper cleaning and/or contamination of equipment. They shall be

preserved, handled like any other sample (e.g. preserved), and submitted with the other samples for analysis. The frequency shall be determined based on the type of sampling that occurs and additional equipment blanks shall be required for changes in sample matrix or equipment type as specified in the site specific SAP. Equipment blanks shall not be required where disposable or dedicated sampling equipment is used.

- Duplicate samples

Duplicate samples shall be collected for each batch of samples (a batch may not exceed 20 samples) collected per matrix, per analysis. The duplicates shall be collected at the same time, in the same manner as their corresponding routine samples and shall be identified in the field notes and logged on the chain of custody forms.

- Background Samples

Upgradient samples may be taken to determine the local naturally occurring conditions. Background samples shall be used as control samples and taken outside the contamination area. These results shall be compared against actual contaminated sample results. The use of background samples shall be specified in the site specific SAP.

- Split Samples

Split samples may be collected to compare the analytical results from one laboratory to another using the same techniques or methods, or to compare the analytical results of different laboratory techniques or methods to determine whether they are generally equivalent. Split samples are identical samples that are collected from the same location at a given time, and divided into two or more portions. Split samples may be collected for one analyte, for a group of analytes, or for all analytes that are being quantified. The number of split samples to be collected shall be determined by the Project Manager.

Split VOC soil samples shall be collected in accordance with NHDES Preservation of VOCs in Soil Samples protocols (see **Appendix C**). Splitting the sample after methanol preservation produces more reproducible results and reduces the potential for VOC loss.

All SAPs shall include the following quality assurance tables:

- A table of the summary of quality assurance samples for that sampling event.
See **Appendix H: Example Table (SAP Table 4) – Summary of Quality Assurance Samples**;
- A summary Table of Field QC Requirements in the text of the SAP, such as the example below.

Example: Field QC Requirements Table

QC Sample	Frequency	Acceptance Criteria	Corrective Action
Trip Blanks	<p>There shall be only one trip blank per chain of custody per sample cooler, except when trip blanks require different preservatives for different methods. Examples include:</p> <ul style="list-style-type: none"> • VOC samples, which require hydrochloric acid and 4 °C +/- 2 °C. One VOC trip blank consists of two full VOA vials. • 1,4-dioxane samples by method 8260 SIM, which require 4 °C +/- 2 °C. One 1,4-dioxane trip blank consists of two full VOA vials. • PFAS samples: typically require 4 °C +/- 2 °C and may require Trizma. One PFAS trip blank typically consists of one 250 ml polypropylene bottle and does not need to be collected headspace free. 	<p>No contaminants are detected</p>	<p>Flag in project report (or as specified in SAP)</p> <p>See Sections 1.6.2.1 and 1.8 above</p>
Duplicate	<p>A minimum of 1 duplicate per batch of 20 samples, per matrix, per analysis, per sampling method. If less than 20 samples are collected, then a minimum of one duplicate per matrix, per parameter, per sampling method is collected.</p> <p>Examples of sampling methods include low flow sampling using a peristaltic pump or bladder pump, bailer, Barcad, etc.</p>	<p>Duplicate concentrations are within +/- 30% for aqueous samples and 50% for solid samples</p>	<p>Flag in project report (or as specified in SAP)</p> <p>See Sections 1.6.2.1 and 1.8 above</p>
Equipment Blanks	<ul style="list-style-type: none"> • If dedicated equipment used, an initial equipment blank is required. No additional equipment blanks are required. • If non-dedicated equipment is used, one equipment blank per sampling event, per equipment type is required. 	<p>No contaminants are detected</p>	<p>Flag in project report (or as specified in SAP)</p> <p>See Sections 1.6.2.1 and 1.8 above</p>
Field Blanks	<p>One field blank is typically collected per batch of 20 samples. Refer to the SAP for specific requirements based on site DQOs.</p>	<p>No contaminants are detected</p>	<p>Flag in project report (or as specified in SAP)</p> <p>See Sections 1.6.2.1 and 1.8 above</p>

Notes:

- 1) Sample duplicates are typically identified by adding “DUP” to the end of the sample ID (e.g., MW-1 DUP) unless they are blind duplicates.
- 2) Trip blanks will be prepared by the appropriate laboratory and maintained at all times with the sample containers. The trip blank will be designated “TRIP BLANK”.
 VOC trip blanks require HCL preservation.
- 3) Equipment blank samples will be designated as “EQUIP BLANK”. Note that a comment is required on the chain of custody indicating what the equipment blank is for (e.g., water level meter).
- 4) Refer to the Summary of Quality Assurance Samples Table in the SAP for the analysis required for each QC sample collected per sampling event (see **Appendix H** for an example of that table.)

3.0 REFERENCES

Refer to the most recent editions of the following:

- U.S.EPA. 1999. The Region 1, EPA-NE Compendium of QAPP Requirements and Guidance, Final October 1999 with Attachments
2006. EPA Requirements for Quality Assurance Project Plans. EPA QA/R-5
2017. Region 1, Calibration of Field Instruments, Revision 3. EPA SOP EQASOP-FieldCalibrat3, March
2017. Region 1, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, Revision 4. EPA SOP #EQASOP-GW-4, September
- 2009 EPA-New England, Region I, Planning and Documenting Brownfields Projects Generic Quality Assurance Project Plans, and Site-specific QAPP Addenda, March <https://www.epa.gov/sites/production/files/2017-07/documents/plandocbrownfields.pdf>
- * 1999. Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. EPA/625/R-96/010b Second Edition, January
2001. Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, Athens, GA. November⁵
- * 2007. SW 846 Test Methods for Evaluation Solid Waste, Physical/Chemical Methods. US EPA, February
- * 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance, PB87107751, US EPA, November
1987. A Compendium of Superfund Field Operation Methods. EPA 540/P-87/001, August.
1986. Test Methods for Evaluations Solid Waste, Third Edition. EPA SW 84
- * 1985. Practical Guide for Ground-Water Sampling. EPA 600/2-85/104, September
1982. Handbook for Sampling and Sample Preservation of Water and Waste Water. EPA 600/4-82/029
- * ASTM International, Standards Related to Environmental Sampling. 2014. Fifth edition ASTM SAMP14
- * 2009. Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds. ASTM D4547-09.
- * 2013. Standard Practice for Environmental Site Assessments: Phase 1 Environmental Site Assessment Process (ASTM E 1527-13)
- * 2010 Standard Guide for Risk Based Corrective Action , ASTM E 2081-00

⁵ <http://www2.epa.gov/aboutepa/about-region-4s-science-and-ecosystem-support-division-sesd>

- * 2010. Standards on Environmental Site Characterization, Fourth Edition (SITECD-10)
- 2008. Standard Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites. ASTM D5088-02, 2008
- 2013. Standard Guide for Sampling Groundwater Monitoring Wells. ASTM D4448-01,2013.

State of New Hampshire, New Hampshire Department of Environmental Services Quality Management Plan⁶

State of New Hampshire, New Hampshire Department of Health and Human Services, Division of Public Health Services Laboratory Quality Systems Manual

* These documents are listed in the current New Hampshire Code of Certified Administrative Rules, Env-Or 600 Contaminated Site Management⁷, Env-Or Appendix B - Incorporated References, and contain environmental sampling methods not found in **Appendix C**, *Standard Operating Procedures, Policies and Guidance Documents* of this QAPP. Any updated versions of these documents should be used if available.

⁶ <http://des.nh.gov/organization/commissioner/pip/publications/co/documents/r-co-06-3.pdf>

⁷ <http://des.nh.gov/organization/commissioner/legal/rules/documents/env-or600.pdf>

APPENDICIES

APPENDIX A
PROGRAM ORGANIZATION AND RESPONSIBILITIES AND
ORGANIZATIONAL CHART

PROGRAM ORGANIZATION AND RESPONSIBILITIES

In accordance with the Master ORCB QAPP and the NHDES Quality Management Plan (QMP), the following individuals will be responsible for major activities performed in the project plans. Class specifications and supplemental job descriptions covering education and experience requirements for specific positions under state law are available through the Division of Personnel in the Department of Environmental Services.

The Program Manager shall be responsible for ensuring that staff have and maintain appropriate training. NHDES provides in-house training and provides for staff participation in other training, such as local and regional workshops. All ORCB personnel and contractors working at contaminated sites shall be certified by USEPA training course Personnel Protection and Safety (165.2) or Hazardous Materials Incident Response Operations (165.5) or by meeting the Occupational Safety and Health Administration's Subpart H – Hazardous Materials, 1910.120 Hazardous waste operations and emergency response standard. Annual refresher courses are required. The QA Manager and the QA Coordinator shall receive specific QA/QC training as needed to ensure that both are qualified to perform the tasks relating to the QAPP. This training may include conferences and training classes provided by private industry, the NHDES or USEPA. Additional training shall be provided for all personnel as it is deemed necessary.

Quality Assurance (QA) Manager

- Oversees the implementation of NHDES's quality systems;
- Maintains independence and impartiality of the data quality review;
- Has no data gathering or reviewing responsibilities that would lead to a possible conflict with the Quality Assurance Manager role;
- Serves as the liaison between the NHDES and the QA staff at USEPA Region I on Quality Assurance/Quality Control (QA/QC) matters;
- Provides interpretations of NHDES QA/QC policies and coordinate the development of policies and procedures that are consistent with the USEPA requirements and NHDES goals;
- Performs the reviews, assessments, and audits;
- Provides technical assistance to support the overall mission of NHDES;
- With program managers, develops guidance on QA/QC issues for use in NHDES;
- Resolves any disputes that may arise regarding quality assurance issues within or between various NHDES units;
- Assures that all program managers and staff understand and implement applicable quality assurance procedures; and
- Ensures proper procedures are being followed through system and performance audits.

Quality Assurance (QA) Coordinator

- Responsible for the preparation of this QAPP, an annual review of the QAPP, any necessary revisions, and notifying all appropriate personnel of such;
- Responsible for responsible for adhering to the QAPP and assuring that the QAPP is adhered to by the Bureau;

- Works with the QA Manager to develop an acceptable quality assurance program for all environmental data generated or processed relating to the Oil Remediation and Compliance Bureau;
- Identifies and responds to QA needs and answers requests for guidance or assistance;
- Maintains lines of communication with the NHDPHS or a contract lab to ensure that all information for staff is received, problems are resolved and corrective action are implemented;
- Receives and reviews the sampling reports from the NHDPHS Lab for quality control; and
- Assists QA Manager in ensuring that proper procedures are being followed.

Program Manager

- Responsible for assuring that staff and State contractors follow the approved QAPP;
- Administers state and federal petroleum site programs and policies, insuring that they are properly implemented;
- Supervises and provides technical assistance to engineers, hydrogeologists, environmentalists, inspectors and waste management specialists involved in activities associated with the study and remediation of petroleum sites to ensure that all projects and/or activities are completed in a timely and appropriate manner;
- Reviews work performed by staff and others to ensure that all projects are conducted in accordance with the best professional practices;
- Assists the Division Director in establishing and implementing Division policies and procedures;
- Provides technical support to the Attorney General's Office as required in order to properly negotiate settlements with potentially responsible parties;
- Coordinates Department activities to secure permits and clearances from state and federal agencies to ensure that the remedial activities are in compliance with applicable environmental regulations;
- Coordinates with the USEPA; and
- Responsible for ensuring that personnel have appropriate training and follow appropriate safety procedures.

Project Managers

- Responsible for assuring that all site work is consistent with the QAPP;
- Responsible for the development and approval of Work-Scopes and site specific SAPs;
- Develop and administer multidisciplinary investigations and remedial actions at petroleum sites;
- Coordinate with the USEPA Remedial Project Manager (RPM);
- Assure that approved procedures meet the project objectives;
- Responsible for implementation of recommendations made by QA Manager and/or QA Coordinator;
- Responsible for initiating corrective actions;
- Review and approve all site procedures;
- Review all site related documentation;
- Ensure that appropriate sampling and analytical procedures are followed;

- Monitor schedules for field, analytical, and data validation activities;
- Coordinate and oversee all sampling and analytical data assessment activities;
- Coordinate with the Lab for analytical support services and the Environmental Health Program for risk assessment evaluations;
- Ensure that the analytical method detection limit is reasonable for the analytical parameters selected and the media sampled;
- Monitor grant money and budget and report financial activities to the USEPA; and
- Authorize spending for equipment, samples and sampling supplies.

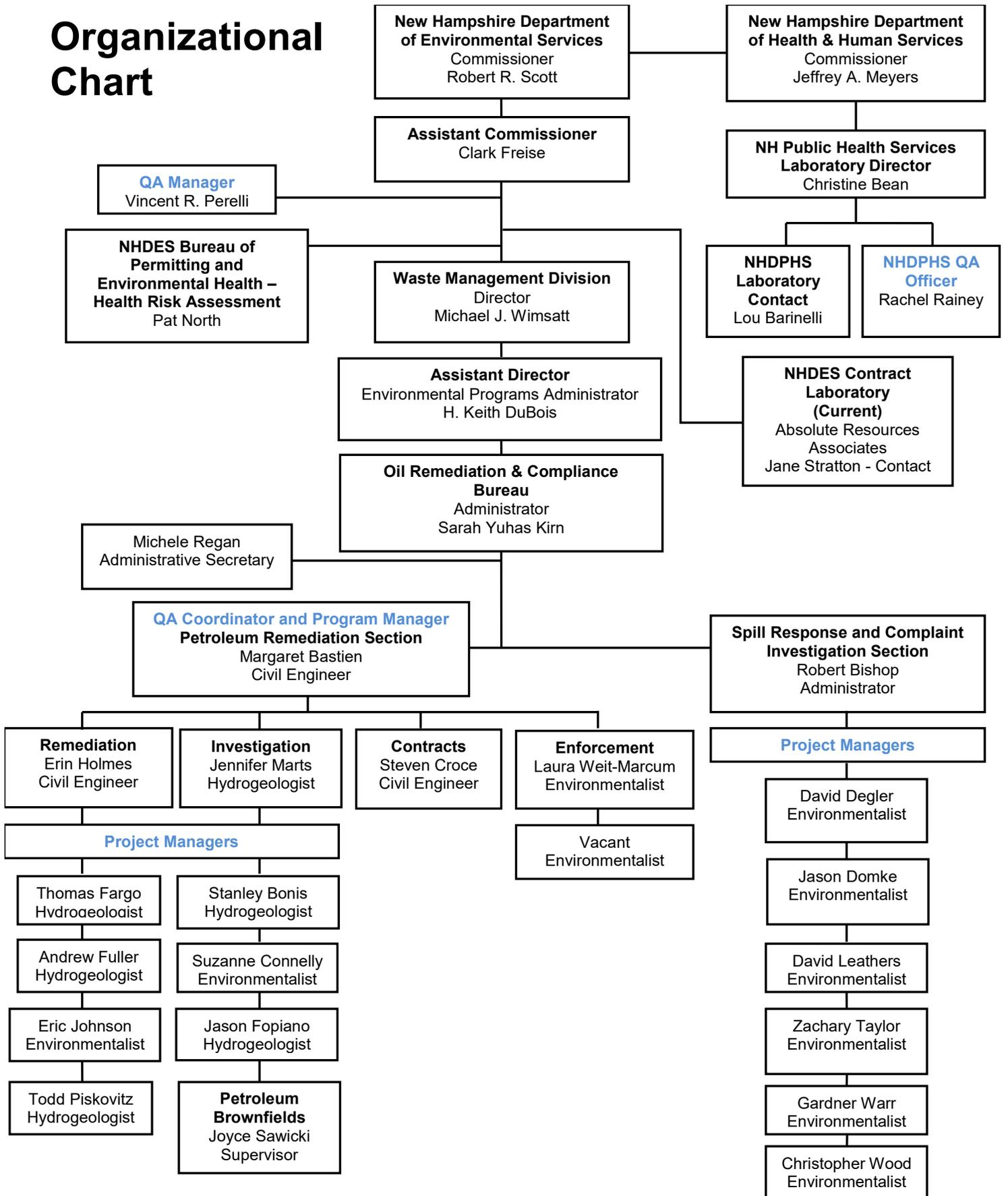
Quality Assurance Officer for the NHDPHS Laboratory Services Unit (NHDPHS Lab)

- Assures that sufficient quality assurance activities are conducted to demonstrate that all data generated by the Lab is scientifically valid, defensible, and of known precision and accuracy.
- For further detail on QA/QC activities of the NHDPHS Lab, see the Lab's QA/QC Program Plan.

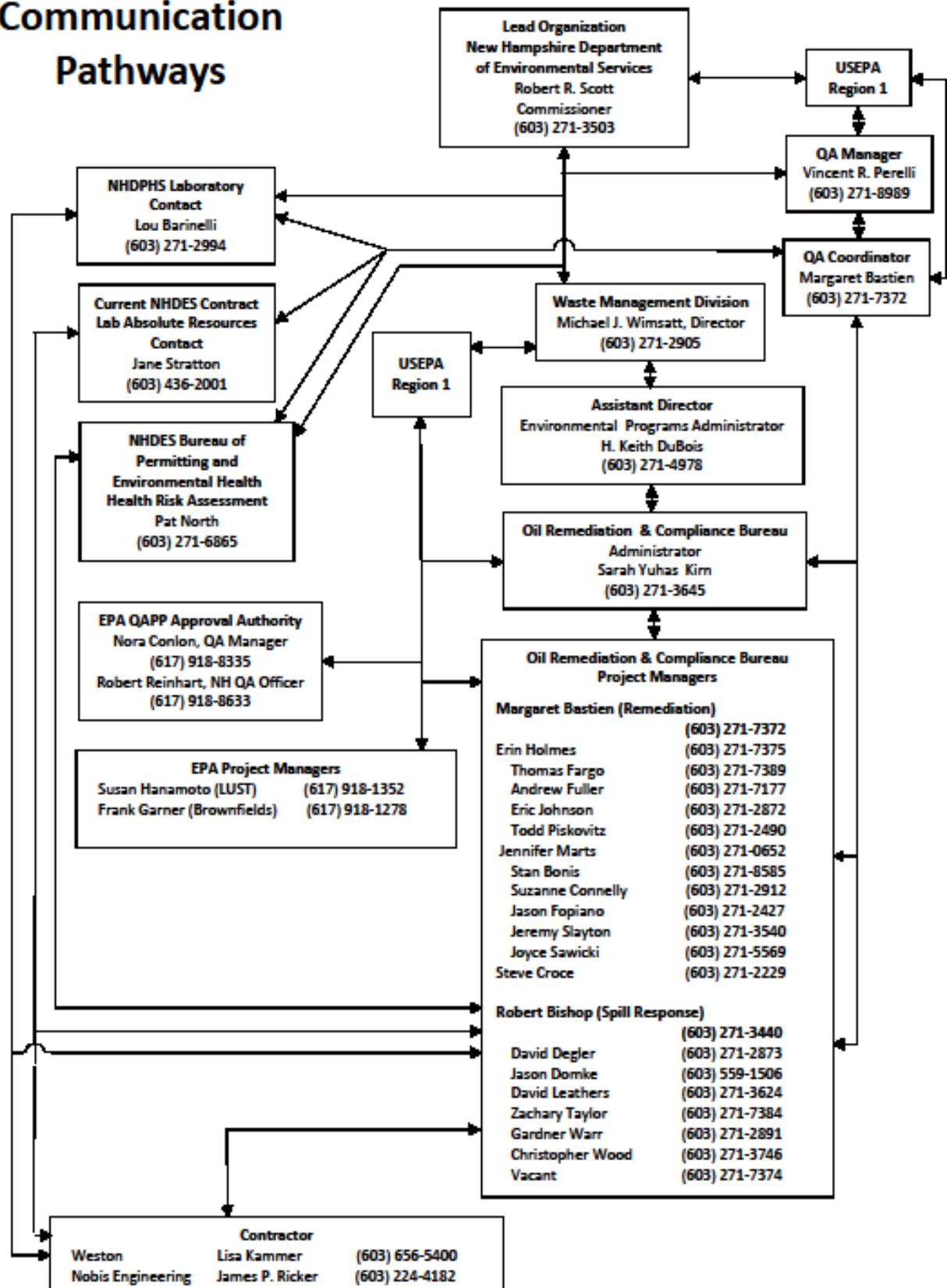
Contractors

- Responsible for developing generic contractor or project specific QAPP. The contractor can also use the NHDES approved QAPP, if project or generic contractor QAPPs are not available. Follow any approved site specific SAPs.
- Ensure that established protocols and approved procedures are used.
- Coordinate with the Project Manager in the development of Work-Scopes;
- Coordinate with the Project Manager in the development of site specific SAPs;
- Perform QA aspects of the project including:
 1. Data review, including an in-house examination to ensure data has been recorded, transmitted, and processed correctly;
 2. Development of the Health and Safety Plan (HASP); and
 3. Any data validation required to ensure that the data has met the objectives and requirements of this QAPP and that the results are technically valid, reliable and usable.
- Coordinate sampling and field activities with the NHDES Project Manager and the lab
 1. Responsible for on-site coordination of field monitoring and sampling activities
 2. Assures that samples are collected in accordance with the QAPP and approved QA procedures
 3. Responsible for the equipment for field activities
 4. Responsible for sample chain-of-custody protocols and sample delivery to the lab
 5. Responsible for the collection of representative field samples
 6. Responsible for periodic auditing of field monitoring and sampling activities as outlined in the SAP

Organizational Chart



Communication Pathways



APPENDIX B
SAMPLING EQUIPMENT / FIELD EQUIPMENT

SAMPLING EQUIPMENT / FIELD EQUIPMENT

This is a list of equipment most commonly used; additional equipment may also be used as needed.

Calibration of the field instruments will be conducted at least daily, prior to the use in the field. The field equipment will be maintained, calibrated and operated in a manner consistent with the manufacturer's guidelines and USEPA standard methods. Manufacturer instructions and other instructional documentation will be kept with the field staff. Additionally, all field equipment will be operated according to the ORCB's SOPs, when applicable. ORCB SOPs are found in Appendix C.

Electronic Water Level Meter

It is used to measure water levels in wells to 1/100 of a foot, which can then be used to calculate purge volumes.

Interface Probe

Similar to a water level meter but is able to differentiate between water and non-aqueous phase liquid (NAPL) contact. It is used to determine the thickness of NAPL layers aqueous in monitoring wells.

Peristaltic Pump (Geotech Series II or similar model)

A low volume suction pump used for both purging and sampling which utilizes a deep cycle battery or generator for power. The maximum effective depth is approximately 29 feet.

Submersible Pump (Grundfos Redi-Flo 2 or similar model)

A submersible centrifugal impeller pump used in conjunction with a generator, or direct source of electricity, for both purging and sampling. It is used in cases where the depth of the water prohibits the use of the peristaltic pump.

Centrifugal Pump (Honda Pump or similar model)

A centrifugal pump is a type of suction pump that uses positive displacement of water. It has a maximum suction head lift of 26 feet and a maximum pumping rate of 53 gpm, and may be used for purging large volumes of water efficiently. Not used for sampling.

Bladder Pump

A bladder pump is a pneumatic pump that incorporates both gravity and compression. It is recommended for purge volumes ranging from 0.5 gpm - 3.3 gpm. It can be used for purging and sampling.

Wattera Hand Pump

This pump is not generally recommended.

This pump can be used for purging wells and sampling if it fits the project's data quality objectives.

It fits into a well with an inner diameter of an inch, can operate at a maximum depth of 250 feet and has a maximum flow of 2 gpm.

Bucket Type Bailer

Stainless steel, Poly, PVC or Teflon bottom filling and bottom emptying type bailers are used to collect samples.

Barcad

A groundwater sampling instrument designed for permanent installation at a fixed depth. Typically a number of these instruments are installed at various depths in a cluster within a single borehole (monitoring well). The sampler contains a check valve through which water can be extracted from the formation and conducted to the surface via a small-diameter riser tube concentric within a larger gas-drive tube.

Barometer

A barometer is used in calibrating dissolved oxygen meters. A separate barometer may be used if the instrument doesn't already have a temperature-compensated barometer. All barometers (either separate or part of a multiparameter meter) must be checked, and adjusted if necessary, at least yearly against a known calibrated barometer such as one used by the National Weather Service.

Gas Cylinders

Portable tanks of compressed inert gas used in the operation of the Barcad sampling instrument and for calibration of PID/FIDs and CGIs.

Tubing

Dedicated polyethylene tubing (1/4" ID x 3/8" OD) will be used in all monitoring wells. Silicone tubing will be used in the pump heads of the peristaltic pumps.

Multi-Parameter Meter (QED PurgeSaver or similar approved model)

This is a multiparameter meter with a flow through cell which measures temperature, specific conductivity, dissolved oxygen, pH, and ORP. These measurements are generally taken for the purpose of determining well stabilization and may also be used as part of the evaluation process of natural attenuation. The meter is calibrated daily before use following the manufacture's guidelines. Note: turbidity measurements must be obtained from a separate instrument as measurements through a flow through cell are not acceptable.

Turbidity Meter (Hach 2100P or similar model)

Measures the turbidity of water for the purpose of determining well stabilization or other purposes, as needed. It determines the turbidity by viewing light through the sample and determining how much light is obstructed. The meter is calibrated daily following the manufacture's guidelines.

pH Meter (Separate meter)

This meter may be used when a multiparameter meter is not required. Calibrate daily before sampling following the manufacture's guidelines.

Dissolved Oxygen Meter (Separate meter)

This meter may be used when a multiparameter meter is not required. Calibrate daily before sampling following the manufacture's guidelines.

Conductivity Meter (Separate meter)

This meter may be used when a multiparameter meter is not required. Calibrate daily before sampling following the manufacture's guidelines.

Thermometer

A separate thermometer may be used when a multiparameter meter is not required. All thermometers (either separate or in a multiparameter unit) must be checked at least yearly against a National Institute of Standards & Technology (NIST) Thermometer.

Auger

The system consists of an auger bit, a series of drill rods, a "T" handle and a thin-wall tube corer. The auger bit is stainless steel and is used to sample hard or packed solid media, soil or sediment.

Shovel

A regular lawn or garden shovel used to remove top cover of soil to desired depth for sampling. Not used to collect sample.

Scoops/Spoons

Made of stainless steel or disposable plastic and used to collect soil samples.

Soil Sampling Device (EnCore™ or similar NHDES approved device)

A disposable syringe type device used to collect soil samples in the field

Air Sampling Devices

Air sampling devices may be used in personnel protection and safety as a screening tool to decide whether a respirator, or a self-contained breathing apparatus should be worn, or whether the area should be evacuated. They are used primarily at locations where the air quality is unknown and may also be used for sampling such as for soil gas surveys.

Portable PID/FID Instruments (such as the HNU HW101)

Portable PID/FID instruments have traditionally been used as general survey instruments for headspace analysis of soil and groundwater samples and to determine safe breathing zones. These hand-held instruments employ either a photoionization detector (PID) or flame-ionization detector (FID) for detection of vapors/gases. They are calibrated using calibration check gas cylinders following manufacturer's manual.

MSA Combustible Gas and Oxygen Meter

The MSA Combustible Gas and Oxygen Meter model 261 is used to determine oxygen content and explosive limits for confined spaces such as well cap, truck bins, drums, closed and open store tanks. It is calibrated using calibration check gas cylinders following manufacture's manual.

Dust Meter

A dust meter is used to monitor dust during excavation in potentially hazardous work zones. It is calibrated according to the manufacture's guidelines.

Gas/Air Collection Containers

Stainless Steel Canisters (such as a Summa Canister)

Pre-evacuated passivated stainless steel canisters. Samples are typically collected under either pressurized or subatmospheric pressures.

Sampling Bags (such as Tedlar Bags)

They are air displacement containers. The bag is evacuated prior to use and a sample is collected by opening an inlet and using a pump for positive pressure.

Test Kits (Hach or similar)

Analysis for various parameters may be determined in the field through the use of Hach kits following the manufacturer's instructions. Some of the parameters that may be tested using this method include alkalinity, ferrous iron, nitrate, sulfate, pH, and dissolved oxygen.

APPENDIX C
STANDARD OPERATING PROCEDURES (SOPs)

SOP Table of Contents

This is a list of Standard Operating Procedures (SOPs) commonly used by the ORCB. Any additional SOPs needed for a specific site shall be approved by the Project Manager in consultation with the Quality Assurance Coordinator. Any deviations from these SOPs shall be approved by the Project Manager in consultation with the Quality Assurance Coordinator.

ORCB-1	Water Level Measurement
ORCB-2	Purge Volume Calculation
ORCB-3	Sample Collection with a Bucket-Type Bailer
ORCB-4	Surface Water Sample Collection
ORCB-5	Soil Sample Collection
ORCB-6	Jar Headspace Technique - Field Screening Soil Samples
ORCB-7	Sediment Sample Collection
ORCB-8	Drinking Water Sample Collection
ORCB-9	Decontamination
ORCB-10	Field Instruments Calibration
ORCB-11	Chain-of-Custody, Sample Handling and Shipping

NHDES Final Policy Preservation of VOCs in Soil Samples, March 2000

NHDES Vapor Intrusion Guidance, July 2006, updated February 2013

NHDES Draft Evaluation of Sediment Quality Guidance Document, April 2005

Field Audit Checklists

WATER LEVEL MEASUREMENT

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to set guidelines for the manual determination of the depth to water in an open borehole, cased borehole, monitoring well, temporary well points, or piezometer, as required.

In general, water-level measurements are used to construct water table or potentiometric surface maps and to determine flow direction as well as other aquifer characteristics. It is preferable that all water level measurements at a site are collected in the shortest possible time within a 24-hour period.

EQUIPMENT AND MATERIALS

- Personal protective clothing and equipment as outlined in a site-specific Health and Safety Plan (HASP).
- Site specific Sampling and Analysis Plan (SAP) or Quality Assurance Project Plan (QAPP).
- Boring logs, if available.
- Electronic water level indicator or chemical/water interface probe of an appropriate length (e.g., 100 foot, 200 foot, 300 foot) capable of measuring to 0.01 feet (e.g., Solinst Models 101 or 122, or similar instrument).

Note: In some cases, such as use with the FLUTe™ Multilevel System, a very small diameter water level probe may be required (e.g., Solinst Coaxial Water Level, Model #102 with a 1/4" diameter P-1 Probe; Heron "Skinny Dipper").

- Site and well keys, along with any other equipment that may be necessary to open wells.
- Field log book or water level worksheet.
- Miscellaneous items such as black-ink pens, markers (Sharpies), paper towels, clipboard, etc.
- Decontamination equipment and supplies in accordance with the Decontamination SOP in the SAP.

PRELIMINARY PROCEDURES

All monitoring wells should be secured at all times, or within a secure area, to ensure the integrity of the well.

Refer to the site-specific SAP for correct reference points, if applicable. If water level measurements are being completed for the first time following well installation, or if a well

reference point has not been established, a survey mark or physical notch should be placed on the top of the riser or casing as a reference point for future static water level measurements. If the top of the riser or casing is not flat, the highest point should be the reference point. The measurement reference point must be documented in the site logbook and on the site-specific Water Level Worksheet.

Once a reference point has been established for a well, the reference point should be documented in the project notes and field personnel should be instructed to collect all static water level data from that point.

Water levels in piezometers and monitoring wells should be allowed to stabilize for a minimum of 24 hours after well construction and development before collecting measurements. Equilibrium may take longer in low yield situations. All measurements should be made to an accuracy of 0.01 feet.

The water level meters or interface probes shall be decontaminated in accordance with the approved decontamination SOP and checked prior to use to ensure that they are in proper working condition.

Water levels should be collected from the least contaminated to the most contaminated wells if possible and where applicable.

SURFACE WATER LEVEL MEASUREMENTS

When surface water measurements are required at one or more permanent locations, permanent staff gages or other fixed reference points are typically used at these locations. Refer to the site-specific SAP. The elevation of surface water staff gages shall be surveyed relative to the site bench mark and the location surveyed or otherwise determined by global positioning system (GPS) methods. The locations shall be included on site maps for future reference.

The water level may be read directly from a surveyed staff gauge or measured from a fixed reference point and recorded in the field log/worksheet.

WATER LEVEL MEASUREMENT PROCEDURES:

Water levels in monitoring wells should be measured carefully to minimize water column disturbance. Use the following procedures to collect water level measurements:

1. Clear the area around the well to control the introduction of contaminants and debris into the open well.
2. Turn the meter on and adjust the sensitivity control, as appropriate. Use the test button to ensure that the unit is operating.
3. Lower the electronic water level meter probe and measuring tape into the well from the reference point until the water surface is reached as indicated by a tone and/or the light

display. If light non-aqueous phase liquid (LNAPL), i.e., floating product, is known or suspected in a monitoring well, use an interface probe to check, measure, and record the depth of the top and bottom of the LNAPL layer.

4. Measure the static depth to water from the well reference point to 0.01 feet and record the measurement along with the date, time and reference point in field log/worksheet. Also record the condition of the well and surrounding area.
5. Remove all downhole equipment used for the water level measurement and secure the well.
6. Thoroughly decontaminate the tape and probe following the approved procedures. The decontamination procedure for water level meters and oil/interface probes shall include at a minimum the probe and the length of tape used in that well.

QUALITY ASSURANCE/ QUALITY CONTROL (QA/QC)

Equipment blanks may be required to ensure that the equipment has been properly decontaminated and the decontamination procedures are adequate. See the SAP for specific QA/QC requirements, if applicable.

ATTACHMENT

Water Level Worksheet

PURGE VOLUME CALCULATION

1. Measure the static water level in the well and the total depth of the well (ORCB-1 Water Level Measurement).
2. Measure the well inside diameter in inches.
3. Calculate one purge volume using the following equation, multiplying by number of purge volumes needed, typically 3 to 5 or use conversion charts shown below and on the next page.
4. The volume of tubing may be calculated by the same method.

CALCULATION OF PURGE VOLUME FOR WELL

$$\text{One Purge Volume (Gallons)} = h \times 3.14(r/12)^2 \times 7.48 \text{ gal/ft}^3$$

Per: Volume = $h \times \pi \times r^2$,

Where: $\pi = 3.14$ (a constant),
 $r = \text{radius} = \text{diameter}/2$ (inches),
 ($r/12$ converts radius to feet)
 $h = \text{length of water column in well}$ (feet),
 $7.48 = \text{gallons in 1 cubic foot of water}$.

CALCULATION OF PURGE VOLUME FOR TUBING

The purge volume is equal to $h \times 3.14(r/12)^2 \times 7.48 \text{ gal/ft}^3$.

Or, using the table below, one purge volume is equal to $(h) \times (f)$ where:

$h = \text{length of tubing}$,

$f = \text{the volume in gal/foot}$.

Then convert gallons to milliliters (1 gallon = 3,785 ml) so that the purge volume can be accurately measured using a graduated cylinder.

The volumes per foot of some typical tubing sizes are shown in the table below.

Tubing ID (Inside Diameter) In inches	1/8 (0.125)	11/64 (0.17)	1/4 (0.25)	3/8 (0.375)	1/2 (0.50)	5/8 (0.625)
Volume (gal/foot)	0.00064	0.00118	0.00255	0.00573	0.01019	0.01593
Volume (ml/foot)	2.42	4.47	9.65	21.69	38.57	60.30

CALCULATION OF PURGE VOLUME FOR WELLS

$$\text{Purge Volume} = h \times 3.14(r/12)^2 \times 7.48 \text{ gal/ft}^3,$$

$$\text{One Purge Volume} = (\text{length of water column}) \times (\text{gallons/foot}),$$

h = length of water column in well (feet).

Casing Diameter (Inches)	Gallons Per Foot	Gallons Per Foot × 3 Volumes	Gallons Per Foot × 4 Volumes	Gallons Per Foot × 5 Volumes	Length of Water Column (Feet)	Purge Volume (Gallons)
1.00	0.04	0.12	0.16	0.20		
1.25	0.06	0.18	0.24	0.30		
1.50	0.09	0.27	0.36	0.45		
1.75	0.12	0.36	0.48	0.60		
2.00	0.16	0.48	0.64	0.80		
2.25	0.21	0.63	0.84	1.05		
2.50	0.25	0.75	1.00	1.25		
3.00	0.37	1.11	1.48	1.85		
3.50	0.50	1.50	2.00	2.50		
4.00	0.65	1.95	2.60	3.25		
6.00	1.47	4.41	5.88	7.35		

SAMPLE COLLECTION WITH A BUCKET-TYPE BAILER

PURPOSE

This Standard Operating Procedure (SOP) is intended to provide general guidance for collecting representative groundwater samples from monitoring wells using a bucket-type bailer, generally referred to simply as a bailer.

This SOP is not intended to give specific guidance on safety procedures. Always refer to the site-specific safety plan and/or other project documentation.

Bottom-dispensing bailers are required for collecting groundwater samples for analysis of volatile organic compounds (VOCs). This procedure is intended for use with a bottom-dispensing bailer.

A bailer generally comprises a cylinder with a loop for attaching twine at the top and a simple ball-style check valve at the bottom. The valve allows water to enter from the bottom as the bailer is lowered through the water column and closes under the weight of the water inside as the bailer is raised. Bailers are typically made of PVC, stainless steel, polyethylene or Teflon®; polyethylene bailers are generally intended to be dedicated for one-time use. One-use bailers are often weighted to ensure a smooth descent through the water column with minimal disturbance. Reusable bailers are generally heavy enough that additional weight is not needed. Bailers are available in a variety of lengths and diameters. The appropriate bailer type, length and diameter for a particular project or well may be specified in the work plan or other site-specific documentation, as applicable.

Bailers are particularly useful when samples must be collected from depths greater than the range, or capability of suction lift pumps, or when the well casing diameter is too narrow to accept a submersible pump. When used carefully, quality groundwater samples may be collected with minimal aeration, a prerequisite for VOC analyses. The selection of bailers for sample collection must always be in accordance with the data quality objectives for the project.

EQUIPMENT AND MATERIALS

The following is a list of equipment and material commonly used for the collection of groundwater samples:

- Appropriate personal protective equipment (PPE) and an approved site-specific Health and Safety Plan, as applicable.
- Site specific Sample Analysis Plan or other project documentation, as applicable, and the Sample Collection with a Bucket-Type Bailer Worksheet.
- An electronic water level meter (ORCB-1 Water Level Measurement).
- A clean or dedicated bottom filling/bottom dispensing bailer of appropriate size and material for the well and the data quality objectives for the project.

- Clean bailer twine made from nylon or alternate materials if allowed by the data quality objectives for the project.
- Well keys, as applicable.
- Toolbox, which typically includes such items as: sharp knife with a locking blade, bolt cutters, spare well locks, screwdrivers, pliers, hacksaw, hammer, flashlight, adjustable wrench, socket wrench set, duct tape, and other applicable field equipment to open wells..
- New plastic sheeting.
- A five-gallon bucket for collecting purge water. The bucket should be marked with graduations defining 1/2 gallon increments.
- A logbook, pencil/pen/sharpies, and a calculator.
- If a synoptic water level measurement event associated with the current sample collection effort was completed, the total well depths measured during the synoptic effort.
- Sample labels, chain-of-custody form, and custody seals, if applicable.
- Pre-preserved sample containers, including extras. Containers provided by the laboratory are preferred, however, containers obtained from an outside vendor may be used if permitted by the data quality objectives of the project.
- Re-sealable plastic bags and packing materials.
- Loose ice and an insulated cooler.
- Trash bags for solid waste and for lining the insulated cooler if samples are being shipped.
- Laboratory-grade deionized (DI) water. Decontamination equipment and supplies in accordance with the ORCB-9 Decontamination and the data quality objectives for the project.

PRELIMINARY PROCEDURES INCLUDING WATER LEVEL MEASUREMENTS

1. If a new, dedicated bailer is not being used, decontaminate the bailer before use, and between uses at different wells, in accordance with the ORCB-9 Decontamination and the data quality objectives for the project.
2. Note the condition of the well and surrounding area in the field book and take photographs as appropriate.
3. Depending on the data quality objectives of the project, a synoptic water level measurement event may have been completed prior to the sample collection effort. Unless the synoptic water level event was completed the same day as the sample collection, the static water level shall be measured and recorded immediately prior to purging the well and collecting the sample. Note that the total depth need not be measured again if it was already measured during a synoptic event associated with the current sample collection effort.

4. Lay out a new piece of plastic sheeting near the well to keep the bailer and twine from contacting the ground and to provide a clean area for containers and other equipment.
5. The use of dedicated bailers and/or appropriate decontamination procedures will limit the potential for cross-contamination between individual wells. When practical, it is preferable to collect samples from the least contaminated wells first and progress to incrementally more contaminated wells in sequence. Site logistics and project requirements may influence the ability to complete the sample collection sequentially from assumed least contaminated to most contaminated. Alternately, if the degree of contamination is unclear from the available data, collect samples from the inferred upgradient wells first and progress to downgradient and source area wells sequentially. Refer to the data quality objectives for the project and other site documentation for further guidance.

PROCEDURE FOR USING A BOTTOM DISPENSING BAILER:

1. Measure the static water level in the well in accordance with ORCB-1 Water Level Management and/or the data quality objectives of the project.
2. If not already known, measure the diameter of the inner casing in inches and record on the worksheet.
3. Use the length of the water column determined from the measured static water level and the total well depth to calculate the required purge volume in accordance with ORCB-2 Calculation of Purge Volume and the data quality objectives of the project and record the volume on the worksheet. Most projects will require purging three to five standing volumes.
4. Attach an appropriate length of new bailer twine to a pre-cleaned or dedicated bailer.
5. Gently lower the bailer to the sample collection depth in accordance with the data quality objectives of the project, limiting the disturbance to the water column. Allow the bailer to fill and gently retrieve the bailer from the well limiting the disturbance to the water column. While handling the bailer, the bailer and twine should be kept off the ground or should only contact the clean plastic sheeting placed prior to attaching the bailer to the twine.
6. Discharge the water from the top of the bailer into the graduated five-gallon bucket.
7. Gently repeat filling and discharging the bailer until the appropriate volume has been purged from the well. Wells installed in certain overburden or bedrock settings may not recover at the rate that they are purged. Refer to the data quality objectives for the project for guidance on acceptable purge volumes or alternate procedures for wells with poor recovery.
8. Record the final purge volume on the worksheet.
9. Discharge the final purge water to the ground or into an appropriate container as specified for the project.
10. To collect a groundwater sample:

- a) Remove the cap from the container for the first sample volume and place it on the plastic sheet or in a location where it will not become contaminated.
- b) Slowly lower and retrieve the bailer as described above.
- c) Attach the sample dispensing spout to the bottom of the bailer.
- d) Begin slowly discharging the groundwater through the spout into the sample container.

All sample containers shall be filled by allowing the discharge to flow gently down the inside of the container with minimal turbulence.

VOC sample volumes are typically collected first. Volumes for other parameters should be collected sequentially in accordance with the data quality objectives of the project

For collection of VOC sample volume, including 1,4-dioxane (analytical method 8260 SIM), carbon dioxide, methane, ethane and ethene, refer to the Special Notes section at the end of this SOP.

- e) Securely cap the sample container immediately after filling and wipe the container dry. Continue to fill containers in sequence until the full sample volume has been collected. Note: If at all possible, sample collection should not be interrupted to record additional notes, communicate with other site personnel, maintain equipment, etc. Once sample collection has begun, it should proceed steadily and continuously until the entire volume, i.e. all containers for various analyses, have been filled and securely capped. Refer to the data quality objectives for the project for guidance or alternate procedures for wells with poor recovery.
- f) If a field duplicate sample and/or field matrix spike/matrix spike duplicate (MS/MSD) volumes are required, they should be collected by filling a separate container for each analysis immediately following the designated field sample collection, e.g., VOC sample volume, VOC duplicate sample volume; 1,4-dioxane sample volume, 1,4-dioxane duplicate sample volume and/or 1,4-dioxane MS/MSD sample volume; etc. In general, duplicate samples are not intended to be blind duplicate samples. They should be designated with a "DUP" after the well designation, e.g., TRY_MW-2 DUP. Refer to the data quality objectives for the project and/or other project documentation for specifics such as sample designation nomenclature, quality control requirements, and the appropriate chain-of-custody (COC) notations required for MS/MSD samples.
- g) The sample volumes should be placed into re-sealable plastic bags and then into an insulated cooler with loose ice immediately after collection. Sample volumes for analysis for metals that have been acidified to less than pH 2 are not required to be kept in ice.

11. Replace the well cap and secure the well.

12. Log all samples in the field book and/or work sheet and ensure that all samples are appropriately labeled.
13. Complete sample management activities and other related paperwork for the sample just collected.
14. Decontaminate all non-dedicated equipment in accordance with ORCB-9 Decontamination and the data quality objectives for the project. Disposable equipment shall be discarded and not reused after collection of the sample is completed.

EQUIPMENT BLANK

The data quality objectives for some projects may require collection of an equipment blank to ensure that the decontamination procedures were adequate. Equipment blanks are generally collected for equipment used in a well with known or expected contamination and immediately after the equipment has been decontaminated in accordance with ORCB-9 Decontamination and the data quality objectives for the project.

Example: Collecting an equipment blank from a non-dedicated bailer.

When the full sample volume has been collected, decontaminate the bailer as described above and consistent with how other bailers are decontaminated for the project. Following the full decontamination procedure, rinse the bailer once with laboratory-grade deionized (DI) water. Collect an equipment blank sample by filling the bailer with DI water and then slowly discharging the water from the bottom of the bailer using the sample dispensing spout, consistent with the collection of field samples. Refill the bailer with DI water as needed to fill all of the appropriate containers. Refer to the project documentation for specific quality control sampling requirements and appropriate COC notations required for samples.

SPECIAL NOTES

Special Considerations for the Collection of Volatile Organic Compound Samples, including 1,4-dioxane samples analyzed by method 8260 SIM.

The act of collecting an aqueous sample from the environment will have an influence on the concentrations of the analytes of interest relative to the true concentration in the environment. In particular, samples volumes for analysis of VOCs require careful handling through specific procedures to limit the loss of the dissolved volatiles and ensure delivery of the most representative sample possible to the analytical laboratory. Collecting samples from the environment, however, may require decisions with respect to collecting a sample under non-ideal conditions and the viability of data reported for samples collected under non-ideal conditions. Fully documenting the decision processes in the field and the conditions under which a sample is collected is an important component of sample collection as a basis for determining the viability of the analytical result. Always refer to the data quality objectives for the project for site-specific guidance on acceptable procedures.

VOC sample volumes shall be collected using the following procedures:

1. Open the vial, set cap in a clean and protected place, and collect the sample by allowing the water to flow gently down the inside wall of the container with minimal turbulence. It is useful to have a device such as a foam block that will securely support the vial so that the field technician's hands are free to control the bailer and sample flow. When collecting quality control samples such as duplicate and MS/MSD volumes, collect them immediately following the original sample volume.
2. For most volatile organic analyses, the sample is preserved to stabilize it and limit analyte loss through organic consumption. For preserved samples, the preservative, usually hydrochloric acid, has been preloaded into the vial by the laboratory or vendor. A pre-preserved vial should never be rinsed and overfilling should be limited. While there are no specified guidelines, field personnel should use experience and good judgement to decide if a vial has been overfilled to the extent that the preservative has been diluted. If a vial is overfilled, it should be discarded and a new vial used.
3. The flow of water into the vial should be as smooth as possible to ensure that aeration is limited. When samples are collected from tubing, there should be no air bubbles in the tubing.
4. Ideally, a sample volume for VOC analysis should have no air bubbles, or "head space", that would allow dissolved volatiles to come out of solution. A volatile organic analysis vial is designed to be filled with a convex meniscus at the top of the vial.
5. Place the cap over the meniscus and gently but firmly secure the cap. When done properly, there will be no bubbles in the sample volume.
6. If a meniscus cannot be created directly from the tubing or bailer spout, a small volume of the sample may be loaded into the vial cap directly from the tubing or bailer spout and then decanted into the vial to create the meniscus.

For methane/ethane/ethene and carbon dioxide analysis, the laboratory typically requests that the sample bottle cap is not used to top off the sample vials. These vials should be filled in the shortest time possible and capped immediately. Do not uncup these vials and add more water. Small bubbles are considered normal for these pre-preserved containers; however, every effort shall be made to collect the highest quality sample possible.

7. Once the vial has been securely capped, invert the vial and tap gently. If an air bubble appears, uncup the vial and attempt to add a small volume of sample to achieve the meniscus without excessively overfilling the vial. If this has to be repeated more than twice, discard the sample volume and begin again with a new pre-preserved container.
8. Some geochemical conditions may result in water with too little surface tension to create a convex meniscus. If a sample volume cannot be collected without bubbles, the best quality sample possible should be collected and the collection conditions and sample quality documented in the project notes. Documentation of the sample conditions may be used when considering the viability of the analytical results.

9. Wells with poor recovery or low standing volume may present challenges for collecting a quality VOC volume with a bailer. The bailer must contain sufficient groundwater to collect one vial volume with an appropriate meniscus; partially filling a vial and refilling the bailer for additional water is not preferred, however, it may be acceptable if the alternative is to not collect a sample. The collection conditions must be fully documented in the field to provide a basis for determining the viability of the analytical result. Refer to the data quality objectives for the project for guidance on acceptable procedures for wells with poor recovery and/or low volume.
10. Wipe the vial dry and immediately place the vial in a re-sealable plastic bag and into loose ice in an insulated cooler.

ATTACHMENT

Sample Collection with a Bucket-Type Bailer Worksheet

Sample Collection with a Bailer Worksheet

Site:

Field Personnel:

Date:

	Well ID
well reference point	
total well depth (from reference point to 0.01 ft.)	
well casing ID (inches)	
static water level (from reference point, to 0.01 ft.)	
water column = total well depth - static water level (to 0.01 ft.)	
sample collection depth*	
required standing well volumes to be purged per project data quality objectives**	
calculated purge volume for well (gal.)	
purge volume = water column length _____ ft. × _____ gal./ft. ³ (see table below)	
actual purge volume (gal.)	
sample collection time	
Sample Designation	
Analyses Requested	
Associated Quality Control Samples	

Calculation of Purge Volumes

$$\text{standing well volume} = \text{water column} \times 3.14(r/12)^2 \times 7.48 \text{ gal./ft.}^3$$

$$\text{one purge volume} = (\text{length of water column}) \times (\text{gal. / ft.})$$

$$\text{length of water column (ft.)} = \text{depth of well} - \text{depth to water level}$$

Purge Volumes by Well Diameter

Inner Casing Diameter (Inches)	gal. / ft.	gal. / ft. × 3 Volumes	gal. / ft. × 4 Volumes	gal. / ft. × 5 Volumes
1.00	0.04	0.12	0.16	0.20
1.25	0.06	0.18	0.24	0.30
1.50	0.09	0.27	0.36	0.45
1.75	0.12	0.36	0.48	0.60
2.00	0.16	0.48	0.64	0.80
2.25	0.21	0.63	0.84	1.05
2.50	0.25	0.75	1.00	1.25
3.00	0.37	1.11	1.48	1.85
3.50	0.50	1.50	2.00	2.50
4.00	0.65	1.95	2.60	3.25
6.00	1.47	4.41	5.88	7.35

Note observations and/or deviations from procedures below

*Refer to project documentation; in lieu of a specified collection depth, the center of the well screen is assumed.

**In lieu of project-specific requirements, a purge volume of 3 standing well volumes is assumed.

SURFACE WATER SAMPLE COLLECTION

PURPOSE

The purpose of the Standard Operating Procedure (SOP) is to provide guidance for collecting surface water samples for laboratory analyses that are representative of environmental conditions at the sample location. Although the SOP makes frequent reference to “upstream” and “downstream” relative to collecting a quality sample, the basic principles and procedures are meant to include waterbodies with little or no flow. The field technician should use experience and judgement when collecting samples from waterbodies with little or no flow to ensure the integrity and viability of the sample.

The act of collecting an aqueous sample from the environment will have an influence on the concentrations of the analytes of interest relative to the true concentration in the environment. In particular, samples volumes for analysis of VOCs require careful handling through specific procedures to limit the loss of the dissolved volatiles and ensure delivery of the most representative sample possible to the analytical laboratory. Collecting samples from the environment, however, may require decisions with respect to collecting a sample under non-ideal conditions and the viability of data reported for samples collected under non-ideal conditions. Fully documenting the decision processes in the field and the conditions under which a sample is collected is an important component of sample collection as a basis for determining the viability of the analytical result. Always refer to the data quality objectives for the project for site-specific guidance on acceptable procedures.

This SOP is not intended to give specific guidance on safety procedures. Always refer to the site-specific safety plan and/or other project documentation.

PREPARATION

Safety is always the primary concern during any field work. In particular, the collection of a sample from a waterbody has the potential to be unsafe under various seasonal conditions and flow regimes. A sample should not be collected if it cannot be collected safely. If collection of a specific sample is determined to be unsafe, the circumstances and decision process shall be documented in the field notes. In general this procedure assumes a minimum of two field personnel working together, i.e. the “buddy system”, to ensure safety. This SOP is not intended to provide specific safety procedures when working near or on open water; refer to the site-specific safety plan and other project documentation for additional guidance.

Surface water, sediment, and/or pore water samples may be collected from the same location during a given sample collection effort. To ensure that the collection of a sample of one media does not adversely affect the quality of the samples subsequently collected from other media at the same location, the sequence and time separation of the collection should be considered. Refer to the data quality objectives for the project and other site documentation for specific guidance.

Refer to the site-specific data quality objectives in the Sampling and Analysis Plan (SAP) or other project documentation, as applicable, for specific details such as sample points, analytes and quality assurance (QA) requirements. This SOP assumes that factors such as the effect of weather conditions on data quality have been addressed on a site-specific basis when planning a surface water sample collection effort and that decision-making guidance is included in the project documentation.

Additionally, this SOP assumes that collection locations have been established, were determined during the planning phase of the project, or that the project documentation will provide specific guidance on selecting and marking repeatable locations.

EQUIPMENT

Some or all of the following equipment may typically be used in collecting surface water samples:

- Appropriate personal protective equipment (PPE) and an approved site-specific Health and Safety Plan, as applicable.
- Site-Specific SAP or other project documentation, as applicable, that includes a site plan showing sample locations and other project-specific information.
- Waders, as applicable.
- Clean glass jars or decontaminated stainless steel containers to use as an intermediary collection vessels to decant surface water samples into pre-preserved containers.
- A pole, strapping, and other materials and equipment, for collecting samples from locations with limited access.
- A supply of 0.45 micron filters and matching syringes to filter surface water sample volumes in the field for analysis of dissolved metals. Collection of one sample volume may require multiple filters so the available supply should exceed the number of samples anticipated.
- Pre-preserved sample containers, insulated coolers, and loose ice.
- Re-sealable plastic bags to protect and store samples.
- Field worksheets, sample labels and chain of custody forms.
- Field book, pencil/pen/sharpeners and calculator.
- Camera; digital is preferred.
- The manufacturer's instruction manuals for all equipment; spare components, as applicable; all required calibrations standards; and ORCB-10 Field Instruments Calibration, as applicable.
- Stream staff/gage or similar measuring device, as applicable.
- GPS unit or similar device, as applicable.

- Decontamination supplies and equipment in accordance with ORCB-9 Decontamination.
- Paper towels.
- A multiparameter meter, preferably with a built in barometer, that is capable of measuring pH ; oxidation reduction potential (ORP) in millivolts (mV); dissolved oxygen (DO) in milligrams per liter (mg/l); specific conductance in microSiemens per centimeter ($\mu\text{S}/\text{cm}$); and temperature in degrees Celsius ($^{\circ}\text{C}$)
- A probe guard for the multiparameter meter for in-situ parameter readings.
- A turbidity meter and appropriate calibration standards, if applicable.
- Peristaltic pump and tubing, as applicable.
- Toolbox to include general items such as large and small wrenches, pliers, screw drivers, 25' measuring tape, hose connectors, sharp knife with locking blade, and duct tape, at a minimum.

Refer to the project documentation for additional or alternate equipment and supply requirements.

GENERAL PROCEDURE

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.

If water quality parameters such as pH, specific conductivity, temperature, ORP and DO are required, they shall be collected in-situ whenever practical. If turbidity measurements are required, a separate turbidity meter shall be used; measuring turbidity with a multiparameter meter is generally not acceptable. If possible, collect a sample of water in the cuvette provided with the meter and measured in the field using a separate turbidity meter. Decanting the turbidity volume from an alternate container should be avoided whenever possible.

Unless calibration documentation is provided by an equipment vendor, or the data quality objectives and other project documentation do not require it, all of the instruments anticipated for use on the project should be successfully calibrated in accordance with ORCB-10 Field Instruments Calibration once prior to mobilization.

Unless the data quality objectives and other project documentation do not require it, the field instruments will be calibrated on site in accordance with ORCB-10 Field Instruments Calibration at the beginning of each day of use. A calibration check should be performed if an instrument gives inconsistent or anomalous readings and re-calibrated if the instrument does not pass the check.

Unless otherwise required by the data quality objectives for the project or other project-specific documentation, the sample volume(s) for laboratory analyses should be collected prior to measuring water quality parameters.

The sample collection location, including upstream and downstream from the same position, should be documented with digital photographs to assist in replicating the location if field markings are lost.

For safety and ease of collection, surface water samples should be collected from the shore whenever possible. If entering moving water to collect a sample is necessary, the water depth should not exceed three feet. If safe access is not available, the sample collection container may be attached to a pole with strapping or tape and collect the sample.

If the data quality objectives and other project documentation require it, measure and record the depth of water from the bottom of the waterbody to the surface of the water, in feet, directly downstream of each sampling location. Some sites may have a permanently-installed staff gage at one location to monitor water levels instead of, or in addition to, measurements at each separate location.

Surface water samples to be collected from the same water body should be collected sequentially from downstream to upstream sample locations. Sample locations will be approached from the downstream side to minimize disturbance of the bottom sediment and the sample should be collected upstream of the field technician. When water samples are collected from a boat, they shall be collected from the bow or upstream side of the boat, away from the motor, taking care to avoid contamination of the sample.

Samples may be collected directly into the laboratory container only if the container is not pre-preserved. If the container is pre-preserved, the sample must be collected using an appropriate clean intermediate container, such as a dedicated glass jar or decontaminated stainless steel beaker and decanted into the pre-preserved container. Sample volumes for analysis of dissolved metals shall be filtered in the field using a syringe and new 0.45 micron in-line filters. Use new 0.45 micron in-line filters for the duplicate, if required. Refer to the project documentation for additional site-specific sample collection requirements.

Avoid entraining floating debris and surface skim in the sample volume. The mouth of the container shall be facing upstream and the container slowly submerged just beneath the surface of the water, unless specified otherwise in the data quality objectives or other project documentation. If surface water is collected with an intermediate container, the container shall be rinsed once downstream of the sampling location before the sample is collected. When the sample is collected in the intermediate container, it shall be immediately decanted to the appropriate pre-preserved containers. Unless new or dedicated containers are used for each location, the intermediate container will then be decontaminated before reuse.

Samples are collected from most to least volatile, e.g., VOCs, SVOCs, total manganese/hardness, dissolved manganese, etc., unless otherwise specified for the project. Collect duplicates and other quality control samples as required in the data quality objectives or other project documentation.

Once the sample containers are filled with the appropriate amount, they are immediately capped and cleaned to remove any potential residue. Place the sample volumes in re-sealable plastic bags and store the samples in accordance with appropriate protocols. If the analytical method requires that the sample volume be maintained at a cool temperature, the samples shall be placed in loose ice in an insulated cooler. Refer to the data quality objectives for the project or other project-specific documentation for additional guidance.

If field parameters are required, the following procedure shall be used:

1. Install the probe guard on the multiparameter meter and rinse the probes in the downstream of the sample collection location.
2. Immerse the probes into the water immediately upstream of any disturbance caused by accessing the sample location, making sure it is deep enough to cover the probes and probe guard. There should be no air bubbles on the probe. To dislodge any bubbles, gently move the probe 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.
3. Allow a minimum of two minutes for the readings to stabilize.
4. Once the readings have stabilized, record the pH, specific conductivity in $\mu\text{S}/\text{cm}$, temperature in $^{\circ}\text{C}$, ORP in millivolts, and DO in mg/l in the field book.
5. Rinse out a turbidity cuvette downstream of the sampling location.
6. Collect a sample in the cuvette and ensure that there are no bubbles in the sample. Completely dry the cuvette before placing it in the sample chamber of the turbidity meter. Record the measurement in NTUs in the field book.

Alternately, subsurface water samples may be collected using an appropriate pump and tubing, extending the tubing to the sample depth; or with a device made of the appropriate materials designed for depth-specific sample collection. Refer to the project documentation for additional guidance on sample collection locations and depth.

QUALITY ASSURANCE SAMPLES

Refer to the data quality objectives and/or other project documentation for site-specific guidance on quality control sample requirements.

For most projects, at least one duplicate sample should be collected per analysis. Use a new 0.45 micron in-line filter and at each new sample location for collecting duplicate sample volumes for analysis of dissolved metals.

Duplicate samples are collected by filling a separate container for each analysis immediately after the designated field sample for the same parameter is collected and should be in the same priority order as indicated in the data quality objectives and/or other project documentation for the site. Duplicate samples are typically not intended to be blind duplicate samples.

Equipment blanks should be collected on non-disposable equipment, such as intermediate collection containers, to ensure that the equipment is clean and the decontamination procedure is adequate.

When collecting a field blank from an in-line filter for dissolved metals, collect an equipment blank prior to collecting the field sample by running deionized water through the filter into the sample container.

DECONTAMINATION

Decontaminate equipment according to the ORCB-9 Decontamination and/or the data quality objectives and/or other project documentation. Discard disposable sample collection equipment after one use.

DOCUMENTATION

Refer to the data quality objectives and/or other project documentation for site-specific guidance on documentation requirements. The data to be measured and recorded in the field, or researched to be included in the project notes, may include, but are not limited to, the following:

1. The sample location, sample identifier, and analytical parameters.
2. The date and time of sample collection.
3. Water depth at the sample location, if required for the project.
4. The water quality parameter field measurements.
5. A general description of the sample and collection location, i.e. color; stream flow, as applicable; physical setting; etc.
6. Observations of weather or other conditions at the time of sample collection that have the potential to influence the sample quality or viability.
7. Digital photographs of the sample location including one or more of the larger surrounding area, along with any notes on the photos.
8. If the project requires it and recording field instrument is not being used, the last seven days of local meteorological data may be researched from the office prior or subsequent to collection of the sample. The available data should be included in the project documentation along with the field records.

SOIL SAMPLE COLLECTION

PURPOSE

This Standard Operating Procedure (SOP) applies to the collection of surface and subsurface soil samples for laboratory analyses. The act of collecting environmental samples will have an influence on the concentrations of the analytes of interest relative to the true concentration in the environment. In particular, samples volumes for analysis of VOCs require careful handling through specific procedures to limit the loss of the dissolved volatiles and ensure delivery of the most representative sample possible to the analytical laboratory. Collecting samples from the environment, however, may require decisions with respect to collecting a sample under non-ideal conditions and the viability of data reported for samples collected under non-ideal conditions. Fully documenting the decision processes in the field and the conditions under which a sample is collected is an important component of sample collection as a basis for determining the viability of the analytical result. Always refer to the data quality objectives for the project for site-specific guidance on acceptable procedures.

This SOP is not intended to give specific guidance on safety procedures. Always refer to the site-specific safety plan and/or other project documentation.

All non-dedicated sample collection equipment shall be decontaminated prior to use and between samples in accordance with ORCB-9 Decontamination and the data quality objectives for the project. In general, sample collection activities are assumed to proceed progressively from the suspected least contaminated area to the suspected most contaminated area whenever possible.

NOTE: The collection of samples for volatile organic compound (VOC) analysis shall follow the guidelines written for soils in the New Hampshire Department of Environmental Services (NHDES) “Final Policy Preservation of VOCs in Soil Samples” dated March 2000.

Unless the sample collection location has been pre-determined and marked, the coordinates of the location should be recorded using a global positioning system (GPS) unit. The expected accuracy of the GPS unit shall be determined in advance and specified in the project documentation. Flagging, stakes, and/or other methods should also be used to mark the location. Take digital photographs of each sample location that include nearby objects and/or landmarks that would help replicate the location if field markings are lost.

A variety of tools may be used for collecting soil samples including stainless steel hand augers, split spoon samplers, coring devices, scoops, spoons, etc.. Shallow boreholes for subsurface soil samples may be advanced by hand boring devices or portable powered augers. When the geology is not appropriate for manual methods or greater depths are required, drilling with methods such as direct push; hollow stem auger; and casing, i.e., drive-and-wash; may be used. This procedure primarily references hand augers but is applicable to other soil sampling equipment.

Refer to the data quality objectives or other project documentation for site-specific guidance on acceptable procedures the type of equipment to be used; the drilling method, as applicable; sample locations; analytes; and quality assurance (QA) requirements.

EQUIPMENT

The following equipment is typically used in collecting soil samples:

- Appropriate personal protective equipment (PPE) and the approved site-specific Health and Safety Plan, as applicable.
- Project documentation that includes information such as the project quality objectives, sample locations, field data requirements, site plan(s), QA requirements, and other project-specific information as applicable.
- EnCore™ samplers or disposable syringes with the tips cut off for collecting VOC samples directly from the collection device. These devices are disposable and shall be used only once. The number of devices available on site should exceed the number of samples anticipated to be collected.
- Stainless steel scoops, bowls, spoons, as applicable.
- Hand augers, as applicable.
- Coring tubes/devices, as applicable.
- Sample containers, preserved as necessary, insulated coolers, and **loose** ice.
- Re-sealable plastic bags to protect and store samples;
- Field data from last sampling event if available and applicable;
- A field book, sample labels, and chain of custody forms;
- The manufactures instruction manuals for all equipment, if applicable;
- Decontamination supplies/equipment, including laboratory-grade deionized water.
- Paper towels.
- Toolbox to include general items such as large and small wrenches, pliers, screw drivers, 25' measuring tape, hose connectors, sharp knife with locking blade, and duct tape, at a minimum.
- Digital camera.
- Marking stakes, flagging, and a GPS unit, as applicable.

GENERAL PROCEDURE FOR COLLECTION OF SOIL SAMPLES

Carefully clear away all surface debris such as leaves, twigs, etc. for a minimum 1-foot radius around the sample location. Stage all equipment and supplies on plastic sheeting, or equivalent, to prevent contact with potentially contaminated surfaces. Avoid entraining plant material and

other debris in the sample volume. Subsurface organic material such as roots should be limited to the extent possible without overly disturbing the sample.

VOCs sample volumes must be collected directly from the sampling device according to the **NHDES “Final Policy Preservation of VOCs in Soil Samples” dated March 2000**. Using the disposable syringe, the proper volume of soil is added to the methanol preserved volatile organic analysis (VOA) vial until the volume in the VOA vial reaches the pre-marked line established by the laboratory. An additional unpreserved volume is collected for determination of the moisture content.

For surface and near surface soil samples, e.g., 0-6”, 0-12”, etc.: using a decontaminated stainless steel hand auger or other sampling device, auger or core into the material which is being sampled to the specified depth, retrieve the sample, collect VOC samples directly from the sampling device, and place remaining sample in a stainless steel or glass pan. Continue to collect additional soil from areas adjacent to the original sample location to ensure staying within the required depth until the appropriate volume of soil is obtained. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the field sample and the duplicate.

For subsurface soil samples: using a decontaminated hand auger or other boring or drilling device, advance the borehole to the appropriate sampling depth. Prior to collecting the sample, remove and/or minimize cuttings/cavings from the borehole to avoid collection of material that is not from the target sampling interval. Then use a decontaminated hand auger or sampling device, such as a thin walled tube or split spoon sampler, to collect the sample. After retrieving the sampler, trim the upper portion of the sample to remove any cuttings or cavings that may be present with the sample, collect VOC samples directly from the sampling device, and place remaining sample in a stainless steel or glass pan. Continue to collect additional soil from areas adjacent to the original sample location to ensure staying within the required depth until the appropriate volume of soil is obtained. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the field sample and the duplicate.

If using a backhoe, shovel or other equipment to remove soil from the excavation: use a stainless steel trowel to collect soil that has not come into contact with the tool used for excavation, collect VOC samples directly from the sampling device, and place remaining sample in a stainless steel or glass pan. Continue to collect additional soil from areas adjacent to the original sample location to ensure staying within the required depth until the appropriate volume of soil is obtained. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the field sample and the duplicate.

Following VOC sample collection, mix and homogenize the remaining soil as described below. Fill and cap the remaining sample containers in the order specified in the project documentation. Clean the exteriors of the containers to remove any potential residue. Place the samples in re-sealable bags. VOC and other samples requiring cooling shall be placed within **loose** ice in an insulated cooler.

With the exception of VOC samples, it is important that the sample be mixed and homogenized as thoroughly as possible to ensure that the sample is representative of the material sampled. A common method of mixing is referred to as quartering. Using a decontaminated stainless steel trowel, the sample in the sample pan is divided into quarters. Each quarter is mixed, and then all quarters are mixed into the center of the pan. This procedure is followed several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material. Note: If samples are predominantly moist and have a high silt and/or clay component, extra effort may be necessary to produce a homogenous mixture.

Record a general physical description of the sample such as color; moisture content, texture and grain size, organic content, and anthropogenic content in the field book. If a formal field classification is a project requirement, note the system of classification, i.e., ASTM, Burmister, etc., should be noted.

Take digital photographs at each sample location, from at least two different positions, so that consistency can be maintained between sampling rounds. The photographs should include nearby reference points or landmarks to assist in replicating the location if the field markings are lost.

If not previously done, use a GPS unit to record the coordinates of the sample location and mark the location with a labeled stake or flagging.

Decontaminate equipment in accordance with ORCB-9 Decontamination and/or the data quality objectives of the project. Disposable sample collection equipment shall be discarded after use at the location.

QUALITY ASSURANCE

Collect appropriate quality assurance samples as specified for the data quality objectives of the project.

For most projects, at least one duplicate sample should be collected. Collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate; thoroughly mix the soil to obtain a homogeneous sample; remove any leaves, twigs, rocks or other gross debris that may have been collected; fill a separate container for each analysis immediately following the actual field sample collection and cap the containers for both the sample and duplicate sample. Note that the VOC sample and duplicate shall be collected directly from the sample collection device, prior to mixing.

Equipment blanks are collected to ensure that the equipment is clean and the decontamination procedure is adequate. An equipment blank is collected for a piece of equipment that has been used to collect a sample and then decontaminated. If applicable, the equipment should have been used to collect a sample in a location known or anticipated to have significant contamination. Note that an equipment blank for equipment used for collection of soil samples comprises an aqueous

sample. To collect the equipment blank, gently pour deionized water over all the decontaminated sample collection equipment. Collect the rinsate that flows off the equipment into the appropriate sample containers. Refer to the project documentation for additional guidance.

DOCUMENTATION SUMMARY

Refer to the data quality objectives and/or other project documentation for site-specific guidance on documentation requirements. The data to be measured and recorded in the field may include, but are not limited to, the following:

1. The sample location, sample identifier, and analytical parameters.
2. The date and time of sample collection.
3. The sample depth, as applicable.
4. Field measurements, as applicable.
5. A general description of the sample and collection location, i.e. moisture content, texture and grain size, organic content, and anthropogenic content, as applicable; physical setting; etc.
6. Observations of weather or other conditions at the time of sample collection that have the potential to influence the sample quality or viability.
7. Digital photographs of the sample location including one or more of the larger surrounding area, along with any notes on the photos.
8. Some projects may require photographic documentation of the sample material; refer to the project documentation for additional guidance.

JAR HEADSPACE TECHNIQUE - FIELD SCREENING SOIL SAMPLES

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe a jar headspace technique” for screening soil samples for volatile organic content in the field using a photoionization detector (PID) or a flame ionization detector (FID). This methodology does not replace laboratory analyses. The technique is a screening tool for determining potential “hot spots” and other areas of high or low concentrations of volatile organic compounds (VOCs) in the field, or for selecting samples for laboratory analysis. This methodology is intended as a reference point for field decisions; it is not intended for regulatory decisions.

The technique comprises partially filling a jar or sealable polyethylene bag with volume of soil, leaving an open area, or “headspace” for volatiles to accumulate and measuring the total volatiles in the headspace in parts per million (ppm) with a PID or FID. Except under limited circumstances, the concentrations of specific VOCs cannot be determined with the technique.

Always refer to the project documentation for the data quality objectives and other guidance. In addition, field personnel should also be familiar with the manufacture’s documentation for the instrument being used and any equipment-specific recommended procedures.

This SOP is not intended to give specific guidance on safety procedures. Always refer to the site-specific safety plan and/or other project documentation. Also refer to ORCB-5 Soil Sample Collection and the project documentation for additional guidance.

EQUIPMENT

The following equipment is typically used in the jar headspace technique for soil samples:

- Sample collection equipment.
- Containers:
 - 16 oz. wide-mouth, metal screw top jars with cardboard lid liner removed and roll of heavy duty aluminum foil; **or**
 - One quart, re-sealable, polyethylene bags.
- PID or FID and the associated manufacture’s manual.
- GPS unit and flagging, as applicable.
- Digital camera.

PROCEDURE

1. Turn on the PID or FID instrument and allow it to warm up. Calibrate the instrument in accordance with the manufacturers recommended procedure (See the *Additional Considerations with the Use of PID/FID* section below). Because temperature and

humidity may influence the PID/FID readings, it is generally preferable to conduct the warm up and calibration of the instrument in the environment that the measures will be taken. The PID and/or FID should be ready for use prior to collection of the first sample.

2. Collect the soil sample using the appropriate equipment in accordance with ORCB-5 - Soil Sample Collection and the data quality objectives for the project.
3. Place approximately 250 grams of the soil sample into a wide mouth jar or polyethylene bag. Do not mix headspace containers types; for comparability between samples one or the other should be consistently throughout the project. To the extent possible, the sample should be mineral soil that is free of vegetation and gravel larger than ½ inch in diameter. When jars are used, the jars should be sealed by placing a square of foil over the mouth and screwing on the lid. When using a bag, the bag should be sealed closed leaving sufficient air in the bag so that the instrument can withdraw an adequate headspace sample.
4. Shake the jars for 30 seconds to thoroughly mix the contents. If bags are used, they may be kneaded until the contents are uniform.
5. Allow at least fifteen minutes for the VOCs in the soil to reach equilibrium with the headspace. When possible, the equilibration time for each sample should be generally equivalent.

During winter conditions, samples should be placed inside a heated vehicle or other warm environment, but not directly heated, to facilitate volatilization while equilibrating.

6. Shake or knead the sample for thirty seconds again after equilibration.
7. Measure the total VOC concentration in the headspace with the instrument. If the jar is used, unscrew and slightly lift the cap allowing insertion of the probe tip, puncture the foil, and insert the probe approximately ½ inch into jar. If using a bag, open the seal just enough to insert the probe. Record the highest reading on the instrument after allowing the probe to “sniff” the container for 10 to 15 seconds. It is important to insert the probe as quickly as possible after the seal to the container has been broken. Once a container has been used, it should not be reused for screening.
8. The soil sample for laboratory analysis should not be prepared from a sample volume that has been screened unless a limited volume of the material makes it necessary. In that case, a full documentation of the sample handling must be included in the field notes. If a limited volume makes it necessary to prepare the sample for laboratory analysis from the screening volume, the shaking/kneading steps should be eliminated.

ADDITIONAL CONSIDERATIONS WITH THE USE OF A PID/FID

While useful information may be collected in the field with PIDs and FIDs, the instruments have limitation. A PID and FID cannot detect all VOCs, nor do they detect all VOCs equally. Factors that influence the response of the particular compound include ionization potential of compound, particular energy rating of lamp, the calibration standard used, the response factor, the response curve, etc. When the contaminant of concern is a single known compound, it may be possible to calibrate the instrument so that a more accurate measurement can be made, however, screening still cannot replace laboratory analysis for regulatory purposes. The user should refer to the equipment manual and the data quality objectives of the project for further guidance.

DOCUMENTATION

Refer to the data quality objectives and/or other project documentation for site-specific guidance on documentation requirements. The information to be measured and recorded in the field may include, but are not limited to, the following:

1. The sample location, sample identifier, and analytical parameters.
2. The date and time of sample collection.
3. The sample depth, as applicable.
4. Field measurements of total VOCs.
5. A general description of the sample in accordance with ORCB-5 Soil Sample Collection and digital photographs, as applicable.
6. Observations of weather or other conditions at the time of sample collection that have the potential to influence the data quality or viability.

SEDIMENT SAMPLE COLLECTION

PURPOSE

This Standard Operating Procedure (SOP) describes methods for collecting sediment samples from rivers, lakes, streams, and other water bodies. Sediment is generally defined as natural materials that have been transported by water until the energy of the water body no longer supports the material and it is deposited: the higher the energy of the water body, i.e., the greater the stream flow, the coarser the sediment. Samples collected for assessment of contamination by laboratory analyses are generally preferred to comprise finer grain material, therefore, a lower energy depositional environment is assumed.

The act of collecting a sample from the environment will have an influence on the concentrations of the analytes of interest relative to the true concentration in the environment. In particular, samples volumes for analysis of VOCs require careful handling through specific procedures to limit the loss of the dissolved volatiles and ensure delivery of the most representative sample possible to the analytical laboratory. Collecting samples from the environment, however, may require decisions with respect to collecting a sample under non-ideal conditions and the viability of data reported for samples collected under non-ideal conditions. Fully documenting the decision processes in the field and the conditions under which a sample is collected is an important component of sample collection as a basis for determining the viability of the analytical result. Always refer to the data quality objectives for the project for site-specific guidance on acceptable procedures.

Safety is always the primary concern during any field work. In particular, the collection of a sample from a waterbody has the potential to be unsafe under various seasonal conditions and flow regimes. A sample should not be collected if it cannot be done safely. If collection of a specific sample is determined to be unsafe, the circumstances and decision process shall be documented in the field notes. In general this procedure assumes a minimum of two field personnel working together, i.e. the “buddy system”, to ensure safety. This SOP is not intended to provide specific safety procedures when working near or on open water; refer to the site-specific safety plan and other project documentation for additional guidance.

The methods described here are appropriate for collection of near surface sediment, generally to a depth of six to eight inches, as well as for collecting sediment cores, which can extend several feet into sediment.

GENERAL

Refer to the site-specific data quality objectives in the Sampling and Analysis Plan (SAP) or other project documentation, as applicable, for specific details such as sample points, analytes and quality assurance (QA) requirements. This SOP assumes that factors such as the effect of weather conditions on data quality have been addressed on a site-specific basis when planning a sediment sample collection effort and that decision-making guidance is included in the project documentation.

Additionally, this SOP assumes that collection locations have been established, were determined during the planning phase of the project, or that the project documentation will provide specific guidance on selecting and marking repeatable locations.

NOTE: The collection of samples for volatile organic compound (VOC) analysis shall follow the guidelines written for soils in the New Hampshire Department of Environmental Services (NHDES) “Final Policy Preservation of VOCs in Soil Samples” dated March 2000.

If samples of multiple media such as surface water, sediment, or pore water are to be collected from the same location, the sequence and separation time of the sample collection must be considered to ensure that the collection of one media does not adversely affect the collection of other media. Refer to the data quality objectives and/or other project documentation for additional guidance.

Sediment samples collected from the same water body should be collected from downstream to upstream locations. Shallow sediment sample locations shall be approached from downstream to upstream locations to minimize bottom disturbance. If the bottom sediment is disturbed, the sample will be collected from progressively upstream locations as required. Samples collected from a boat shall be collected from the bow or upstream side of the boat, away from the motor, with extreme care taken to avoid contamination of the sample.

EQUIPMENT

Some or all of the following equipment may typically be used in collecting sediment samples:

- Appropriate personal protective equipment (PPE) and an approved site-specific Health and Safety Plan, as applicable.
- Site-Specific SAP or other project documentation, as applicable, that includes a site plan showing sample locations and other project-specific information.
- Waders, as applicable.
- EnCore™ samplers or disposable syringes with the tips cut off for collecting VOC samples directly from the collection device. These devices are disposable and shall be used only once. The number of devices available on site should exceed the number of samples anticipated to be collected.
- Stainless steel scoops, bowls, and spoons, as appropriate.
- Hand augers, as appropriate.
- Coring tubes, as appropriate.
- Eckman or Ponar dredges, as appropriate.
- A tripod or other device to hold the Ponar dredge during excess water removal.
- Stream staff gage or similar measuring device.

- Sample containers, pre-preserved as necessary, cooler and loose ice.
- Re-sealable plastic bags to protect and store samples.
- Field data from last sample collection event, as applicable.
- Sample labels and chain of custody forms.
- Field book, pencil/pen/sharpiers and calculator, as applicable.
- The manufacturer's manuals for all equipment, as applicable.
- Decontamination supplies/equipment in accordance with ORCB-9 Decontamination and the data quality objectives of the project.
- Paper towels.
- Toolbox to include general items such as large and small wrenches, pliers, screw drivers, 25' measuring tape, hose connectors, sharp knife with a locking blade, and duct tape, at a minimum.
- Digital camera.
- GPS unit and flagging to mark locations, as applicable.

GENERAL PROCEDURE FOR COLLECTION OF SURFACE SEDIMENT

Surface sediment samples, in shallow water, may be collected with stainless steel scoops, bowls, spoons, hand augers, or coring tubes that are hand held or attached to a coring tool. In deeper waters dredge samplers, such as Eckman or Ponar dredges, should be used unless otherwise specified. All non-dedicated sampling equipment shall be decontaminated prior to use and between samples in accordance with ORCB-9 Decontamination and the data quality objectives of the project. The following procedure is applicable for surface sediment sample collection.

1. If the project requires it, measure and record the depth of water from the bottom of the streambed to the surface of the water in feet, directly downstream of the sampling location in order not to disturb the sediment where the sample is collected.
2. If possible without disturbing fine materials, carefully clear away all debris such as organic material for a 1-foot radius around the sampling location.
3. Using a stainless steel scoop, dredge, or other sampling device, slowly scoop or otherwise collect and retrieve the surface sediment from the bottom of the upstream location. The sample volume should be protected from winnowing during recovery through the water column.
4. Carefully remove organic debris, gravel, or other coarse material that may have been entrained in the sample volume.
5. Collect VOC sample volumes directly from the sampling device according to the **NHDES "Final Policy Preservation of VOCs in Soil Samples" dated March 2000**. Using a disposable syringe, collect the appropriate volume of sediment and place it in the methanol preserved volatile organic analysis (VOA) vial until the volume in the VOA vial

reaches the pre-marked line established by the laboratory. An additional unpreserved sample volume is collected for determination of moisture content.

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 representative sample cannot be collected using a syringe, a stainless steel spoon may be used to transfer sediment from the sampling device to the VOC sample vial.

6. Transfer the remaining sediment to a pre-decontaminated stainless steel mixing bowl. Continue to collect additional sediment from areas adjacent to the original sample location, staying within the required depth. Continue this procedure until the appropriate volume of sediment is collected and carefully decant excess liquid from the bowl.
7. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate.
8. Thoroughly mix the sediment by quartering to obtain a homogeneous sample. Refer to the Sample Mixing section for a description of the quartering method.
9. Record a general physical description of the sample such as color, texture and grain size, organic content, and anthropogenic content in the field book.
10. Following collection of the sample volume for VOC analysis, the remaining sample containers should be filled in the order specified in the project documentation.
11. Fill and cap the sample containers and clean the exteriors of the containers to remove any potential residue. Place the sample volumes in re-sealable plastic bags. VOC and other sample volumes requiring cooling shall be placed in **loose** ice in an insulated cooler.
12. If required for the project, use a GPS unit to record the coordinates of the sample location. Use flagging or other methods to mark the location if possible.
13. Take digital photographs at each sample location, from at least two different positions, so that consistency can be maintained between sampling rounds. The photographs should include nearby reference points or landmarks to assist in replicating the location if the field markings are lost.
14. Decontaminate the equipment in accordance with ORCB-9 Decontamination and the data quality objectives for the project. Dispose of any dedicated equipment after one use.

PONAR DREDGE PROCEDURE FOR COLLECTING SURFACE SEDIMENT

1. Decontaminate the Ponar dredge in accordance with ORCB-9 Decontamination and the data quality objectives of the project.
2. Set up the tripod or other device to hold the dredge once it has been filled.
3. Attach a dedicated nylon rope to the hook at the top of the dredge.
4. Set the Ponar dredge sampler in the open position. The sampler should remain open when lifted from the top.
5. If the project requires it, measure and record the depth of water from the bottom of the

streambed to the surface of the water in feet, directly downstream of the sampling location in order not to disturb the sediment where the sample is collected.

6. If possible without disturbing fine materials, carefully clear away all debris such as organic material for a 1-foot radius around the sampling location.
7. Slowly lower the sampler to a point approximately 2 inches above the sediment surface.
8. Allow the sampler to drop into the sediment, then pull sharply up on the line, releasing the trip bar and closing the dredge.
9. Raise the sampler to the surface and slowly decant any free liquid through the screens at the top of the dredge, being careful to retain fine sediments.
10. Suspend the dredge on the tripod.
11. Open the dredge and carefully use a syringe to draw off excess water to the extent possible while minimizing the disturbance of any fines. Remove as much organic debris, gravel, and anthropogenic material as possible.
12. Collect VOC sample volumes directly from the sampling device according to the **NHDES "Final Policy Preservation of VOCs in Soil Samples" dated March 2000**. Using a disposable syringe, collect the appropriate volume of sediment and place it in the methanol preserved volatile organic analysis (VOA) vial until the volume in the VOA vial reaches the pre-marked line established by the laboratory. An additional unpreserved sample volume is collected for determination of moisture content.

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 representative sample cannot be collected using a syringe, a stainless steel spoon may be used to transfer sediment from the sampling device to the VOC sample vial.

13. Transfer the remaining sediment to a pre-decontaminated stainless steel mixing bowl. Continue to collect additional sediment from areas adjacent to the original sample location, staying within the required depth. Continue this procedure until the appropriate volume of sediment is collected and carefully decant excess liquid from the bowl.
14. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate.
15. Thoroughly mix the sediment by quartering to obtain a homogeneous sample. Refer to the Sample Mixing section for a description of the quartering method.
16. Record a general physical description of the sample such as color, texture and grain size, organic content, and anthropogenic content in the field book.
17. Following collection of the sample volume for VOC analysis, the remaining sample containers should be filled in the order specified in the project documentation.
18. Fill and cap the sample containers and clean the exteriors of the containers to remove any potential residue. Place the sample volumes in re-sealable plastic bags. VOC and other sample volumes requiring cooling shall be placed in **loose** ice in an insulated cooler.

19. If required for the project, use a GPS unit to record the coordinates of the sample location. Use flagging or other methods to mark the location if possible.
20. Take digital photographs at each sample location, from at least two different positions, so that consistency can be maintained between sampling rounds. The photographs should include nearby reference points or landmarks to assist in replicating the location if the field markings are lost.
21. Decontaminate the equipment in accordance with ORCB-9 Decontamination and the data quality objectives for the project. Dispose of any dedicated equipment after one use.

SUBSURFACE SEDIMENT SAMPLE COLLECTION

Subsurface sediment samples greater than 8 inches in depth may be collected using coring devices that are pushed, driven, dropped, or vibrated into the sediment, and retrieved. The coring devices include split spoon type samplers, and tubes made of metal or plastic material, from which samples are extruded (with or without the aid of a tube liner). During retrieval, the core is typically retained in the tube by one or more of the following: capping the top of the tube to provide a vacuum, use of a core catcher, or by driving the tube into a clay layer to form a plug. The following procedures are applicable to subsurface sediment sample collection.

1. Decontaminate the Ponar dredge in accordance with ORCB-9 Decontamination and the data quality objectives of the project.
2. If the project requires it, measure and record the depth of water from the bottom of the streambed to the surface of the water in feet, directly downstream of the sampling location in order not to disturb the sediment where the sample is collected.
3. If possible without disturbing fine materials, carefully clear away all debris such as organic material for a 1-foot radius around the sampling location
4. Advance the coring device into the sediment. A gentle rotation of the coring tube may aid penetration.
5. Cap the top of the tube, if applicable, to provide a vacuum for sample retention during retrieval.
6. Pull the sampler from the sediment and decant excess liquid from the surface of the sample. If the sample is to be stored or transported for processing, cap both ends of the core barrel (or the insert after removal) and store upright in a re-sealable plastic bag (the top of the barrel or insert shall be marked or identified).
7. Collect VOC samples directly from the sampling device according to the **NHDES “Final Policy Preservation of VOCs in Soil Samples” dated March 2000**. Using a disposable syringe, collect the appropriate volume of sediment and place it in the methanol preserved volatile organic analysis (VOA) vial until the volume in the VOA vial reaches the pre-marked line established by the laboratory. An additional unpreserved sample volume is collected for determination of moisture content.

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 representative sample cannot be collected using a syringe, a stainless steel spoon may be used to transfer sediment from the sampling device to the VOC sample vial.

8. Transfer the remaining sediment to a pre-decontaminated stainless steel mixing bowl. Continue to collect additional sediment from areas adjacent to the original sample location, staying within the required depth. Continue this procedure until the appropriate volume of sediment is collected and carefully decant excess liquid from the bowl.
9. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate.
10. Thoroughly mix the sediment by quartering to obtain a homogeneous sample. Refer to the Sample Mixing section for a description of the quartering method.
11. Record a general physical description of the sample such as color, texture and grain size, organic content, and anthropogenic content in the field book.
12. Following collection of the sample volume for VOC analysis, the remaining sample containers should be filled in the order specified in the project documentation.
13. Fill and cap the sample containers and clean the exteriors of the containers to remove any potential residue. Place the sample volumes in re-sealable plastic bags. VOC and other sample volumes requiring cooling shall be placed in **loose** ice in an insulated cooler.
14. If required for the project, use a GPS unit to record the coordinates of the sample location. Use flagging or other methods to mark the location if possible.
15. Take digital photographs at each sample location, from at least two different positions, so that consistency can be maintained between sampling rounds. The photographs should include nearby reference points or landmarks to assist in replicating the location if the field markings are lost.
16. Decontaminate the equipment in accordance with ORCB-9 Decontamination and the data quality objectives for the project. Dispose of any dedicated equipment after one use.

SAMPLE MIXING

With the exception of VOC samples, it is important that the sample be mixed and homogenized as thoroughly as possible to ensure that the sample is representative of the material sampled. A common method of mixing is referred to as quartering. Using a decontaminated stainless steel trowel, the sample in the sample pan is divided into quarters. Each quarter is mixed, and then all quarters are mixed into the center of the pan. This procedure is followed several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material. Note: If samples are predominantly moist and have a high silt and/or clay component, extra effort may be necessary to produce a homogenous mixture.

QUALITY ASSURANCE

Collect appropriate quality assurance samples as specified for the data quality objectives of the project.

For most projects, at least one duplicate sample should be collected. Collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate; thoroughly mix the soil to obtain a homogeneous sample; remove any leaves, twigs, rocks or other gross debris that may have been collected; fill a separate container for each analysis immediately following the actual field sample collection and cap the containers for both the sample and duplicate sample. Note that the VOC sample and duplicate shall be collected directly from the sample collection device, prior to mixing.

Equipment blanks are collected to ensure that the equipment is clean and the decontamination procedure is adequate. An equipment blank is collected for a piece of equipment that has been used to collect a sample before decontamination. If applicable, the equipment should have been used to collect a sample in a location known or anticipated to have significant contamination. Note that an equipment blank for equipment used for collection of sediment samples comprises an aqueous sample. To collect the equipment blank, gently pour deionized water over all the decontaminated sample collection equipment. Collect the rinsate that flows off the equipment into the appropriate sample containers. Refer to the project documentation for additional guidance.

DOCUMENTATION SUMMARY

Refer to the data quality objectives and/or other project documentation for site-specific guidance on documentation requirements. The data to be measured and recorded in the field may include, but are not limited to, the following:

1. The sample location, sample identifier, and analytical parameters.
2. The date and time of sample collection.
3. The sample depth, as applicable.
4. Field measurements, as applicable.
5. A general description of the sample and collection location, texture and grain size, organic content, and anthropogenic content, as applicable; physical setting; etc.
6. Observations of weather or other conditions at the time of sample collection that have the potential to influence the sample quality or viability.
7. Digital photographs of the sample location including one or more of the larger surrounding area, along with any notes on the photos.
8. Some projects may require photographic documentation of the sample material; refer to the project documentation for additional guidance.

DRINKING WATER SAMPLE COLLECTION

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe a procedure for collecting various water samples, including Per- and Poly-Fluorinated Alkyl Substances (PFAS) samples from drinking water supply wells at or near contaminated sites.

Collecting samples for PFAS requires special handling. When collecting sample volumes for PFAS analysis, refer to the [NHDES Perfluorinated Compound \(PFC\) Sample Collection Guidance](#), dated November 2016.

The act of collecting an aqueous sample from the environment will have an influence on the concentrations of the analytes of interest relative to the true concentration in the environment. In particular, samples volumes for analysis of VOCs require careful handling through specific procedures to limit the loss of the dissolved volatiles and ensure delivery of the most representative sample possible to the analytical laboratory. Collecting samples from the environment, however, may require decisions with respect to collecting a sample under non-ideal conditions and the viability of data reported for samples collected under non-ideal conditions. Fully documenting the decision processes in the field and the conditions under which a sample is collected is an important component of sample collection as a basis for determining the viability of the analytical result. Always refer to the data quality objectives for the project for site-specific guidance on acceptable procedures.

All samples must be collected prior to any type of system treating the water supply. This SOP assumes that the property owner has granted access to collect a sample during the planning phase of the project and. Refer to the project documentation if additional guidance is required.

Safety is always the primary concern during any field work. Field personnel should never enter a private property without prior authorization from the owner or if they perceive that it is unsafe to do so. If collection of a specific sample is determined to be unsafe, the circumstances and decision process shall be documented in the field notes. In general this procedure assumes a minimum of two field personnel working together, i.e. the “buddy system”, to ensure safety.

Refer to the site-specific Sampling and Analysis Plan (SAP) or other project documentation for specific details such as collection points, analytes, quality assurance (QA) requirements, and data quality objectives.

EQUIPMENT AND MATERIALS

Some or all of the following equipment may typically be used in collecting drinking water samples:

- Appropriate personal protective equipment (PPE) assumed to be nitrile gloves for drink water sample collection, and an approved site-specific Health and Safety Plan, as applicable.
- Site-Specific SAP or other project documentation, as applicable, that includes a site plan showing sample locations and other project-specific information.
- Trip blanks and pre-preserved sample containers as necessary, an insulated cooler and **loose** ice.
- Re-sealable plastic bags and bubble wrap when applicable, to protect and store samples.
- Labels, chain-of-custody forms and field book.
- An appropriate container to collect purge water from a tap at the tank in the basement if necessary. This may require a low profile container to collect purge water from a low-lying tap.
- In some cases, a brass tap apparatus with a permanently attached length of polyethylene or Teflon® tubing is useful to obtain a laminar flow when collecting sample volumes for volatile organic compound (VOC) analysis from an outside or basement tap. This apparatus is not to be used on kitchen or bathroom faucets. The brass tap apparatus is not to be used to collect samples for PFAS.
- Flashlight or other portable lighting, as necessary.
- Paper towels
- Decontamination supplies and equipment in accordance with ORCB-9 Decontamination and as applicable.
- Trash bags for solid waste.
- Arsenic (As) speciation kits, if required. The New Hampshire Division of Public Health Services (NHDPHS) Laboratory requires the following: a 500 milliliter (ml) unpreserved plastic bottle for total As, a 250 ml unpreserved plastic bottle for As (III), a 60 ml syringe and a special Meng filter tip. Other laboratories may have different requirements. Refer to the project documentation for detailed information.
- The following additional equipment is required if measuring water quality parameters:
 - A multiparameter meter, preferably with a built in barometer, that is capable of measuring pH; oxidation reduction potential (ORP) in millivolts (mV); dissolved oxygen (DO) in milligrams per liter (mg/l); specific conductance in microSiemens per centimeter ($\mu\text{S}/\text{cm}$); and temperature in degrees Celsius ($^{\circ}\text{C}$). Include a container of appropriate size and volume to completely immerse the probe.
 - A turbidity meter and appropriate calibration standards, if applicable.
 - Unless calibration documentation is provided by an equipment vendor, or the data quality objectives and other project documentation do not require it, all of the instruments anticipated for use on the project should be successfully calibrated in

accordance with ORCB-10 Calibration of Field Instruments once prior to mobilization.

- Unless the data quality objectives and other project documentation do not require it, the field instruments will be calibrated on site in accordance with ORCB-10 Calibration of Field Instruments at the beginning of each day of use. A calibration check should be performed if an instrument gives inconsistent or anomalous readings and re-calibrated if the instrument does not pass the check.

PRELIMINARY PROCEDURES

1. When possible, field personnel should inspect the plumbing system and document the pipe material; filtration; water softeners; and/or other treatment such as pH adjuster, point of entry (POE) treatment system, radon system, carbon system, chlorination system, reverse-osmosis system, or ultra violet system. The sample must be collected prior to any type of water treatment system or the system must be bypassed. The collection port and plumbing should be documented with photographs whenever possible.
2. A sample may be collected from an indoor faucet or an outside spigot, preferably from the closest spigot to the pressure tank.
3. When collecting a sample from a faucet, always remove the aerator. If the aerator cannot be removed, the sample should be collected at a different location. If no other location is available and the aerator cannot be removed it must be documented and included in the final report. Refer to the project documents for additional guidance.
4. If the sample is collected from an outside spigot, or if the outside spigot is used to purge water, the water may be purged through a garden hose with the hose directed away from the building foundation and positioned so as not to cause erosion. Sample volumes for laboratory analysis of measurement of water quality parameters in the field should never be collected from a hose.
5. Remove any hoses or attachments prior to collecting the sample. It may not be possible to remove all attachments; however, if there is an attachment made of plastic or other material that cannot be removed and could potentially contaminate the sample, the sample should be collected at a different location. Refer to the project documents for additional guidance.
6. If the sample is collected directly from the pressure tank, first purge the well using the one of the other outlets, then purge water from the tap at the tank itself into an appropriately sized container to flush the faucet, piping and connections back to the tank, of any debris.
7. Make sure that the sample collection point is clean and free of grease, lead soldering, or other possible contaminants. Remove possible sources of cross-contamination such as gas cans, solvents, etc., from the area, if possible. If overt petroleum or solvent odors are noted, consider collecting the sample from a different location, away from the odors.
8. Always wear new nitrile gloves at each location and between samples.
9. **Please note:** A given water supply may have numerous sample collection locations. The New Hampshire Department of Environmental Services (NHDES) environmental

monitoring database (EMD) requires that each specific sampling location have its own unique identification known as a Station ID. Refer to the project documentation for additional guidance.

SAMPLING PROCEDURE

The following steps are to be performed once the preliminary steps have been reviewed and implemented as appropriate:

1. Purging the system. To ensure a representative sample, purge the pipes and pressure tank. Turn on a cold water tap at a high rate of flow for a minimum of 10 minutes.
2. While the water is running, record any observations in a field book and prepare the sample labels.
3. Collecting the samples.

Once the water has been running for a minimum of ten minutes:

- a. If collecting a volume for PFAS analysis, reduce the flow to a very slow flow rate. The PFAS sample must be collected *first*, prior to collecting samples for any other parameters and collected directly from the spigot or sampling port. **Do not use a brass tap apparatus to collect PFAS samples**
 - 1) While wearing a new pair of nitrile gloves, collect the PFAS sample volume by allowing the water to flow gently down the inside wall of the container with minimal turbulence.
 - 2) Do not place the sample bottle cap on any surface when collecting the sample and avoid all contact with the inside of the sample bottle and cap.
 - 3) Once the sample is collected, capped, and labeled, place the sample in an individual re-sealable plastic bag and then into **loose** ice (preferably from a verifiable PFAS-free source) in an insulated cooler. PFAS sample volumes must be segregated in a dedicated cooler containing only ice and other PFAS sample volumes.

If using a brass tap apparatus to collect additional samples, continue to Step 3b; if not, continue to Step 4.
 - b. If using a brass tap apparatus to collect additional samples, shut the water off. Attach the brass tap apparatus to the tap. Turn water back on at a very slow flow rate. Purge a small amount of water through the apparatus to rinse it with the water being sampled. **Do not use the brass tap apparatus on kitchen or bathroom faucets or when collecting PFAS samples.**
4. Collect the samples into the appropriate containers in the order specified in the project documentation. Sample volumes for analysis of VOCs are generally collected first, unless PFAS sample volumes are to be collected.

Remove the cap from the sample container and place it on the plastic sheet or in a location

where it won't become contaminated.

All sample containers shall 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. Sample containers must be wiped dry.

- a. **For collecting VOC samples, including 1,4-dioxane (for analytical Method 8260 SIM), carbon dioxide, methane, ethane and ethene, refer to the *Special Notes* section at the end of this SOP.**
- b. If collecting samples for arsenic speciation, refer to the specific procedure outlined in a separate section below.
- c. When collecting samples for water supplies treated with a POE system, the project may require samples of pre-treated, mid-treatment, and fully treated water in addition to untreated water. Always inspect the system to ensure that the flow sequence is understood and that all valves appear to be in the correct position. If the sample collection ports are labeled, the correctness of the labels should be confirmed. The collection ports and valve settings should be documented with photographs for comparison with the historic record for the project and for reference during future sample collection. If there is any question as to the correct port for collecting a given sample, or the appropriate valve settings, collection of the samples should be delayed until the questions are definitively resolved and documented. When the locations and settings have been confirmed, the samples should be collected beginning with the presumed cleanest, i.e., the fully treated water, and sequentially to mid-treatment, pre-treated, and untreated water. Wear new nitrile gloves for each successive sample. The times assigned to the samples should document the order of collection.

Field duplicate and matrix spike/matrix spike duplicate (MS/MSD) samples are collected by filling separate containers for each analysis immediately following collection of the designated field sample, e.g., VOC sample, VOC duplicate sample, VOC MS/MSD sample. Refer to the project documentation for guidance on specific quality control (QC) sample requirements, sample designations, and appropriate chain-of-custody notations required for MS/MSD samples.

5. Place the samples in re-sealable plastic bags and then in **loose** ice in the insulated cooler. Metal samples that have been acidification to pH 2 or less do not need to be chilled.
6. When all the samples have been collected, measure the water quality parameters, if required.
7. When all of the samples have been collected, remove the brass tap apparatus, if it was used, and return all plumbing to the original condition.
8. Decontaminate the brass tap apparatus in accordance with ORCB-9 Decontamination.

Procedure for Collecting Samples for Arsenic Speciation

The following is a specific procedure for collecting arsenic speciation samples to be analyzed by the NHDPHS Laboratory in Concord, New Hampshire. Other laboratories may have different requirements.

The arsenic speciation kit includes the following: a 500 ml unpreserved plastic bottle for Total As (and possibly other total metals), a 250 ml unpreserved plastic bottle for As (III), a 60 ml syringe and a special Meng filter tip to remove As (V).

1. Fill the 500 ml total arsenic bottle.
2. Draw up 60 ml of water from the total arsenic bottle with the syringe.
3. Attach the special filter tip.
4. **Discard the first five ml of water** (to rinse the filter before collecting the sample).
5. **SLOWLY*** dispense the remaining 55 ml of water through the filter into the 250 ml arsenic (III) bottle.

***It must take a minimum of ONE MINUTE to dispense the remaining volume of water in the syringe through the filter into the arsenic (III) bottle in order for the filter to work properly.**

6. Remove the filter tip, fill the syringe from the total arsenic bottle for the second time, attach the filter tip again and **SLOWLY** dispense the entire syringe contents through the filter into the same 250 ml arsenic (III) bottle. A minimum of 100 ml of water is needed in the 250 ml arsenic (III) bottle. It is not necessary to discard an additional 5 ml of water the second time the filter tip is used.
7. DO NOT add more water to the total arsenic bottle.
8. If a duplicate sample is required, collect it at the appropriate locations using a new kit for each sample, including a new filter tip.
9. These sample bottles DO NOT need to be put on ice if the samples are brought back to the NHDPHS lab daily. The lab will acidify the samples once they are received.

If water quality parameters are required, the following procedure shall be used:

- a. Install the probe guard on the multiparameter meter and rinse the probe and a collection container large enough to completely submerge the probe with a volume of the water to be measured and discard the rinse.
- b. Collect a fresh volume of water in the container and immerse the probe in the water. There should be no air bubbles on the probe. To dislodge any bubbles, gently move the probe through the water before recording the measurement.
- c. Allow a minimum of two minutes for the readings to stabilize.
- d. Once the readings have stabilized, record the pH, specific conductivity in $\mu\text{S}/\text{cm}$, temperature in $^{\circ}\text{C}$, ORP in millivolts, and DO in mg/l in the field book.
- e. Rinse out a turbidity cuvette with the water to be measured.
- f. Collect a sample in the cuvette and ensure that there are no bubbles in the sample. Completely dry the cuvette before placing it in the sample chamber of the turbidity meter. Record the measurement in NTUs in the field book.

- g. Decontamination of the multiparameter probe, the collection container, and the turbidity cuvette is not required, however, they should be rinsed at every new location prior to use.

SPECIAL NOTES

Special Considerations for the Collection of Volatile Organic Compound Samples, including 1,4-dioxane samples analyzed by method 8260 SIM.

VOC sample volumes shall be collected using the following procedures:

1. Open the vial, set cap in a clean and protected place, and collect the sample by allowing the water to flow gently down the inside wall of the container with minimal turbulence. It is useful have a device such as a foam block that will securely support the vial so that the field technician's hands are free to control the bailer and sample flow. When collecting quality control samples such as duplicate and MS/MSD volumes, collect them immediately following the original sample volume.
2. For most volatile organic analyses, the sample is preserved to stabilize it and limit analyte loss through organic consumption. For preserved samples, the preservative, usually hydrochloric acid, has been preloaded into the vial by the laboratory or vendor. A pre-preserved vial should never be rinsed and overfilling should be limited. While there are no specified guidelines, field personnel should use experience and good judgement to decide if a vial has been overfilled to the extent that the preservative has been diluted. If a vial is overfilled, it should be discarded and a new vial used.
3. The flow of water into the vial should be as smooth as possible to ensure that aeration is limited. When samples are collected from tubing, there should be no air bubbles in the tubing.
4. Ideally, a sample volume for VOC analysis should have no air bubbles, or "head space", that would allow dissolved volatiles to come out of solution. A volatile organic analysis vial is designed to be filled with a convex meniscus at the top of the vial.
5. Place the cap over the meniscus and gently but firmly secure the cap. When done properly, no there will be no bubbles in the sample volume.
6. If a meniscus cannot be created directly from the collection port, a small volume of the sample may be loaded into the vial cap directly from the tubing or bailer spout and then decanted into the vial to create the meniscus.

For methane/ethane/ethene and carbon dioxide analysis, the laboratory typically requests that the sample bottle cap is not used to top off the sample vials. These vials should be filled in the shortest time possible and capped immediately. Do not uncapped these vials and add more water. Small bubbles are considered normal for these pre-preserved containers; however, every effort shall be made to collect the highest quality sample possible.

7. Once the vial has been securely capped, invert the vial and tap gently. If an air bubble

appears, uncap the vial and attempt to add a small volume of sample to achieve the meniscus without excessively overfilling the vial. If this has to be repeated more than twice, discard the sample volume and begin again with a new pre-preserved container.

Some geochemical conditions may result in water with too little surface tension to create a convex meniscus. If a sample volume cannot be collected without bubbles, the best quality sample possible should be collected and the collection conditions and sample quality documented in the project notes. Documentation of the sample conditions may be used when considering the viability of the analytical results.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Refer to the project documentation for specific quality assurance and laboratory requirements.

When sample volumes for arsenic speciation are collected, an equipment blank may be required. The sample should be collected on a syringe and filter tip before sampling by filling one of the 500 ml total arsenic bottles with distilled water from the lab and proceed with the steps outlined above under **Procedure for Collecting Samples for Arsenic Speciation** so there is a total arsenic sample and an arsenic (III) sample.

If the brass tap apparatus is used, collection of an equipment blank after decontamination may be required.

DECONTAMINATION

Decontaminate reusable equipment according to the ORCB-9 Decontamination and/or the data quality objectives and/or other project documentation. Discard disposable sample collection equipment after one use.

DOCUMENTATION

Refer to the data quality objectives and/or other project documentation for site-specific guidance on documentation requirements. The data to be measured and recorded in the field, or researched to be included in the project notes, may include, but are not limited to, the following:

1. The sample location, sample identifier and analytical parameters.
2. The date and time of sample collection.
3. The water quality parameter field measurements.
4. A general description of the sample collection location.
5. Observations of conditions at the time of sample collection that have the potential to influence the sample quality or viability.
6. Digital photographs of the sample location including collection ports, valve settings, or other plumbing, as appropriate.

DECONTAMINATION

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe decontamination procedures for limiting the potential for cross-contamination of environmental samples and the potential for contaminated equipment becoming an exposure vector to site personnel. This procedure is intended to ensure that field equipment is properly and adequately decontaminated in order to preserve the integrity of data collected with that equipment in the field, as well as to protect staff working with the equipment from exposure to contaminants. When an exclusion zone is established for a site, decontamination procedures limit the transport of contaminants outside of the defined zone.

This SOP focuses on decontamination of small equipment such as pumps, water level meters, hand augers, stainless steel spoons and mixing bowls.

For decontamination of large equipment, such as backhoes, bulldozers, drill rigs, etc., refer to the project documentation. In general, gross contamination is removed by brushing, scraping, washing and/or steam cleaning. Such maximum contact points as tires, treads, buckets, blades, and drill pipe/bits, should be thoroughly decontaminated to prevent migration of contaminants off the site.

When any equipment is decontaminated, the wash fluids may need to be controlled, containerized, and properly disposed of. Refer to the project documentation for further guidance.

Decontamination consists of physically removing contaminants or changing their chemical nature to innocuous substances. The type and concentrations of contaminants will dictate the extent of decontamination appropriate for the project. The more harmful the contaminant, the more extensive and thorough decontamination must be. Less harmful contaminants may require less decontamination. Decontamination procedures shall be determined on a site-by-site basis and detailed in the project documentation.

Decontamination is an essential component of a successful field operation to prolong the usable life of the equipment; lessen the potential for cross-contamination of samples; prevent the mixing of incompatible substances; and reduce the likelihood of contamination leaving the site and becoming a potential exposure vector for potential off-site receptors.

In addition to this guideline, personnel should also review the manufacturer's user manual for any equipment specific recommended decontamination procedures.

EQUIPMENT AND MATERIALS

The following is a list of equipment and material commonly used for decontamination:

- An approved site-specific Health and Safety Plan.
- Appropriate personal protective equipment (PPE).

- Site-specific Sample Analysis Plan (SAP) or other project documentation.
- Non-phosphate detergent.

Note: Some non-phosphate detergents may contain 1,4-Dioxane. See the section below on quality assurance samples.

- Solvent rinses appropriate for the contaminants of concern, as currently understood.
- Tap water.
- Laboratory-grade deionized (DI) water.
- Long and short handled brushes and bottle brushes.
- Drop cloth/plastic/polyethylene sheeting.
- Paper towels.
- Plastic, galvanized or stainless steel tubs or buckets, as appropriate.
- Spray bottles and/or pressurized sprayers.
- Aluminum foil and/or re-sealable plastic bags.
- Appropriate containers for safely storing decontamination waste products.

GUIDELINES

This SOP is not intended to describe specific safety procedures for all projects; always refer to the site specific Health and Safety Plan for detailed guidance. In general, decontamination procedures should be completed with an appropriate level of PPE that is, at a minimum, equal to the level required for the fieldwork. The assumed PPE is no less than level D which includes safety glasses, chemically resistant gloves, boots, etc. Some solvents used in decontamination may require more stringent protection levels than what is applicable for the fieldwork.

Safety Data Sheets (SDS) will be maintained on site for all detergents, acids, solvents, and other substances used for decontamination. The SDS will be readily available to all personnel on the site. Access to the SDS will always be granted on request, with no delay.

Tools used for decontamination will also become contaminated. The tools should be dedicated to decontamination activities and must be appropriately handled, stored, and either decontaminated or disposed of. Decontamination tools are never used for other general cleaning work. It is sometimes impractical to decontaminate items such as small hand tools and tools with wooden handles or other porous components. The use of such tools should be limited to tasks which will not result in cross contamination or the spread of contaminants outside the defined exclusion zone, as applicable. Tools that cannot be practically decontaminated should not be removed from the site and should be disposed of properly when the associated task or project is completed. Refer to the site-specific Health and Safety Plan and other project documentation for additional guidance.

Decontamination activities will generate investigation-derived waste (IDW) such as contaminated rinse liquids and sludges that may need to be containerized onsite until proper disposal arrangements are made. Refer to the site-specific Health and Safety Plan and other project documentation for additional guidance.

GENERAL PROCEDURE FOR SMALL EQUIPMENT DECONTAMINATION

This procedure applies to all equipment surfaces, where appropriate.

The decontamination procedure is summarized as follows:

1. Set up a decontamination line on polyethylene sheeting. The line should progress from “dirty” to “clean”, with an area for drying fully decontaminated equipment.
2. Disassemble any items that might trap contaminants internally before washing. Do not reassemble until decontamination is complete.
3. Remove gross contamination from the equipment by brushing and then rinsing with tap water.
4. Wash the equipment with a non-phosphate detergent* and tap water, as required.
5. Rinse with tap water.
6. Rinse with the appropriate solvents**, as required.
7. An additional step of wiping the equipment with appropriate solvent (e.g., hexane) saturated paper towels may be necessary if the equipment made contact with a light non-aqueous phase liquid (LNAPL) to assist in its removal.
8. Rinse the equipment with DI water between solvent rinses, with a final rinse of DI water.
9. Air dry and secure clean equipment.

***Non-Phosphate Detergent**

In some cases, it may not be necessary to wash the equipment with a non-phosphate detergent if it can be demonstrated that washing the equipment with tap water alone and rinsing with DI water is sufficient.

****Solvents**

Depending on the contaminants of concern, an additional wash with a solvent, such as isopropyl alcohol or hexane, may be required depending upon the contaminant. A solvent wash and/or wipe may be necessary when there are high levels of contamination known or suspected, or when the sample media includes contaminants that are particularly difficult to clean such as LNAPL or coal tar. Refer to the project documentation for additional guidance on additional or extended decontamination procedures.

Decontaminating Pumps

When practical, it is preferable to disassemble pumps and decontaminate the components. Non-dedicated bladder pumps are generally used in conjunction with kits that include a new bladder and o-rings. The pump is disassembled after each use, the replaceable parts discarded, and the remaining components decontaminated. The pump is reassembled with the new components and

is ready to use. When pumps cannot be disassembled, they may be decontaminated by running solutions through the pump. The solution is prepared in a bucket or other container of sufficient volume and, using appropriate new or decontaminated tubing, pumped in to the disposal container. Some submersible pumps may be partially disassembled. In that case, the accessible components may be decontaminated, the pump reassembled, and a solution run through the pump. Pumps must be thoroughly rinsed by pumping DI water through them after the decontamination solution.

SPECIAL NOTES

The decontamination procedure for water level meters and oil/interface probes shall include the probes and, at a minimum, the length of tape used in that well.

Instruments that do not contact analytical volumes and do not present an overt contact hazard to the on-site personnel such as multiparameter meter probes and turbidity cuvettes, flow through cells shall be thoroughly rinsed with DI water between sample locations. If appropriate, some instruments may be washed with non-phosphate detergent and tap water, rinsed with tap water and finally rinsed with DI water, however, more aggressive decontamination methods may not be compatible with all instruments. Most environmental instruments are expensive and are not expendable; do not use a procedure that might damage an instrument. When appropriate, consult with the manufacturer if more thorough decontamination is required.

IDW Disposal, if appropriate

Solid Waste – Determining how to manage the disposal of used equipment and supplies is part of the planning phase. The project documentation should specify what materials, if any, can be included in the municipal solid waste stream, what materials and supplies require special management, and provide guidance on management and disposal.

Liquid Waste – Determining how to manage the disposal of liquids generated during decontamination is part of the planning phase. The project documentation should specify what liquids require special management and provide guidance on management and disposal.

ALTERNATIVES

Decontamination is, by its nature, an arduous and painstaking task that creates waste that must be managed. Whenever feasible, avoid the need for decontamination by implementing alternative actions such as:

- Dedicating specific equipment to a well when economically feasible;
- Using disposable equipment when appropriate; and
- Minimizing contact with potential contaminated media, when possible. This may include protocols such as changing contaminated gloves before handling equipment that is not in direct contact with potential contaminated media and using disposable plastic bags or wraps to protect instruments.

QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

Equipment blanks should be collected on non-disposable equipment to insure that equipment is clean and the decontamination procedure is adequate. Equipment blank samples shall be collected and analyzed according to the site-specific SAP or other project documentation.

If 1,4-Dioxane is a concern at the site it may be appropriate to seek a non-phosphate detergent that does not contain 1,4-Dioxane. At a minimum, an equipment blank should be collected and analyzed for 1,4-Dioxane to ensure that the decontamination procedure is adequate and that there is no 1,4-Dioxane residue. If 1,4-Dioxane is found in the equipment blank the sampling data must be qualified.

Blanks are collected from equipment that has been decontaminated after use, preferably in media with known or expected high levels of contamination. When equipment blank analyses indicate cross contamination, a thorough review of the decontamination procedures may be required.

REFERENCES

ASTM D 5088 – 02, 2008. Standard Practice for Decontamination of Field Equipment Used at Waste Sites. American Society for Testing and Materials (ASTM), Pennsylvania
<http://www.astm.org>

US DHHS, 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. U.S. Department of Health and Human Services, Washington, D.C.
<https://www.osha.gov/Publications/complinks/OSHG-HazWaste/4agency.html>

US EPA, 1984. Standard Operating Safety Guides. Office of Emergency and Remedial Response, Washington, D.C.

FIELD INSTRUMENTS CALIBRATION

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe the calibration of field instruments used to measure water quality parameters for ground water, surface water and pore water. Water quality parameters include temperature, pH, dissolved oxygen (DO), specific conductance, oxidation reduction potential (ORP) and turbidity.

This SOP provides for calibration of the field instruments cited. The basic calibration, confirmation, and documentation protocols may be applied to other similar instruments. For New Hampshire Department of Environmental Services (NHDES) Oil Remediation and Compliance Bureau (ORCB) projects, the rigorous procedures described herein may not be required or applicable. At a minimum, instruments should be calibrated in accordance with the manufacturer's instructions before use when collecting data that may ultimately be used for regulatory decisions. Documentation of calibration from a vendor may be acceptable for one-day use. Refer to the data quality objectives and other project documentation for further guidance.

This SOP is written for instruments where the probe readings for pH, dissolved oxygen, and specific conductance are automatically corrected for temperature; such as the YSI Models 600XL/XLM and the In-Situ smarTROLL™ multiparameter meter (referred to as the Smartroll in this SOP). Meters measuring pH must be calibrated using three pH standards (4, 7 and 10). Turbidity must be taken with a separate meter such as the Hach 2100P or 2100Q Turbidity meters).

While still in common use, the YSI Models 600XL/XLM multiparameter meters are no longer supported by YSI; therefore, this SOP also includes instructions on calibrating the In-Situ Smartroll multiparameter meter. The Smartroll combines water quality sensors with the mobility of an Android™ or iOS™ mobile device (i.e., a rugged tablet). The VuSitu™ mobile app runs on an Android device and the iSitu® mobile app runs on an iOS device. The Smartroll was chosen because it appears to meet all of the New Hampshire Department of Environmental Services (NHDES) requirements for field instrumentation and will eliminate or reduce the amount of data needed to be recorded on hand written worksheets. The Smartroll meter is in the evaluation phase and will be used alongside the YSI meters until it is proven to be an acceptable replacement. NHDES requires that field personnel use a rugged field electronic tablet with the Smartroll to calibrate and record data in the field in order to view all data simultaneously and clearly; **it is not acceptable to use a smartphone, iPod, or equivalent due to screen-size limitations.**

This SOP includes the calibration procedure for both the Hach 2100P and 2100Q turbidity meters. The instructions for the 2100P are included as the NHDES Hazardous Waste Remediation Bureau has a number of 2100P units that are still in service and may be used at any given site.

For ground water monitoring, the instrument must be equipped with a clear flow-through cell

with a maximum capacity of 250 milliliters and the display/logger or computer display screen needs to be large enough to simultaneously display the readouts of each probe in the instrument. Turbidity samples must be taken at a point before the flow-through cell and analyzed in a separate meter. A three-way stopcock is needed to divert sample flow prior to the flow-through cell so that an aliquot can be collected for the turbidity reading. Turbidity cannot be measured in or after a flow-through cell because the flow-through cell acts as a sediment trap. This procedure is applicable for use with the current Low Flow Groundwater Purging and Sampling SOP in the Hazardous Waste Remediation Bureau Master Quality Assurance Project Plan (HWRB Master QAPP).

Refer to the site-specific Sampling and Analysis Plan (SAP) for details concerning specific makes and models of instruments, calibration solutions, and other pertinent information.

HEALTH AND SAFETY WARNINGS

Read all labels on the standards and note any warnings on the labels. Wear appropriate personal protection equipment (e.g., gloves, eye shields) when handling the standards. If necessary, consult the Safety Data Sheets for additional safety information on the chemicals in the standards.

CALIBRATION ACCEPTANCE CRITERIA

All field instruments shall be calibrated successfully and have a successful calibration check in the office prior to the sampling event (within one week) according to the Calibration SOP to ensure that the equipment is working properly and meets the QA criteria. The calibration/calibration check shall be documented on the Calibration Log.

The instruments shall be calibrated at the beginning of each sampling day at the Site prior to sample collection. The calibration shall then be checked immediately following the calibration to ensure the instrument was calibrated properly. If the morning calibration check is not within the acceptable range for a 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. In general, if the calibration or calibration check is not successful, recalibrate using a new standard solution with a different lot number and recheck. Then, if the calibration or calibration check is still unsuccessful, replace the meter with a backup unit. Backup instruments shall be fully calibrated, checked and used in place of the inoperable unit.

The calibration shall be checked again at the end of the day of use to ensure that the instruments have remained in calibration throughout the day. In addition, should any erratic or illogical readings occur during the field day and between calibrations/calibration checks, the calibration shall be re-checked for those parameters and recalibrated, as necessary, in order to ensure 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 at the end of the day is not within the acceptable range for that parameter, the data collected that day 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 the afternoon pH calibration check was not within the acceptable range that day, the pH data collected by that instrument on that day 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 worksheets for each of the locations where the instrument was used.

WEATHER CONDITIONS

Normally, everyday calibration procedures are performed in the field. However, under adverse weather conditions, it is permissible to perform the beginning-of-day calibration and calibration check in the office or other facility just prior to going into the field. It is also permissible under similar conditions to perform the end-of-day calibration check off-site. The calibration solutions must be brought into the field with the multiparameter meters and protected from extreme temperatures.

EQUIPMENT AND MATERIALS

The following is a list of equipment and materials required for calibration:

- Site-specific SAP
- Manufacturer's instruction manuals (including the instrument specifications) to accompany the instruments into the field.
- Multiparameter probe and handheld meter (such as the YSI Models 600XL/XLM or and the In-Situ Smartroll). At least one meter shall have a built in barometer.
- Calibration solutions:

It is advisable to have a sufficient number of extra bottles of each standard on hand in case of complications (especially the conductivity standards). Be sure that the standards are not near their expiration dates (e.g., greater than one month from expiration).

- Small wet sponge or paper towel for DO 100% saturation calibration.
 - "Zero" (0) milligrams per liter (mg/l) DO check standard (minimum of two bottles from two separate lots for the Smartroll)
 - pH buffers 4, 7 and 10
 - Two standards for specific conductance: 718 microsiemens per centimeter ($\mu\text{S}/\text{cm}$) and 1,413 $\mu\text{S}/\text{cm}$. One to use for calibration and the other one to use for checking the calibration.
 - Zobell Solution for ORP
- Separate Turbidimeter (Hach 2100P or 2100Q Turbidity meter) w/calibration standards: <0.1, 10, 20, 100, 800 Nephelometric Turbidity Units (NTUs) as appropriate for each meter.

- Calibration cup/Storage cup.
- Cooler (for storage of calibration solutions).
- Laboratory-grade deionized (DI) water.
- Paper towels.
- Kimwipes.
- NIST certified thermometer, degrees Celsius (if the vendor has not verified the accuracy of the instrument temperature sensor).
- Calibration Log.
- If using the Smartroll, you **MUST** request the following specific equipment from the vendor as they may not automatically be provided with the Smartroll:
 - The appropriate blue tooth connection for the operating system of the tablet (no smartphones or iPods) you are using (i.e., Power Pack for Android™ or the Battery Pack for the iOS™ [Apple product]). The power pack, or battery pack, enables wireless communication between the device and the probe and supplies power to the probe; they are not interchangeable.
 - A ring stand and clamp.
 - A spare RDO probe.
 - The Smartroll MP Storage and Calibration cup.

The Storage and Calibration cup (referred to as the storage cup when discussing the Smartroll in this SOP) is a rugged alternative to the standard calibration cup. This storage cup is not provided with the Smartroll multiparameter meters from In-Situ. The vendor orders them separately from In-Situ and you must specifically request the storage cup from the vendor.

Do not use the larger and more flexible calibration cup referred to in the manual (with or without the probe guard) for the following reasons: 1) the probe guard makes it hard to see the probes making rinsing and drying the probes between each standard unnecessarily difficult; 2) the large cup requires more calibration solution; 3) the calibration cup is flimsy; and 4) the flexible collar makes it harder to connect to the rest of the calibration apparatus and instrument.

GENERAL INFORMATION

This SOP requires that the manufacturer's instruction manuals (including the instrument specifications) accompany the instruments into the field.

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. It is assumed that most of this equipment will be rented and is not owned by the contractor. Any reference made to a vendor applies to the owner/renter of the equipment.

All calibration solutions shall be stored at room temperature or at cool/stable temperatures in the field. Storage of calibration solutions in an insulated cooler kept in the shade will help to maintain calibration solution integrity.

All calibration solutions shall be placed into the calibration cup (or, in the case of the Smartroll, the storage cup) to calibrate the instrument and to check the calibration. The calibration cup shall be rinsed with DI water and dried with paper towels or Kimwipes between each standard. The probes shall not be put directly into the bottles of calibration solutions from the vendor. The volume of the calibration solutions must be sufficient to cover both the probe and temperature sensor. See manufacturer's instructions for additional information. Do not pour the used calibration solutions back into their original bottles.

While calibrating or measuring, make sure there are no air bubbles lodged on or between the probes.

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.

GENERAL PRELIMINARY CALIBRATION PROCEDURES

1. Prior to calibration, all instrument probes must be cleaned in accordance with the manufacturer's instructions, preferably by the vendor if the unit is to be rented. Failure to perform this proper maintenance step can lead to erratic measurements. The vendor is required to provide written documentation (which will be included in sampling reports) that indicates the equipment was cleaned, who cleaned it and the date of the cleaning.
2. Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature in °C; pH; DO in % for calibration and mg/l for measurements; DO charge in millivolts; specific conductance in $\mu\text{S}/\text{cm}$; and ORP in millivolt (mV). The DO charge is not applicable for the Smartroll.
3. Allow all calibration standards to equilibrate to the ambient temperature.
4. Mark the "date opened" on each new bottle of calibration solution. Record the lot number and expiration date on the Calibration Log.

MULTIPARAMETER METER CALIBRATION PROCEDURES

A. TEMPERATURE (this section applies to both YSI and In-Situ models)

This procedure is not to be done in the field.

For instrument probes that rely on the temperature sensor, each temperature sensor must be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST) prior to the sampling event. A temperature check is required once a year for each instrument, at a minimum.

The temperature check shall be performed prior to the field event, preferably via the vendor if the unit is rented. If the check is not performed by the vendor, then it must be performed by field personnel prior to using the unit. Verification and documentation, including accuracy, dates and personnel, of this procedure are required. The documentation shall be recorded on the Calibration Log and included in any sampling reports.

Temperature Sensory Accuracy Procedure

1. Allow a container filled with water to come to room temperature.
2. Place a NIST thermometer and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.
3. Compare the two measurements and record the results on the Calibration Log. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (typically ± 0.15 °C or ± 0.2 °C). Check the manual that came with the instrument. If the measurements do not agree, the instrument may not be working properly and the vendor/manufacturer may need to be consulted or the unit replaced.

YSI 600XL/XLM Calibration/Calibration Check Procedures

Preliminary/general steps to set up the instrument for calibration:

1. Make sure that the cable is connected to the unit and the handheld display.
 - a. Align the pins on the cable with the pins on the unit, and then twist the outer portion of the connector until the connection is secure.
 - b. Align the pins on the cable with the pins on the handheld display and then twist the outer portion of the connector until the connection is secure.
2. Turn on the instrument and allow it to warm up according to the manufacturer's instructions.
3. Select Calibrate from the Main Menu.

YSI - DISSOLVED OXYGEN

The YSI instrument measures dissolved oxygen (DO) content in water using a membrane electrode. The instrument is calibrated to 100% DO saturation and then the calibration is checked with a 0% saturated DO solution.

The DO probe's membrane and electrolyte solution shall be replaced prior to the sampling event and replaced as needed thereafter. Failure to perform this step may lead to erratic measurements. If the vendor changes the membrane and electrolyte solution, they must send the appropriate documentation with each unit. If there is no documentation with the unit, the field personnel will have to replace the membrane and electrolyte solution before the sampling event begins. Documentation shall be noted on the Calibration Log.

YSI - DO Calibration/Calibration Check Procedure

1. Record the DO charge on the worksheet. Note: According to manufacturer, the DO charge should be between 25-75 millivolts for the probe to be working correctly. If the DO charge is outside this range, replace the membrane and electrolyte solution prior to calibration.
2. Gently dry the temperature sensor and remove any droplets of water from the DO probe's sensor membrane according to manufacturer's instructions. Inspect the DO membrane for air bubbles and nicks. If any are found, replace the membrane and electrolyte solution.
3. 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.
4. Place the DO probe loosely into the calibration container to prevent the escape of moisture evaporating from the sponge or paper towel while allowing pressure equilibration before calibration. Do not allow the probe to come into contact with the wet sponge or paper towel. **The storage cup must be vented to the atmosphere.** Do not screw the calibration cup tightly onto the probe.
5. Allow the confined air to become saturated with water vapor (saturation occurs in approximately 10 to 15 minutes). Make sure that the instrument is turned on during this time to allow the DO probe to warm-up according the manufacturer's directions. Make sure that both the DO reading and the temperature have stabilized before starting the calibration sequence.
6. Select calibration mode; then select "DO %".
7. 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.
8. Record the barometric pressure on the Calibration Log.
9. 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).
10. Record the initial DO reading in mg/l and temperature reading in °C on the Calibration Log immediately after calibration.
11. To check the calibration, select monitoring/run mode (on a run/measurement screen), remove the probe from the container and place it into a 0.0 (zero) mg/l DO standard.

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 reads above 0.5 mg/l or reads a negative 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.

If the afternoon calibration check is not within the acceptable range then the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

Remove probe from the zero DO standard, rinse with DI water, and gently blot dry. Rinse the calibration cup with DI water and dry it with paper towels or Kimwipes.

YSI - pH (ELECTROMETRIC)

The YSI instrument measures the pH of a sample electrometrically using a glass electrode. Three standards are needed for the calibration: pH 4, 7 and 10. Rinse the calibration cup with DI water and dry it with paper towels or Kimwipes between standards.

YSI - 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 DI water, and gently blot dry with a Kimwipe. Use caution during drying, such 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.
6. Enter the buffered standard value (e.g., pH 7) into the instrument. Wait until temperature and pH readings stabilize. If the readings do not change within 30 seconds, press enter to accept the calibration.
7. Remove probe from the initial standard, rinse with DI water, and gently blot dry.
8. Immerse probe into the second standard (pH 4). Repeat step 6.
9. Remove probe from the second standard, rinse with DI water, and gently blot dry.
10. Immerse probe into the third standard (pH 10) and repeat step 6.
11. Remove probe from the third standard, rinse with DI water, and gently blot dry.
12. To check the calibration, select monitoring/run mode (on a run/measurement screen) and 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, recalibrate the instrument using fresh standards for all three values and check it again. If re-calibration fails, clean the pH probe, recalibrate and check the calibration. If the calibration check fails again, consult the manufacturer/vendor or replace the unit.

If the afternoon calibration check is not within the acceptable range then the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

Remove probe from the pH 7 check standard, rinse with DI water, and gently blot dry. Rinse the calibration cup with DI water and dry it with paper towels or Kimwipes.

YSI - SPECIFIC CONDUCTANCE

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. When monitoring groundwater, surface water or pore water, use the specific conductance readings and record in $\mu\text{S}/\text{cm}$.

Most instruments are calibrated against a single standard which is near, (above or below) the specific conductance of the environmental samples. A second standard is used to check the linearity of the instrument in the range of measurements. Specific conductivity standards concentrations are generally dependent on expected field conditions and availability. However, there have been some issues with the stability of some of the standards in the field. Unless specified in a site-specific SAP, NHDES and EPA Region 1 have agreed that specific conductivity is, in general, a non-critical measurement and it is more important to use standards that are stable in the field even though the actual field measurements may not be bracketed by the high and low standards.

Therefore, the HWRB recommends using the following standards as they have been field tested, are readily available from most vendors, and are acceptable for use by EPA: a 1413 $\mu\text{S}/\text{cm}$ standard and a 718 $\mu\text{S}/\text{cm}$ standard. It is acceptable to use either one of the standards to calibrate and the other to check the calibration. **The use of only ONE standard to both calibrate and check the calibration is NOT ACCEPTABLE**, as the second standard is used to check the linearity of the instrument in the range of measurements.

In general, the 718 $\mu\text{S}/\text{cm}$ standard will be used to calibrate and a 1413 $\mu\text{S}/\text{cm}$ standard used to check the calibration. **It is advisable to have a sufficient number of extra bottles of each standard on hand in case of complications. Be sure that the standards are not near their expiration dates (e.g., greater than one month from expiration).** Rinse the calibration cup with DI water and dry it between standards.

Preliminary Cleaning Procedure

Before calibrating for specific conductance, clean the probe according to the manufacturer. In general, dip a small cleaning brush in DI water and insert it into each hole 15-20 times. Rinse with DI water and dry thoroughly.

YSI - Specific Conductance Calibration/Calibration Check Procedure

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 (718 $\mu\text{S}/\text{cm}$) specific conductance standard, discard the rinsate and place the probe into the standard. Be sure that the temperature sensor and the probe's vent hole are fully immersed in the standard. Gently move the probe 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 (718 $\mu\text{S}/\text{cm}$). Allow the temperature and specific conductance to stabilize. If the reading does not change within 30 seconds, press enter to accept the calibration.
5. Remove probe from the specific conductance check standard, rinse with DI water, and gently blot dry. Rinse the calibration cup with DI water and dry it with paper towels.
6. To check the calibration, select the monitoring/run mode (a run/measurement screen). Remove the probe from the first standard, rinse the probe with DI water and then a small amount of the second (1413 $\mu\text{S}/\text{cm}$) standard, discard the rinsate and place the probe into the second standard. The second standard will serve to verify the linearity of the instrument. Wait until the specific conductance and temperature readings have stabilized. Read the specific conductance value from the instrument and record the value on the Calibration Log. Compare the value to the standard. The value must be $\pm 5\%$

When the 718 $\mu\text{S}/\text{cm}$ standard is used to calibrate, 5% of the 1413 $\mu\text{S}/\text{cm}$ solution is 1342-1484 $\mu\text{S}/\text{cm}$. When the 1413 $\mu\text{S}/\text{cm}$ standard is used to calibrate, 5% of the 718 $\mu\text{S}/\text{cm}$ solution is 682-754 $\mu\text{S}/\text{cm}$.

If the applicable range is not met, check the calibration using a fresh solution with a different lot number from that used in the initial calibration check. Then, if the range is not met, recalibrate using a fresh calibration solution with a different lot number and check again.

If this range is still not met, calibrate using the second calibration solution and repeat the process above. If this is not successful, consult the manufacturer/vendor or replace the unit.

For example: if the 718 $\mu\text{S}/\text{cm}$ standard is used to calibrate, then the 1413 $\mu\text{S}/\text{cm}$ solution is used to check the calibration. If the 1413 $\mu\text{S}/\text{cm}$ solution is not within the acceptable range of 1342-1484 $\mu\text{S}/\text{cm}$, then check the calibration with a fresh 1413 $\mu\text{S}/\text{cm}$ solution with a different lot number. If this range is still not met, recalibrate the instrument using a new 718 $\mu\text{S}/\text{cm}$ standard from a different lot number and check again.

If the acceptable range is still not met, calibrate the instrument using the 1413 $\mu\text{S}/\text{cm}$ standard and check the calibration with a 718 $\mu\text{S}/\text{cm}$ solution. If the 718 $\mu\text{S}/\text{cm}$ solution is not within the acceptable range of 682-754 $\mu\text{S}/\text{cm}$, then check the calibration with another 718 $\mu\text{S}/\text{cm}$ solution with a different lot number. If this range is still not met, recalibrate the instrument using a new 1413 $\mu\text{S}/\text{cm}$ standard from a different lot number and check again.

If that does not solve the problem, consult the manufacturer/vendor or replace the unit.

If the afternoon calibration check is not within the acceptable range then the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

Remove probe from the specific conductance check standard, rinse with DI water, and gently blot dry. Rinse the calibration cup with DI water and dry it with paper towels.

YSI - OXIDATION/REDUCTION POTENTIAL (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent. A Zobell solution is required to calibrate ORP. Read the warning on the label before use.

YSI 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, rinse the probe with DI 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 mV value at this temperature from the temperature / mV chart found below and on the Calibration Log. 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, select monitoring/run mode (on a run/measurement screen). Immerse the probe in the Zobell solution. Wait until the ORP and temperature readings have stabilized. Read the temperature and the ORP on the instrument. Record the values on the Calibration Log. The instrument value must be within +/- 5% of the mV value for the current temperature. See the chart below 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 manufacturer/vendor or replace the unit. For the afternoon calibration check, the instrument must be within +/- 5% of the mV value for the current temperature or the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

Remove the probe from the ORP check standard, rinse with DI water, and gently blot dry. Rinse the calibration cup with DI water and dry it with paper towels or Kimwipes.

Zobell Solution mV Values Based on Temperature for ORP Calibration
Calibration Check Range Values (+/- 5%)
 (Round off temperature to whole number, e.g., 23.5 °C rounds up to 24 °C)

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

C. In-Situ Smartroll Calibration Procedures

When using the Smartroll, calibrate all parameters first, then select the “live readings” screen on the tablet display and check all the parameters after the calibration procedure has been completed.

Preliminary/general steps to set up the instrument for calibration:

1. Make sure that the cable is connected to the instrument and the battery/power pack.
 - a. Align the pins on the cable with the pins on the probe, and then twist the outer portion of the connector until the connection is secure.
 - b. Align the pins on the cable with the pins on the battery/power pack, and then twist the outer portion of the connector until the connection is secure.
2. Storage cup

Use the storage cup that was specifically requested under the equipment section above to calibrate the instrument (the same type of storage/calibration cup as the YSI unit). **Do not use** the larger and more flexible calibration cup referred to in the manual. The storage cup is not referenced in the user manual because it is sold separately.

If there is a metal sleeve in the storage/calibration cup, it must be removed before use so that the probes are visible.

Unscrew the bottom of the calibration cup and pull the sleeve out prior to calibration. Remember to put the sleeve back in before you send the unit back to the vendor.

3. Press the power button on the battery/power pack.
4. Turn on the tablet.
5. Tap on the VuSitu or iSitu icon to open the application in the tablet. Connect to the instrument via Bluetooth. If using more than one Smartroll, be sure to connect to the Bluetooth device you are using and not others around you. The serial number of the Bluetooth battery pack connected to the multiparameter meter will be displayed on your tablet.
6. Tap the **Calibration** icon (it looks like a laboratory beaker) on the bottom left of the tablet to access a list of sensors that are available for calibration.
7. Then tap the first parameter to be calibrated.
8. Calibration of each parameter should take no more than 1 or 2 minutes and is often quicker than 1 minute. If any parameter calibration reads “nominal”, but is within the allowable range, you may accept the calibration. Often waiting another minute will allow the reading to stabilize. If any parameters indicate that they did not stabilize, perform the calibration procedure again.

IN-SITU - DISSOLVED OXYGEN

The In-Situ instrument measures DO content in water using an optical sensor.

The Smartroll performs a two part calibration for DO: 100% saturation and 0% saturation. The meter should automatically detect all standard calibration solution values. If you are using a non-standard calibration solution, you have the option to manually enter the value.

In-Situ - DO Calibration Procedure

1. Inspect the rugged dissolved oxygen (RDO) cap for air bubbles and nicks. If any are found, replace the RDO cap.
2. Tap the **Calibration** icon on the tablet display to access a list of sensors that are available for calibration.
3. Tap **RDO Saturation** on the tablet display.
4. Select the two-point calibration method to calibrate the sensor: Tap **100% and 0% Saturation**.
5. Remove (unscrew) the bottom of the storage cup and place a water-saturated sponge or a small amount of water (cannot touch DO probe) in the end cap to create a 100 percent water-saturated air environment.
6. Place the probe **loosely** into the storage cup in order to vent the storage cup to barometric pressure. **The storage cup must be vented to the atmosphere.** Do not screw the storage cup tightly onto the meters.
7. Tap **Start** on the tablet display.
8. Allow the confined air to become saturated with water vapor.

9. The instrument will indicate that the calibration is in progress.
10. When the instrument indicates that the calibration is stable, record the initial DO reading in % and mg/l, and temperature reading in °C, on the Calibration Log.
11. Tap the **Accept** button on the tablet display.
12. Remove the sponge, dry the storage cup with paper towels or Kimwipes and add fresh sodium sulfite solution (zero DO solution) to the fill line.
13. Place the instrument into the storage cup, and tap **Start**.
14. When the instrument indicates that the calibration is stable, tap the Accept button.
15. Remove probe from the storage cup containing the zero DO standard, rinse well with DI water, and gently blot dry.
16. Rinse the storage cup well with DI water and dry it with paper towels or Kimwipes.
17. Tap on the left arrow “sensor calibration” in the top left corner of the tablet display to return to the calibration menu to select the next parameter.

RDO SALINITY SETTING

The Smartroll RDO does not include automatic salinity compensation, so you must set it manually.

1. From the main menu, select **Connected Instrument**.
2. Select **Instrument Settings**.
3. From the Instrument Settings menu select **Salinity Setting**.
4. Select the appropriate setting for your sampling environment (e.g., fresh, brackish, or salt water). The typical setting is fresh water.

IN SITU - pH (ELECTROMETRIC)

The pH of a sample is determined electrometrically using a glass electrode. Three standards are needed for the calibration: pH 4, 7 and 10. The meter should automatically detect all standard calibration solution values.

In-Situ - pH Calibration Procedure

1. Tap the **Calibration** icon on the tablet display to access a list of sensors that are available for calibration.
2. Tap **pH Sensor**.
3. Tap **3-Point Calibration**.
4. Fill the storage cup to the fill line with the first calibration buffer (pH 4).
5. Place the instrument into the storage cup, and tap **Start** on the tablet display.

6. When the instrument indicates that the calibration is stable, tap the **Accept** button on the tablet display.
7. Remove probe from the storage cup containing the standard, rinse with DI water, and gently blot dry.
8. Rinse the storage cup with DI water and dry it with paper towels or Kimwipes.
9. Fill the cup to the fill line with the second calibration buffer (pH 7).
10. Place the instrument into the storage cup, and tap **Start** on the tablet display.
11. When the instrument indicates that the calibration is stable, tap the **Accept** button on the tablet display.
12. Remove probe from the storage cup containing the standard, rinse with DI water, and gently blot dry.
13. Rinse the storage cup with DI water and dry it with paper towels or Kimwipes.
14. Fill the cup with the third calibration buffer (pH 10).
15. Place the instrument into the storage cup, and tap **Start** on the tablet display.
16. When the instrument indicates that the calibration is stable, tap the **Accept** button on the tablet display.
17. The tablet will automatically return to the initial pH Calibration screen (where the 3-point calibration was selected).
18. Remove probe from the storage cup containing the standard, rinse with DI water, and gently blot dry.
19. Rinse the storage cup with DI water and dry it with paper towels or Kimwipes.
20. Tap on the left arrow “sensor calibration” in the top left corner of the tablet display to return to the calibration menu to select the next parameter.

IN-SITU - SPECIFIC CONDUCTANCE

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. When monitoring groundwater, surface water, or pore water, use the specific conductance readings and record in $\mu\text{S}/\text{cm}$.

Most instruments are calibrated against a single standard that is near (above or below) the specific conductance of the environmental samples. A second standard is used to check the linearity of the instrument in the anticipated range of measurements. Specific conductivity standards concentrations are generally dependent on expected field conditions and availability. However, there have been some issues with the stability of some of the standards in the field. Unless specified in a site-specific SAP, NHDES and EPA Region 1 have agreed that specific conductivity is, in general, a non-critical measurement and it is more important to use standards that are stable in the field even though the actual field measurements may not be bracketed by the high and low standards.

Therefore, the ORCB recommends using a 1413 $\mu\text{S}/\text{cm}$ standard and a 718 $\mu\text{S}/\text{cm}$ standard as they have been field tested, are readily available from most vendors, and are acceptable for use by EPA. It is acceptable to use either one of the standards to calibrate and the other to check the calibration.

The use of only ONE standard to both calibrate and check the calibration is NOT ACCEPTABLE, as the second standard is used to check the linearity of the instrument in the range of measurements.

In general, the 718 $\mu\text{S}/\text{cm}$ standard will be used to calibrate and a 1413 $\mu\text{S}/\text{cm}$ standard used to check the calibration. **It is advisable to have a sufficient number of extra bottles of each standard on hand in case of complications. Be sure that the standards are not near their expiration dates and are from different lots.** Rinse the storage cup with DI water and dry it between standards.

The meter should automatically detect all standard calibration solution values. If you are using a non-standard value calibration solution (e.g., 718 $\mu\text{S}/\text{cm}$), you have the option to manually enter the value.

Preliminary Cleaning Procedure

Before calibrating for specific conductance, clean the probe according to the manufacturer. Avoid damaging the plastic material of the conductivity cell. In general, gently wipe the conductivity cell with a soft polyurethane foam swab, or a thin cotton pipe cleaner, and DI water using a gentle back-and-forth motion. Rinse the probe with DI water and dry thoroughly.

In-Situ - Specific Conductance Calibration Procedure (718 $\mu\text{S}/\text{cm}$ standard)

1. Tap the **Calibration** icon on the tablet display to access a list of sensors that are available for calibration.
2. Tap **Conductivity Sensor**.
3. Tap 1-Point Calibration.
4. Fill the storage cup to the fill line with 718 $\mu\text{S}/\text{cm}$ calibration standard.
5. Place the instrument into the storage cup, and tap **Start** on the tablet display.
6. The tablet app does not automatically recognize the value of the 718 $\mu\text{S}/\text{cm}$ standard. The value of the standard must be manually entered into the tablet app. To enter the value manually:
 - a) At the top of the screen there is white blank box to the left of “ $\mu\text{S}/\text{cm}$ ”
 - b) Tap the blank box and a keyboard will appear.
 - c) Enter 718 and tap the return button.
 - d) The meter will start the calibration process.

Note: If using the 1413 $\mu\text{S}/\text{cm}$ calibration standard to calibrate, the tablet app will

automatically recognize the value of the 1413 $\mu\text{S}/\text{cm}$ calibration standard; therefore, the value does not have to be manually entered.

7. When the instrument indicates that the calibration is stable, tap the **Accept** button on the tablet display.
8. Remove probe from the storage cup containing the standard, rinse with DI water, and gently blot dry.
9. Rinse the storage cup with DI water and dry it with paper towels or Kimwipes.
10. Tap on the left arrow “sensor calibration” in the top left corner of the tablet display to return to the calibration menu to select the next parameter.

IN-SITU - OXIDATION/REDUCTION POTENTIAL (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent. A Zobell solution is required to calibrate ORP. Read the warning on the label before use.

The meter should automatically detect all standard calibration solution values including the ORP standard corrected for temperature.

In-Situ - ORP Calibration Procedure

1. Tap the **Calibration** icon on the tablet display to access a list of sensors that are available for calibration.
2. Tap **ORP Sensor**.
3. Tap 1-Point Calibration
4. Fill the storage cup with Zobell calibration standard.
5. Place the instrument into the storage cup, and tap **Start** on the tablet display.
6. When the instrument indicates that the calibration is stable, record the ORP and temperature values on the Calibration Log.
7. Tap the **Accept** button on the tablet display.
8. Tap on the left arrow “sensor calibration” in the top left corner of the tablet display to return to the calibration menu to select the next parameter.

Once the last parameter has been calibrated, then tap on the left arrow on the tablet display and select “live readings” screen to perform the calibration check procedure.

D. In-Situ Smartroll Calibration Check Procedure

General procedure to check the parameter calibration:

1. Select the “live readings” screen on the tablet display.
2. Fill the storage cup to the fill line with the appropriate calibration check standard and

insert the probe in the solution.

3. Wait until the temperature and parameter readings have stabilized (i.e., no changes in the temperature and parameter readings for minimum of 30 seconds).
4. Record the parameter reading on the Calibration Log.
5. Refer to each parameter below for instructions to follow if the check standard is outside the acceptable range.
6. Remove probe from the storage cup containing the check standard, rinse with DI water, and gently blot dry.
7. Rinse the storage cup with DI water and dry it with paper towels or Kimwipes.
8. Repeat these steps with each calibration check standard.

Acceptable Ranges for Check Standards:

A. In-Situ – DO Check (Zero DO standard)

The instrument must read 0 to 0.5 mg/l DO. If the instrument reads above 0.5 mg/l or reads a negative value, it will be necessary to recalibrate the instrument for both 100% and 0% saturation and check again. If this is unsuccessful, use a new Zero DO standard with a different lot number. If these measures are still unsuccessful, consult the manufacturer/vendor. It may be necessary to replace the RDO cap on the Smartroll or replace the unit.

If the afternoon calibration check is not within the acceptable range then the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

B. In Situ - pH Calibration Check (pH 7 standard)

The value must be pH 7 +/-5% (pH 6.65-7.35). If the calibration check failed, recalibrate the instrument using fresh standards, with different lot numbers from those used in the initial calibration, for all three values and check it again. If re-calibration fails, clean the pH probe, recalibrate and check the calibration again. If the calibration check fails again, consult the manufacturer/vendor or replace the unit.

If the afternoon calibration check is not within the acceptable range then the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

C. In-Situ - Specific Conductance Check (1413 μ S/cm standard)

When the 718 μ S/cm standard is used to calibrate, 5% of the 1413 μ S/cm solution is 1342-1484 μ S/cm. When the 1413 μ S/cm standard is used to calibrate, 5% of the 718 μ S/cm solution is 682-754 μ S/cm.

If the applicable range is not met, check the calibration using a fresh solution with a different lot number from that used in the initial calibration check. Then, if the range is

not met, recalibrate using a fresh calibration solution with a different lot number and check again.

If this range is still not met, calibrate using the second calibration solution and repeat the process above. If this is not successful, consult the manufacturer/vendor or replace the unit.

For example: if the 718 $\mu\text{S}/\text{cm}$ standard is used to calibrate, then the 1413 $\mu\text{S}/\text{cm}$ solution is used to check the calibration. If the 1413 $\mu\text{S}/\text{cm}$ solution is not within the acceptable range of 1342-1484 $\mu\text{S}/\text{cm}$, then check the calibration with a fresh 1413 $\mu\text{S}/\text{cm}$ solution with a different lot number. If this range is still not met, recalibrate the instrument using a new 718 $\mu\text{S}/\text{cm}$ standard from a different lot number and check again.

If the acceptable range is still not met, calibrate the instrument using the 1413 $\mu\text{S}/\text{cm}$ standard and check the calibration with a 718 $\mu\text{S}/\text{cm}$ solution. If the 718 $\mu\text{S}/\text{cm}$ solution is not within the acceptable range of 682-754 $\mu\text{S}/\text{cm}$, then check the calibration with another 718 $\mu\text{S}/\text{cm}$ solution with a different lot number. If this range is still not met, recalibrate the instrument using a new 1413 $\mu\text{S}/\text{cm}$ standard from a different lot number and check again.

If that does not solve the problem, consult the manufacturer/vendor or replace the unit.

If the afternoon calibration check is not within the acceptable range then the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

D. In-Situ ORP Calibration Check (Zobell solution)

The Smartroll automatically corrects the ORP solution according to the temperature of the solution.

Wait until the ORP and temperature readings have stabilized. 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 at the time of calibration. The instrument must be $\pm 5\%$ of the mV value for the current temperature. See the chart below for the check range. If it is not within $\pm 5\%$, recalibrate using a new Zobell solution. If the re-calibration is not successful, consult the manufacturer/vendor or replace the unit. For the afternoon calibration check, the instrument must be within $\pm 5\%$ of the mV value for the current temperature or the data collected using the instrument that day must be qualified in its use as described above under Calibration Acceptance Criteria.

Zobell Solution mV Values Based on Temperature for ORP Calibration
Calibration Check Range Values (+/- 5%)
 (Round off temperature to whole number, e.g., 23.5 °C rounds up to 24 °C)

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

E. Turbidity Calibration Procedures

The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidity meter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source. All turbidity vials must be free of scratches. If a vial is scratched, the vial must be replaced.

The HWRB low flow procedure requires that the turbidity meter shall have a calibration range from 0.00 to 800 (or 1000) NTUs.

Condensation (fogging) of Turbidity Vial:

Condensation may occur on the outside of the sample cell when measuring a cold sample in a warm, humid environment. Condensation interferes with turbidity measurement, so all moisture must be thoroughly wiped off the sample cell before measurement. If fogging recurs, let the sample warm slightly by standing at ambient temperature or immersing in a container of ambient temperature water for a short period. After warming, gently invert the sample cell to thoroughly mix the contents before measurement.

This procedure is based on the use of the Hach 2100P or the 2100Q turbidimeter and the commercially available StablCal® Formazin Primary Turbidity Standards appropriate for each meter.

Hach 2100P Turbidity Meter Calibration/Calibration Check Procedures

1. Use the commercially available StablCal® Formazin Primary Turbidity Standards: <0.1, 20, 100 and 800 NTUs.
2. Before performing the calibration procedure, make sure the cells containing the standards are not scratched. If a cell is scratched, the standard must be replaced.
3. Allow the calibration standards to equilibrate at the ambient temperature.
4. Turn on the meter.
5. 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)
6. Gently invert the standards to thoroughly mix the contents. **(DO NOT SHAKE)**
7. Wipe the standards with a soft, lint free cloth or Kimwipe to make sure the outside surfaces are dry and free from fingerprints and dust.
8. Insert the standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.
9. Insert the first (blank) standard, <0.1 NTU, into the cell compartment and close the lid.
10. Press **CAL**. The “CAL” and “S0” icons will be displayed (the “0” will flash).
11. Press **READ**. The instrument will count down from 60 to 0, read the blank and use it to calculate a correction factor for the second, 20 NTU standard. The display will automatically increment to the next standard. The display will now show “S1” (with the 1 flashing) and “20 NTU”, the value of the second standard. Remove the <0.1 NTU standard from the compartment.
12. Insert the second, 20 NTU, standard into the cell compartment and close the lid.
13. Press **READ**. The instrument will count down from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard with the display showing “S2” (with the 2 flashing) and “100 NTU”, the value of the third standard. Remove the 20 NTU standard from the compartment.
14. Insert the third, 100 NTU, standard into the cell compartment and close the lid.
15. Press **READ**. The instrument will count down from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard. The display will show the “S3” (with the 3 flashing) and the 800 NTU standard, the value of the fourth standard. Remove the 100 NTU standard from the compartment.
16. Insert the fourth and last, 800 NTU, standard into the cell compartment and close the lid.
17. Press **READ**. The instrument will count down from 60 to 0, measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the 800 NTU standard from the compartment and close the lid.

18. Press **CAL** to accept the calibration. The instrument will return to the measurement mode automatically.
19. To check the calibration (in run mode), insert the 20 NTU standard into the cell compartment and close the lid.
20. Press **READ**. The meter will display a lamp symbol (which looks like a light bulb) indicating that the reading is in progress. The lamp turns off and the measurement value is displayed. Record the turbidity reading on the Calibration Log. The calibration check must be +/- 5% (19-21 NTUs). If not, recalibrate using all standards. If re-calibration is unsuccessful, use new standards, consult the manufacture/vendor or replace the unit.
21. Remove the 20 NTU check standard from the compartment and close the lid.

Hach 2100Q Turbidity Meter Calibration/Calibration Check Procedures

1. Use the commercially available StablCal® Formazin Primary Turbidity Standards: 20, 100 and 800 NTUs and the 10 NTU Verification Standard.
2. Before performing the calibration procedure, make sure the cells containing the standards are not scratched. If a cell is scratched, the standard must be replaced.
3. Allow the calibration standards to equilibrate at the ambient temperature.
4. Turn on the meter.
5. Push the **CALIBRATION** key to enter the Calibration mode.

The Calibration key is the graph symbol with 2 points in the lower left hand side.  The screen shows the three standards (20, 100 & 800 NTUs). The 20 NTU standard is shown bolded with a box around it indicating that is the first standard to be calibrated.

6. Gently invert the standards to thoroughly mix the contents. (**DO NOT SHAKE**)
7. Wipe the standards with a soft, lint free cloth or Kimwipe to make sure the outside surfaces are dry and free from fingerprints and dust.
8. Insert the first standard, 20 NTU, into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment and close the lid firmly. Note: the standard to be inserted is highlighted on the display screen.
9. Press **READ** (right hand key). The display shows Stabilizing and then shows the results accompanied by an audio beep. The display will automatically request the next standard by highlighting it and darkening the first standard. Remove the 20 NTU standard from the compartment.
10. Insert the second, 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 and close the lid firmly.
11. Press **READ**. The display shows Stabilizing and then shows the results accompanied by an audio beep. The display will automatically request the next standard by highlighting it and darkening the previous standards. Remove the 100 NTU standard from the compartment.

12. Insert the third and last, 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 and close the lid firmly.
13. Press **READ**. The display shows “Stabilizing” and then shows the results accompanied by an audio beep. Remove the 800 NTU standard from the compartment.
14. Push **DONE** to complete a 3 point calibration and review the calibration details (values of the three standards).
15. Push **STORE** to save the results.
16. After a calibration is complete, the meter automatically goes into the Verify Cal mode.
17. Insert the 10 NTU Verification Standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment and close the lid firmly.
18. Push **READ** (right hand key). The display shows Stabilizing and then shows the results and the tolerance range. The calibration check must be +/- 10% (9.0- 11.0 NTUs).
19. Push **DONE** to return to the reading display.
20. If the calibration verification (Cal Check) is not within the +/- 10% range, repeat the calibration verification. If that fails, recalibrate using all standards. If re-calibration is unsuccessful, use new standards, consult the manufacture/vendor or replace the unit.

OVERNIGHT STORAGE OF THE YSI AND IN-SITU INSTRUMENTS

Check with the vendor for the appropriate overnight storage of the probes. Some manufacturers/vendors may recommend storing the multiparameter probes overnight in a storage cup filled with pH 4 solution. If so, fill the storage cup with pH 4 solution, place the probes into the storage cup and seal tightly.

DATA MANAGEMENT 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 (if applicable); changed DO membrane and solution/RDO cap, etc. Each daily Calibration Log shall be dated and signed by the user.

REFERENCES

USEPA, Region 1, Standard Operating Procedure Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction potential [ORP], and turbidity), EPA SOP# EQASOP-FieldCalibrat3, Revision Number 3, March 23, 2017.

Instruction manuals for the YSI Models 600XL/XLM Multiparameter Meter & probe, In-Situ

smarTROLL Multiparameter Meter and Hach Models 2100P and 2100Q Portable Turbidity Meters.

ATTACHMENT

Instrument Calibration/Maintenance Log

INSTRUMENT CALIBRATION / MAINTENANCE LOG

Date: _____ **Time:** _____ **Field Personnel (print):** _____

Meter: (circle one) **YSI:** Models 600XL or XLM, 6820 **In-Situ:** Smartroll **Rental Company:** _____

Multimeter Serial Numbers (Probe & Meter): _____

Beginning of Day Instrument Calibration

Multimeter Calibration	Value of Standard	Check as Completed	Lot #	Expiration Date	Comments
DO (% saturation)	100%				Allow time for stabilization per manufacture Record these values immediately after calibration
DO mg/l reading					
DO Temp. (°C) reading					
DO (0% Saturation)-Smartroll	0%				2 point DO Calibration for Smartroll only (100 & 0%)
pH 1st Standard	7				
2nd Standard	4				
3rd Standard	10				
Specific Conductance (µS/cm)					One standard is used to calibrate, second one to check (1413 and 718 standards) Using one standard for both is unacceptable.
ORP using Zobell Solution					See Chart on Page 2 for ORP Zobell Solution mV Value Based on Current Temperature
Zobell Solution _____ °C					

Additional Information for Dissolved Oxygen Calibration

Barometric Pressure Check: NWS Barometer Location: _____ Personnel _____ Date: _____

NWS Pressure: _____ mm Hg Original Hand-held Barometer Pressure _____ mm Hg Adjusted to NWS Pressure (circle one) YES or NO

Barometric Pressure of Meter or Hand Held Barometer : _____ mm Hg [BP inches _____ x 25.4 + BP _____ mm Hg]

Dissolved Oxygen Charge (YSI Meters): _____ (Acceptable Range: 25 to 75) You MUST change the membrane if charge is out of range.

Inspected DO membrane/RDO CAP for nicks or bubbles (check as completed) ____ Personnel: _____

Changed YSI Dissolved Oxygen Membrane and Electrolyte Solution (circle one) YES or NO

Replaced Smartroll Rugged Dissolved Oxygen CAP (circle one) YES or NO

HACH 2100P or 2100Q * Turbidimeter Calibration	Value of Standard	Check as Completed	Lot #	Expiration Date	Comments
Turbidity 1st Standard (blank)	<0.1 NTU				Calibrate w/ StablCal® Formazin Primary Turbidity Standards
2nd Standard	20 NTU				
3rd Standard	100 NTU				
4th Standard	800 NTU				

HACH Serial Number: _____ **Rental Company:** _____

* Circle appropriate model. NOTE: the 2100Q does not have a <0.1 standard, record N/A (not applicable) in the <0.1 standard boxes as appropriate.

* When performing calibration checks, wait for temperature and parameter readings to stabilize before recording the results.*

Post Calibration Check

Date: _____ **Time:** _____ **Personnel:** _____

Calibration Check	Value of Standard	Check Results	Acceptable Range	Within Range (yes/no)	Lot #	Expiration Date	Comments
Zero DO check (mg/l)	0		0 to 0.5 mg/l				
pH 7 check	7		+/- 5%				Range 6.65 - 7.35 pH
Specific Conductance (µS/cm) Second standard used for check	718		+/- 5%				Range 682 - 754 µS/cm (718) <u>or</u> Range 1342 - 1484 µS/cm (1413)
ORP check - Zobell (mV) Zobell Solution _____ °C			+/- 5%				See Chart on Page 2 for ORP Zobell Solution mV Value Based on Current Temperature
Turbidity Standard (NTU) 2100P	20		+/- 5%				Range 19.0 - 21.0 NTU (2100P)
Turbidity Standard (NTU) 2100Q	10		+/- 10%				Range 9.0 - 11.0 NTU (2100Q)

Calibration & Post Calibration Check Performed by: _____ (Print) _____ (Sign)

* When performing calibration checks, wait for temperature and parameter readings to stabilize before recording the results.*

END OF DAY INSTRUMENT CALIBRATION CHECK

Calibration Check	Value of Standard	Check Results	Acceptable Range	Within Range (yes/no)	Lot #	Expiration Date	Comments
Date: _____ Time: _____		Personnel: _____					
Zero DO check (mg/l)	0		0 to 0.5 mg/l				
pH 7 check	7		+/- 5%				Range 6.65 - 7.35 pH
Specific Conductance ($\mu\text{S/cm}$) Second standard used for check	718		+/- 5%				Range 682 - 754 $\mu\text{S/cm}$ (718) or Range 1342 - 1484 $\mu\text{S/cm}$ (1413)
ORP check - Zobell (mV) Zobell Solution _____ °C			+/- 5%				See Chart below for ORP Zobell Solution mV Value Based on Current Temperature
Turbidity Standard (NTU) 2100P⁵	20		+/- 5%				Range 19.0 - 21.0 NTU (2100P)
Turbidity Standard (NTU) 2100Q⁵	10		+/- 10%				Range 9.0 - 11.0 NTU (2100Q)

Notes:

- 1) NWS = National Weather Service
- 2) If the post calibration check is not within the acceptable range the meter must be recalibrated.
- 3) If the end of the day calibration check is not within the acceptable range the data collected that day for that parameter shall be qualified in it's use.
- 4) All calibration checks must be made in the run mode (on a run/measurement screen) or on the live readings screen, not the calibration mode.
- 5) If the lot numbers and expiration dates are the same as the initial calibration place a check mark in the appropriate box.
- 6) Either standard (718 or 1413 $\mu\text{S/cm}$) maybe used to calibrate specific conductance, the second standard is used to check it.
- 7) Record N/A (Not Applicable) in the boxes for the turbidity meter that was not used.

Probe Pre-cleaned Certification Provided By: Name _____	Date: _____
Temperature Calibration: Name: _____	Date: _____
Manufactures Accuracy Range of Sensor (e.g. +/- 0.2°C): _____	Check results YSI: _____ NIST: _____ Difference: _____

Calibration Check by _____
Print Name
Signature

List wells sampled using this equipment on this day **ONLY IF THE DATA NEEDS TO BE QUALIFIED.**

Zobell Solution mV Value Based on Temperature for ORP Calibration								
Calibration Check Range Values (+/- 5%)								
Round off temperature to whole number (e.g. 23.5 °C rounds up to 24 °C)								
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

CHAIN-OF-CUSTODY, SAMPLE HANDLING AND SHIPPING

PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to describe a method for maintaining sample integrity from the time that sample containers are in the possession of the field team until the samples are accepted by a laboratory. The method includes proper sample labeling, completion of chain-of-custody (COC) forms, and sample packaging and shipment.

This SOP does not include specific guidance regarding the determination of hazardous materials and the handling of hazardous materials. Refer to the site-specific health and safety plan and other project documentation for additional guidance.

A COC is a legal document designed to document the individuals who are responsible for the management of the sample container, collection of the sample, delivery of the sample to a laboratory, storage of the sample, and analysis of the sample. The field technician is personally responsible for the care and custody of the samples, including un-used sample containers, until they are transferred or properly dispatched. As few individuals as possible should handle the samples.

A sample, including empty sample containers, samples and coolers, are under an individual's custody if it meets the following requirements:

- It is in the individual's possession;
- It is in the individual's view, after being in the individual's possession;
- It was in the individual'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. All samples and un-used sample containers must be in the individual's possession or placed in a locked location at all times.

All samples submitted to a laboratory shall be accompanied by a properly completed COC form, packaged and delivered or shipped, as appropriate. Refer to the project documentation and the laboratory for specific requirements regarding COCs. For reference, copy of the current New Hampshire Department of Health and Human Services, Division of Public Health Services (NHDPHS) Laboratory COC form is attached.

Failure to maintain possession as outlined in this SOP may constitute a break in sample custody with the potential to discredit affected samples as use of evidence in court proceedings. The field technician must assume that all samples collected will someday be used as evidence in court and treat the task of sample custody accordingly.

A site-specific Sampling and Analysis Plan (SAP) or other project documentation will include site-specific information.

Sample Management Note: With the exception of preserved sample volumes for analysis of dissolved metals, the general assumption is that samples will be maintained at a temperature of 4 degrees Celsius (°C) immediately after collection. The acceptance criterion is generally a range of +/-2 °C of the assumed temperature, i.e., 2 °C to 6 °C. The analytical data for samples maintained at a temperature outside the acceptable range may be qualified or invalidated. The sample handling practice described herein is directed toward maintaining samples at the 4 °C temperature acceptance range.

EQUIPMENT AND MATERIALS

The following is a list of equipment and material commonly used for labeling, packaging and shipping samples:

- COC forms and custody seals.
- Bubble wrap or air cushions and packing.
- Re-sealable plastic bags.
- Black ink pen. **Note: Only ball point pens with black ink shall be used to record field data (e.g., COCs, log books).** Sharpies can bleed through pages and smudge, making the documentation hard to read.
- Insulated coolers that are robust enough to protect the samples if shipping containers.
- Loose ice. **Note: All samples requiring cooling should be placed in loose ice within an insulated cooler; the use of block ice, bagged ice and ice packs is not acceptable.**
- Sample labels and packing tape.

CUSTODY PROCEDURES

1. The field technician and the sample manager, if applicable, will review the SAP or other project documentation for specific COC record-keeping requirements. Note the following key COC related items:
 - a. The specific laboratory to be used along with contact information.
 - b. Specific quality assurance/quality control (QA/QC) data validation packages for project-specific data validation needs.
 - c. Laboratory reporting options, including preliminary results or electronic deliverables.
 - d. Standard or rush turn-around-times required.
 - e. Special laboratory requirements including lower detection limits; short hold times; and sample volume issues.
2. The field technician or sample manager will label all sample bottles, using waterproof ink, with the following information at a minimum:
 - a. Sample identifier.

- b. Site name or location.
- c. The name of the field technician that collected the sample.
- d. Date and time of collection.
- e. Analysis requested.
- f. Preservative used.

Note: If soil volatile organic compound (VOC) samples are collected, no additional labels or tape shall be applied to the sample container, as these are pre-weighed by the laboratory.

3. The unique laboratory COCs will be prepared by either the field technician collecting the samples or the sample manager for the project and include the following information at a minimum:

- a. The site/project name.
- b. Town the site is located in.
- c. Appropriate activity/project number.
- d. Unique sample identifiers.
- e. Time and date of collection.
- f. Matrix type.
- g. Laboratory analyses and methods requested.
- h. Number of containers.
- i. Preservatives.
- j. Name and phone number of the field technician or sample manager.
- k. Name and phone number of the project contact person.
- l. Additional analytical requirements such as specific reporting detection limits (RDLs).
- m. Any special notes or requirements such as the lab account number, OneStop Project identifier, etc.
- n. The street addresses corresponding to residential samples are included in the comment section for each sample, unless otherwise specified in the project documentation.
- o. All quality assurance/quality control (QA/QC) samples and associated information such as:

1) **Trip Blanks:**

Trip blanks for volatile organic compound (VOC) analysis typically consist of one or more sample vials prepared by the laboratory with DI water and the same preservative as the field samples. In some cases, the field technician may prepare the trip blank. The trip blank is assigned a date and time documenting

that is has accompanied all of the VOC field sample volumes in a given batch from the time of collection.

The trip blank must be labeled as “TRIP BLANK” in capital letters without any other designation on the COC and should be recorded on the first line along with the date and time. The date and time are unique to the specific trip blank in a specific batch.

There shall only be one trip blank per COC form except when trip blanks require different preservatives for the same batch of samples, such as VOCs, some 1,4-dioxane methods and Per- & Poly-Fluorinated Alkyl Substances, (e.g., VOC samples typically require hydrochloric acid and 4° C +/- 2° C; whereas some 1,4-dioxane analytical methods [Method 8260 SIM] only require 4° C +/- 2° C; Per- & Poly-Fluorinated Alkyl Substance samples typically require Trizma). Additionally, all of the field samples associated with the trip blank should be maintained in the same cooler. If multiple coolers are required, a trip blank should be included in each cooler and a COC form for each cooler is required.

2) Duplicates:

Unless otherwise specified in the project documentation, sample duplicates are identified by adding “DUP” (in capital letters) to the end of the station ID. There must be one space between the sample identifier and DUP (example “OKT_MW-14D DUP”). The duplicate samples should appear on the next line of the COC after the regular samples. If blind duplicates are collected, refer to the site-specific SAP for proper identification and labeling.

3) Matrix Spike (MS) Matrix Spike Duplicate (MSD) samples:

MS/MSD samples are typically collected together at one sample location. Refer to the project documentation for specific MS/MSD requirements. There are generally two types of MS/MSD samples:

a) Lab QC MS/MSD Samples:

A laboratory may require the collection of extra sample volume as part of their quality assurance program. If so, indicate that in the comments section on the COC (e.g., “Lab MS/MSD QC or “Lab MS/MSD-1,4-dioxane” specifying the analysis). The lab typically does not report these results. The number of sample containers on the COC will also change to indicate the extra bottles. These lab QC samples are not be on a separate line on the COC. The NHDPHS lab typically requires extra sample bottles for their internal QC for 1,4-dioxane analysis. One set of MS/MSD samples are generally collected for each batch of 10 or 20 samples. Refer to the specific lab and the SAP for MS/MSD requirements.

b) Site MS/MSD Samples:

The data quality objectives of the project may require MS/MSD samples to be collected at a specific location, and require the lab to report those results, as part of a site-specific sample collection program if matrix interference is suspected. If so, indicate that in the comment section on the COC (e.g., “MS/MSD Report Results” or “MS/MSD-SVOCs Report Results” specifying the analysis if it is not required for each analysis). The number of samples containers will also change to indicate the extra bottles for the MS/MSD sample. These MS/MSD samples may be on a separate line on the COC. Refer to the specific lab and the site-specific SAP for MS/MSD requirements.

4) **Equipment Blank Samples:**

Equipment blank samples will be designated as “EQUIP BLANK” in capital letters on the COC without any other designation. Add a note to the comment section of the COC indicating what the equipment blank is for (e.g., water level meter, etc.).

5) **Field Blank Samples:**

Field Blanks must be labeled “FIELD BLANK” (in capital letters) without any other designation. This is an EMD requirement. The name of the person who collected the field blank must be in the comments section of the COC form, as different samplers may be collecting and submitting field blanks during a particular sample collection event.

6) **Temperature Blanks:**

A temperature blank will be included in each cooler to verify that samples have been maintained at the required temperature during shipping. Check off the box on the COC to indicate that there is a temperature blank in the cooler. If there is no box, indicate the temperature blank’s presence in the comment section of the COC.

4. Prior to leaving the site and before the samples are delivered to the lab, the field technician or sample manger will check for errors on the sample label and COC form and verify that all pertinent data is present and correct.
5. 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 field technician to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

Only one field technician or sample manger signs 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

individuals to take custody of the sample, the form has additional lines for signatures. All signatures must be in ballpoint pen and are followed by a date and time that the COC was signed. The last line of the NHDPHS COC is provided for personnel from the laboratory to sign for receiving the sample. The line at the bottom of the page “Data Reviewed By” is for Lab use only. If the samples are taken to the NHDPHS lab via courier the field technician may relinquish the samples to “NHDPHS Laboratory via courier”, as appropriate. Pre-approved NHDES personnel may relinquish the samples to “locked storage” in the NHDPHS Lab.

Note: Any errors must struck out with a single line, initialed, dated and the correction written in. A strike-out for correction will never obliterate the error; it must only make it clear that the particular entry is not to be used. The erroneous entry should remain legible in case future review is necessary.

6. When the COC comprises multiple pages, each page should be clearly marked with the page number and the total pages, i.e. Page 1 of 4, Page 2 of 4, etc. If the pages are not marked as such, each page may be interpreted as a separated COC. In some cases it may be acceptable to reference the first page of the COC in preference to repeating some project-specific information on each page of a COC. Refer to the project documentation and contact the laboratory, as appropriate, for additional guidance.
7. If the samples are relinquished to a shipper or other courier not associated with the project, the airbill generally serves as the COC record for that portion of the trip and will be retained by the field technician and provided to the Project Manager as part of the permanent documentation.
8. Project personnel will review the COC to evaluate completeness; holding time or sample volume issues that may impact the validity of the results.

SAMPLE PACKAGING PROCEDURES

From the time of collection, all samples shall be handled and transported to the laboratory so as to prevent breakage and preserve sample integrity. Sample containers are generally packed in insulated coolers for shipment or pickup by the laboratory courier. Appropriate packing materials include bubble wrap and air cushions. Sample containers are packed tightly so minimize movement during shipment that may cause breakage. Bubble wrap is assumed to be used on all glass containers; unwrapped glass container should never be in contact with other unwrapped glass container during transport. In some cases, using sample volumes in plastic containers to separate glass container during shipping may afford additional protection.

1. Unless the field personnel are transporting the coolers directly to the laboratory, the cooler should be lined with a durable plastic trash bag and approximately one inch of inert material placed in the bottom of the cooler. The **loose** ice is loaded into the trash bag liner.
2. Place each sample container, or set of sample containers, inside a re-sealable plastic bag as a precaution against cross-contamination due to leakage or breakage.

3. Place all containers in an upright position into the **loose** ice in the cooler and place all glass containers in such a way that they do not come into contact with each other during shipment. The field technician or sample manager should use good judgement when loading the cooler; the number of sample containers should not limit the volume of **loose** ice to the extent that the appropriate temperature is not maintained. More ice is always better than too little; when in doubt, use an additional cooler.
4. Place the temperature blank in the cooler so that the temperature of the blank will be representative of the temperature maintained in the cooler and the blank will be easily accessible when the cooler is checked in at the laboratory. When samples are transported to the laboratory directly from the field, there is no assumption that the samples will be cooled to a designated temperature before they are accepted by the laboratory. The temperature blank is intended to document that the samples were maintained under the appropriate conditions regardless of the length of time they were in the cooler. The temperature measurement at the laboratory should always be on the designated temperature blank, not a field sample.
5. After samples have been packed, add **loose** ice, as necessary, to fill the cooler. The additional ice will take up space and limit movement of the containers as well as assist in maintaining the appropriate temperature.
6. Use wire ties to close and seal the plastic trash bag. Place a signed COC form in a re-sealable plastic bag in the cooler and outside the liner. The COC should be the first thing the sample receiver at the laboratory sees when the cooler is opened. If the field technician is delivering the cooler directly to the laboratory, it should be in the cooler on arrival and may be removed from the cooler in the presence of the sample receiver. When multiple coolers are shipped, only one COC form is required unless there are other considerations. The cooler with the COC should be marked so that the sample receiver can easily locate it. Additionally, the cooler number and total number of coolers in a shipment should be marked in each cooler in the shipment, i.e., 1 of 4, 2 of 4, etc.
7. Coolers that are shipped will be secured with strapping tape in at least two locations for shipment to the laboratory and include a custody seal at the lid break point.
8. The appropriate personnel shall make a determination as to whether the materials in any cooler comprise hazardous materials prior to shipping the sample. Refer to the project documentation for additional guidance. .

SAMPLE PICKUP/SHIPPING PROCEDURES

Unless otherwise specified in the project documentation, the field technician or the sample manager is responsible for the samples arriving at the laboratory in an acceptable condition and in a timely manner, i.e., with adequate time to complete sample preparation and analyses within the designated holding time for a given analysis without incurring additional surcharges. In general, samples are maintained under more ideal circumstances at a laboratory than at a field site. As such, it is usually preferable to transfer custody of samples to the laboratory as soon

after collection as is practical.

Sample Pickup/Delivery

Samples may be delivered directly to the laboratory by the field team or the laboratory may send a courier to take custody either at the site or at an interim location. The laboratory is considered to have custody of the samples when they are accepted by a courier representing the laboratory. Unless otherwise specified in the project documentation, custody seals are used if samples are transported by an independent contract courier that does not directly represent the laboratory.

Shipping Samples to the Laboratory

When samples need to be shipped, they are typically sent next-day delivery by an overnight carrier. Field personnel will coordinate directly with the appropriate laboratory in advance for delivery times and requirements and will notify the laboratory, typically, no later than 48 hours, prior to sample shipment. The field technician or sample manager must confirm that the laboratory will have a sample receiver on duty to accept and manage the samples when the shipment arrives. Coolers will be secured with strapping tape in at least two locations for shipment and include a custody seal. If the sample is considered hazardous, consult appropriate trained personnel for proper packaging and labeling.

For shipments by commercial carrier, the appropriate side of the shipping container should be prominently marked with a "This End Up" label with arrows pointing in the correct orientation. The shipping company label is affixed to the top of the cooler. The label should include the shipper's name, address, and telephone number, and the name, address, and telephone number of the receiving laboratory. Also on the top of the shipping container, the shipper's return address should be written in black ink.

If the samples are shipped by a commercial carrier the airbill generally serves as the chain-of-custody record for that portion of the trip and will be retained by the field technician or sample manager and included in the field documentation.

DOCUMENTATION

The original COC record will accompany the cooler and a copy will be retained by the field technician or sample manager and included in the field documentation for the project.

ATTACHMENT

NHDPHS Laboratory Services Login and Custody Sheet



FINAL POLICY

**PRESERVATION OF VOCs in
SOIL SAMPLES**

MARCH 2000

Soil Sampling for VOC Analysis Policy

1.0 INTRODUCTION

This New Hampshire Department of Environmental Services (DES) “Soil Sampling for VOC Analyses” guidance document contains recommendations for soil sampling protocols for all petroleum and hazardous waste sites. The protocols are applicable to all soil samples analyzed for volatile organic compounds (VOC). This guidance was developed in response to a preponderance of scientific evidence indicating the under-reporting of VOC concentrations due to VOC loss during sample collection and storage. The three main mechanisms responsible for the VOC loss are: 1) initial sampling and sub-sampling activities that disturb/destroy soil structure and/or aerate samples, 2) volatilization/diffusion out of the sample container during storage and 3) biodegradation of contaminants during storage.

The EPA has issued soil VOC sampling and analysis methodology [SW 846 Method 5035 (December 1996)]. ASTM has also adopted a standard for low VOC loss sampling [ASTM Standard D4547-98 (Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds)]. In these methods (see Appendix A), methanol is added immediately to the sample while in the field to preserve the soil sample. Region IV and a number of states, including Alaska, Massachusetts, Minnesota, New Jersey, New Mexico, Pennsylvania, South Carolina and Wisconsin, have adopted policies requiring methanol preservation of soil samples containing VOCs. In Massachusetts the methanol preservation requirement was established on October 31, 1997 for the Volatile Petroleum Hydrocarbon (VPH) analysis method and on March 5, 1999 for all soil samples subject to VOC analysis (Preservation Techniques for Volatile Organic Compound (VOC) Soil Sample Analyses: WSC #99-415). The Massachusetts Policy and a general article on VOC loss from samples are included in Appendix B.

DES believes that the availability of specialized soil VOC sample containers with pre-measured methanol and the recent development of alternative low VOC loss sample devices/containers minimizes the costs and logistical requirements for implementing this new sampling approach.

2.0 APPLICABILITY

Sampling protocols contained in this document are required for all soil samples that will be analyzed for VOCs by EPA SW 846 Methods 8015A, 8021B, 8260B or equivalent EPA Standard Methods procedures. The sampling protocols should also be used whenever VOC loss can significantly affect the accuracy of the results, such as the analysis of gasoline contaminated soil for TPH. The policy does not apply to onsite mobile laboratory analyses, when samples are collected and analyzed the same day. The policy also does not apply to field screening methodologies, such as PID/FID headspace screening, UV Fluorescence & Adsorption, Immunoassay Test Kits or portable GC units that are used on a real time basis. All other data obtained from a sampling methodology that does not follow this policy will be considered to be improperly preserved and not scientifically valid. DES may reject the results and require resampling when the soil sampling protocols in this policy are not properly followed. No phase-in of the policy is

recommended because of the general availability of the required sampling equipment, and the familiarity of the laboratories in the region with the required methodologies due to the similarity with Massachusetts' policy. This policy will become effective March 30, 2000.

3.0 PREVIOUSLY OBTAINED OR SUBMITTED DATA

The following table describes how unpreserved VOC soil data will be managed, based upon the sample collection and the report submission date.

Sample Collection Date	Data Submission Date	Comments
Before 3/30/2000	Before 3/30/2000	DES will not reopen sites that were closed based on previous sampling practices, unless new data or information becomes available. DES may require reevaluation of data at active sites, if evidence exists that may be significant health and environmental concerns. Factors that will be considered when making a decision to reevaluate existing data are listed below.
Before 3/30/2000	On or after 3/30/2000	Consultants and site owners should evaluate the data and site characterization to determine whether loss of VOCs is a significant issue. The report should discuss the sampling protocols that were used and recommend whether the soil should be resampled.
After 3/30/2000	On or after 3/30/2000	Proper preservation techniques must be used, or DES will not accept the data. The petroleum reimbursement funds will not reimburse for the cost of the analysis of samples that were collected improperly. Change orders for related costs can be submitted to the reimbursement program for work scopes submitted prior to implementation of the policy.

Data Evaluation Factors

1. VOC headspace and other screening data indicate significant levels of VOCs;
2. The type, toxicity and persistence of VOCs present (e.g., Chlorinated compounds and MtBE generally pose a greater long term threat to groundwater and the environment);
3. High and/or consistent levels of VOCs in groundwater indicate that VOCs in soil may be a continuing source; or
4. The presence of sensitive receptors or exposure pathways at or in the vicinity of the disposal site.

4.0 METHODOLOGY

The methodology in ASTM Standard D4547-98 or EPA Method 5035 should be followed for the collection of all VOC samples. These methods provide additional, valuable guidance on sampling protocols, for example, procedures necessary to successfully sample oily wastes. DES believes that in the vast majority

of cases samples can be collected using the following two soil preservation techniques discussed in ASTM D4547-98 and EPA Method 5035: 1) field preservation with methanol and 2) the use of a low VOC loss sampling system such as the EnCore™ sampler or equivalent. The DES requires that the laboratory report a minimum wet weight estimated quantitation limit of 100 µg/kg for these two methods.

A third methodology can potentially be used to achieve a lower VOC detection limit (<100 µg/kg). This method is known as the low level or sodium bisulfate preservation technique. DES notes that only the following twelve VOC contaminants have S-1 soil cleanup standards equal to or below the <100 µg/kg detection limits achievable by methanol preservation: acrylonitrile, bromodichloromethane, bromoform, chloroform, dibromochloromethane, dibromochloropropane, 1,2-dichloroethane, 1,2-dichloropropane, ethylene dibromide, methylene chloride, 1,1,2,2-tetrachloroethane and 1,1,2-trichloroethane. All of the S-1 soil standards for these compounds were based on a potential threat to groundwater, not direct contact risk. As a result, it is not necessary to achieve the lower detection limit using the sodium bisulfate preservation technique, if data exists indicating that groundwater impacts have not occurred. It should be noted that the bisulfate method has the following shortcomings: a) special equipment is required at the laboratory, b) the sodium bisulfate may react with humic compounds to generate acetone and 2-butanone, c) the sample will effervesce when carbonates are present and d) more complex field protocols are required. DES, as a result, does not recommend the use of the sodium bisulfate preservation technique, unless the lower detection limit is absolutely necessary to identify groundwater contamination source areas containing one of the twelve contaminants with S-1 standards less than or equal to 100 µg/kg.

DES will consider other low VOC loss sampling protocols beyond the three discussed in this document on a case-by-case or site-specific basis. DES approval is required prior to sample collection for any other low VOC loss protocol that is not specifically discussed in this policy.

4.1 Methanol Preservation

The methanol preservation technique must be performed in the field and involves the following key steps:

- Collection of 5 to 25 grams of soil. Typically the lab will mark a level on the bottle that indicates the volume that should result after the addition of the soil to the methanol. A duplicate sample should be collected, in case the sample analysis must be rerun. Additional samples may need to be collected based on site-specific QA/QC requirements (i.e., matrix spike, matrix spike duplicate, etc.)
- Addition of “purge and trap” grade or equivalent methanol to the sample vial at a desired ratio of 1:1 (grams soil/mL methanol). The tolerance for this ratio is +/- 25%. Ratios outside of this range may be acceptable, depending on data quality objectives. Soil samples must be completely immersed in methanol.
- It is not necessary to weigh the sampled soil in the field as long as the weight of the soil can be calculated and the soil weight/volume ratio is +/- 25% of the acceptable 1:1 ratio. There are a number of soil sample collection devices available to facilitate accurate collection of the required

volume of sample.

- An additional unpreserved sample must be collected to allow for a determination of moisture content. Without the additional sample, the laboratory cannot report the results on a dry-weight basis. Moisture effects may become significant at moisture contents greater than 25%. When moisture content is greater than 25%, data reports should discuss the implications of sample dilution resulting from the high moisture content.
- The sample must be analyzed by an EPA or New Hampshire accredited laboratory.

DES prefers the use of sampling bottles obtained from the laboratory with pre-measured quantities of methanol. This will ensure that appropriate purity methanol is used and minimizes handling of methanol by field personnel. DES also recommends using a volumetric sampling device to collect the soil sample. This minimizes the loss of VOCs during sample collection and eliminates the need to weigh samples in the field. Sample containers should not remain open for long periods of time to minimize the potential for cross contamination of the sample and the loss of methanol. Please refer to ASTM D4547-98 and EPA Method 5035 for additional information about proper sampling technique and the sodium bisulfate method (if site specific circumstances warrant its use).

4.2 Alternate Sampling Methods

An EnCore™ sampler or similar DES approved device with proven effectiveness may be used to obtain samples in the field without preservation, provided that the sample is extruded into methanol or extracted by a laboratory within 48 hours of sample collection. The sampler must follow the manufacturer's directions for the sampling device used and all other appropriate sample preservation protocols, such as keeping samples at or below 4° C. Information on the use of EnCore™ samplers is included in ASTM 4547-98 in Appendix A.

5.0 SAMPLE COMPOSITING

Composite samples can be collected using the methanol method of sampling. To accomplish this, grab samples would be collected in accordance with the methodology discussed in section 4.1 of this policy. The laboratory then prepares the composite sample by using a syringe to collect equal amounts of the methanol preserved sample from each of the vials. The subsamples are then combined to yield the required composite sample volume.

An alternate approach to collecting composite samples that does not require compositing of the samples at the laboratory is to use a large VOC vial with septum lid. Methanol is added to the VOC vial in proportion with the number of samples that will be composited to ensure that the desired ratio of 1:1 (grams soil/mL methanol) is maintained. For example, 25 ml of methanol would be added to composite five, 5 gram soil samples. All of the soil samples that are to be composited are then added to the VOC vial containing the methanol with care exercised to prevent methanol from splashing out of the vial.

Soils that are proposed for reuse onsite must be analyzed using a low VOC loss composite sampling methodology such as this, or by representative low VOC loss grab sampling. DES does not require that this policy be used for the purposes of characterizing soil for an offsite disposal facility. It is necessary to use the sampling approach discussed in this policy, however, if the data will be used for both offsite site disposal facility purposes and remedial decision making on whether the soil can remain onsite.

Appendix A
ASTM D 4547-98 and EPA Method 5035

Appendix B
Massachusetts [Policy](#) and Article

NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES

DRAFT

**EVALUATION OF SEDIMENT QUALITY
GUIDANCE DOCUMENT**



April 2005



**NEW HAMPSHIRE
DEPARTMENT OF ENVIRONMENTAL SERVICES**

**EVALUATION OF SEDIMENT QUALITY
GUIDANCE DOCUMENT**

April 2005

Prepared by
Lori S. Siegel, Ph.D.
Watershed Management Bureau
New Hampshire Department of Environmental Services
29 Hazen Drive
Concord, NH 03302-0095
www.des.nh.gov

Michael P. Nolin
Commissioner

Harry T. Steward, P.E.
Director, Water Division



EVALUATION OF SEDIMENT QUALITY

BACKGROUND

This document paper sets forth DES guidance for the application of Surface Water Quality Standards to freshwater, estuarine, and marine sediments. The narrative standards of Env-Ws 1703.19 *Biological and Aquatic Community Integrity* and Env-Ws 1703.21 *Water Quality Criteria for Toxic Substances* are applicable to sediment chemistry and biology. In addition, Env-Ws 1703.08 *Benthic Deposits* applies to sediments and refers to the physical, chemical, and biological nature of these substrates.

Sediments found in streams, rivers, lakes, and estuaries are habitat for many forms of aquatic life. This bottom-dwelling aquatic life -- including, but not limited to, amphipods, bivalves, midges, polychaetes, oligochaetes, mayflies, and cladocerans -- is intimately linked via nutrient and energy exchange webs to additional ecological resources, including finfish, shellfish, birds and other wildlife associated with surface water ecosystems. Sediments can serve as a repository and source of persistent and potentially toxic inorganic and organic chemicals. Contaminated sediments may adversely impact these ecological resources or humans who consume these resources.

APPLICABLE LAWS / REGULATIONS

Env-Ws 1703.08 **Benthic Deposits**

- a. Class A waters shall contain no benthic deposits, unless naturally occurring.
- b. Class B waters shall contain no benthic deposits that have a detrimental impact on the benthic community, unless naturally occurring.

Env-Ws 1703.19 **Biological and Aquatic Community Integrity**

- a. The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
- b. Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.

Env-Ws 1703.21 **Water Quality Criteria for Toxic Substances**

- a. Unless naturally occurring or allowed under part Env-Ws 1707, all surface waters shall be free from toxic substances or chemical constituents in concentrations or combinations that:
- (1) Injure or are inimical to plants, animals, humans or aquatic life; or
 - (2) Persist in the environment or accumulate in aquatic organisms to levels that result in harmful concentrations in edible portions of fish, shellfish, other aquatic life, or wildlife that might consume aquatic life.

GUIDANCE DOCUMENT

Introduction

Risk posed to sediment-dwelling organisms should be assessed according the Sediment Quality Triad approach, described in Section I below.

Certain contaminants in sediment may bioaccumulate in intermediate to higher trophic organisms. Associated risks, which increase if the contaminant has low water solubility and high lipid solubility ($\text{Log } K_{ow} > 4.2$), should be assessed according to Section II on page 10. The document EPA-823-R-00-001 lists the “Important Bioaccumulative Compounds” (USEPA, 2000c). The EPA also addresses these persistent, bioaccumulative, and toxic pollutants (PBTs) according to their multimedia strategy, which aims to protect human and ecosystem health from these highly toxic, long-lasting substances. According to <http://www.epa.gov/opptintr/pbt/cheminfo.htm>, PBTs include, **but are not limited to:**

- | | |
|---------------------|-----------------------------|
| ● aldrin/dieldrin | ● mercury and its compounds |
| ● benzo(a)pyrene | ● mirex |
| ● chlordane | ● octachlorostyrene |
| ● DDT, DDD, DDE | ● PCBs |
| ● hexachlorobenzene | ● dioxins and furans |
| ● alkyl-lead | ● toxaphene |

I. Sediment Quality Triad Approach for Sediment-Dwelling Organisms (addresses Env-Ws 1703.08 and 1703.19)

Adverse effects on sediment aquatic life will be assessed using the Sediment Quality Triad approach (USEPA, 1992). This methodology integrates both chemical and biological data in

order to assess ecological resource risk. The methodology has three components that are applied sequentially and yield complementary data. The components are:

- A. Sediment chemical analyses
- B. Sediment toxicity bioassays (laboratory)
- C. Community assessment (field)

The Sediment Quality Triad (chemistry, toxicity, and community) will be performed as this guidance document specifies in the description of each component. As outlined in the flowchart presented in Figure 1, the assessor will weigh the results of each component, as it becomes necessary to perform, to conclude whether or not the chemical contamination is impacting the benthic community. Considering the weight of evidence, the decision making process follows a matrix of outcomes (Table 1) that, if applicable, also considers the characterization of bioaccumulation risk, as determined according to Section II.

While an exceedance of the appropriate thresholds, determined in Component A of the triad, mandates further risk characterization, the severity of the risk may be so strongly predictive of impairment that the waterbody will be listed as impaired if not further characterized within an assessment period. With further characterization, the assessor may assume that Component B will reveal sediment toxicity. In this case, the assessor could skip Component B and proceed directly to Component C, i.e., community assessment. However, if the community assessment does not reveal any impact, the assumption of positive sediment toxicity must figure into the weight of evidence and typically mandates at least continued monitoring of the site for future impacts. Justification to omit Component B without this mandate may be made site-specifically. For example, any impacts would already have occurred at a site where the contamination source has been eliminated and sediment contaminants have been present for a significant (depending on site conditions) length of time. This determination will be made at the discretion of DES. Another option would be to perform Components B and C concurrently.

In the case of free product and observable ecological impacts that clearly indicate a violation of water quality standards, it may be more efficient to initially skip the triad and move directly to remediation. Following remediation, as a performance standard to ensure effectiveness, sediment sampling should be performed and the triad applied as applicable.

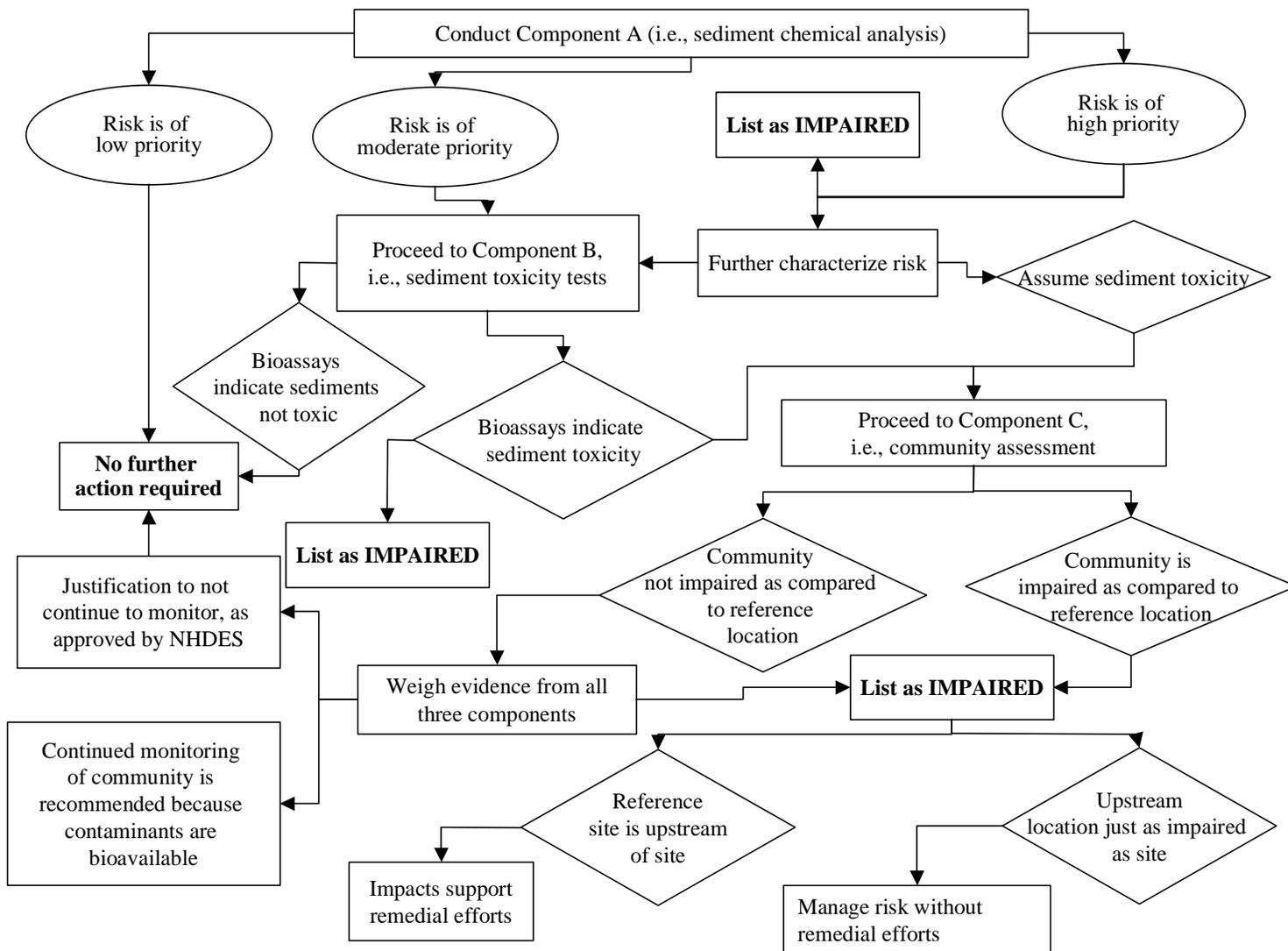


Figure 1 Flowchart of Triad Approach

Triad Components

A. Conduct sediment chemical analyses. Chemical profiles of sediment samples are compared with standard screening level reference values.

Sediment samples shall be collected in accordance with standard protocols (e.g., USEPA EPA-823-B-01-002, 2001; refer to www.epa.gov/waterscience/cs/collection.html for downloading this manual). The two main categories of sampling equipment are coring and grab devices. Data quality objectives and site specifics control the choice of sampling equipment.

Besides chemical concentrations, total organic carbon (TOC) and grain size should be quantified for each sample. The spatial distribution of contaminants at the site should be evaluated and compared to that at a reference near the site yet not impacted by the site, i.e., local conditions. If evidence suggests the concentrations of contamination of potential concern exceed those of local conditions, chemical concentrations of samples will be compared with published, peer-reviewed screening level contaminant lists, which include, but are not limited to:

- 1) NOAA 1999 – SQuiRT Tables (NOAA Hazmat Report 99-1).
- 2) Oak Ridge National Laboratory 1997 – Toxicological Benchmarks (ORNL ES/ER/TM-95/R4).
- 3) US Environmental Protection Agency 1996 – Ecotox Thresholds (USEPA EPA 540/F-95/038).
- 4) MacDonald *et al.*, 2000 – Arch. Environ. Contam. and Toxicology Vol 39: 20-31.

The following steps, as outlined in the flowchart presented in Figure 2, specify the sequence of events for screening at each sediment sampling location. The number of sample locations increases the statistical significance of the site risk characterization. Contaminants that have the potential to bioaccumulate must be further evaluated according to Section II.

Steps

1. For each contaminant, choose an appropriately conservative **THRESHOLD EFFECT CONCENTRATION (TEC)** and **PROBABLE EFFECT CONCENTRATION (PEC)** from available guidelines for each contaminant of concern. TEC values are screening thresholds **below which adverse effects are unlikely**. Data are typically from studies with sensitive species in laboratory exposures. PEC values are screening thresholds **above which adverse effects are likely**. For freshwater environments, although consensus-based (CB) TEC and PEC values (MacDonald *et al.*, 2000) are not the most conservative, they do have the most statistical justification. Assessors may choose thresholds from other sources provided they are at least as conservative as the CB thresholds. For contaminants with no available threshold, calculate a standard using the contaminant's surface water standard with appropriate partitioning coefficients.

For less sensitive ecosystems, as determined site-specifically and approved by DES in advance, comparisons to the contaminant's PEC alone may suffice.

2. Calculate the hazard quotient (HQ) for each contaminant detected in each sample by dividing the sediment contaminant concentration by the threshold value. An HQ calculated with a TEC (HQ-TEC) of one or greater indicates the possibility that the contaminant may adversely affect sediment organisms. An HQ calculated with a PEC (HQ-PEC) of one or greater indicates the likelihood that the contaminant will adversely affect sediment organisms.
3. According to Section II, contaminants with high bioaccumulative potential that have $HQ > 1$ (HQ calculated with TEC) or for which a TEC is not available, must concurrently assess the risk to higher trophic organisms.
4. Qualify risk from each contaminant according to HQ as low ($HQ-TEC < 1$), moderate ($HQ-TEC > 1$), and high ($HQ-PEC > 1$). Contaminants classified as moderate to high risk are retained as contaminants of concern (COCs).
5. If the sample location has at least one COC, determine its maximum HQ (HQ_{max}) calculated with TEC and PEC (or just with PEC if approved by NH DES) and proceed to Step 6. Otherwise, eliminate that location from concern.
6. Include the location in the priority list for further assessment according to its maximum level of risk. Qualify risk at each location as moderate ($HQ-TEC_{max} > 1$) or high ($HQ-PEC_{max} > 1$). Moderate to high risk may indicate a surface water quality violation.
7. Sample locations with moderate risk priority require additional risk characterization according to Component B of the triad. Sample locations with high-risk priority are assumed to be impaired and will be listed as such unless additional risk characterization according to Components B and/or C suggest otherwise.

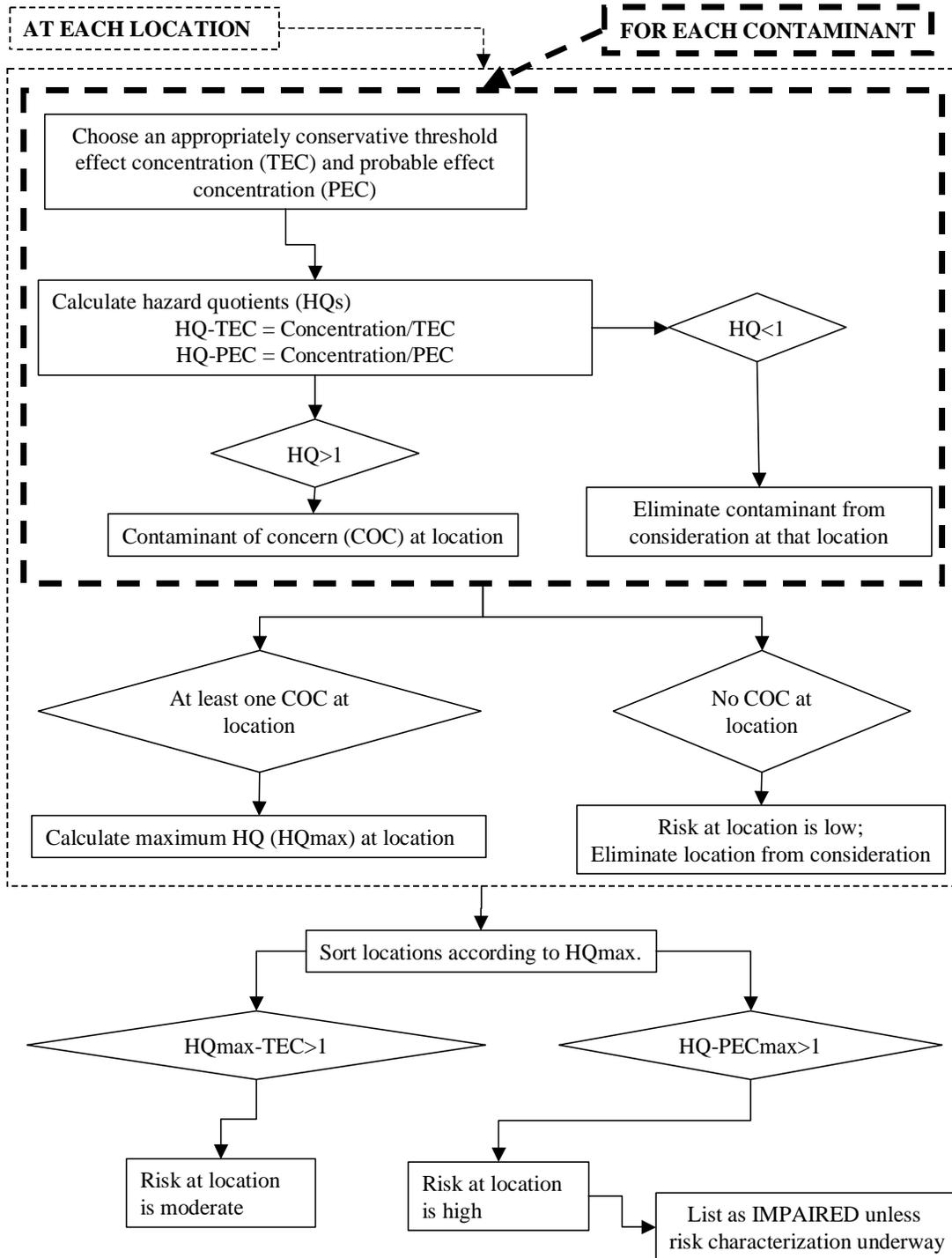


Figure 2 Flowchart of Component A of Triad Approach

B. Conduct sediment toxicity bioassays using sediment samples from potentially impacted sites

Additional sediment samples will be collected by standard protocols (e.g., USEPA EPA – 823-B-01-002, 2001) and used in standard sediment acute and chronic toxicity tests (e.g., EPA 600/R-99/064, 2000, EPA 600/R-01/020, 2001, EPA 600/R-94/025) with test organisms most appropriate for the site. Typical test organisms appropriate for freshwater environments include the amphipod *Hyalella azteca* (*H. azteca*) and the chironomids *Chironomus dilutus* (*C. dilutus*) (formerly known as *C. tentans*) and *Chironomus riparius*. Typical test organisms appropriate for marine environments include the amphipods *Rhepoxynius abronius*, *Eohaustorius estuaries*, *Ampelisca abdita*, and *Grandidrerella japonica*. More than one organism should be evaluated for each sample location. Sample methodology, toxicity test, and test organism(s) are subject to review and approval by DES. If sample collection is not feasible due to sediment characteristics, alternative analyses, e.g., pore water analyses/toxicity, may be substituted for sediment toxicity bioassays, but only upon prior approval by DES.

Although assessment endpoints are site-specific, an effect of 20 percent on the endpoint will indicate positive toxicity. In particular, a decrease in survival of more than 20 percent is generally unacceptable (Kuhn *et al.* 2002; Long *et al.*, 2001). However, when growth is the endpoint, literature (e.g., Kubitz *et al.*, 1996) supports a growth inhibition of an organism of 25 percent to be indicative of non-lethal effects.

Potential endpoints are a function of the duration of the bioassay. Tests may be categorized as acute (e.g., 48 to 96 hours), short-term chronic (e.g., 10 days), or long-term chronic (e.g., at least 20 days). The chronic bioassays are critical to evaluate impacts on survival and growth. Cost and time considerations associated with this requirement have typically rendered the 10-day bioassay to be performed. However, toxicity is sometimes observed only after this test would be terminated, as indicated by the long-term chronic test. Research suggests and the NH DES now recommends that, at a minimum, the long-term chronic bioassay be conducted for at least one of the organisms for samples from certain key locations. Survival and growth must be reported at the short-term and long-term marks. If significant toxicity is observed at the short-term mark, the test may be terminated then.

In the event that laboratory testing reveals acute or chronic sediment toxicity, the assessment may progress to Component C, i.e., benthic community assessment, or be deemed to pose risk. The ability and practicality of performing this third component with enough statistical power for relatively small sites, which are more typical than not at the State level, may eliminate its merit. The triad approach for which the evidence is also weighed supports the approach that if the chemistry and bioassays lead to a benthic assessment but that assessment is not rigorous enough, then the site will still be considered impacted. If chemistry indicates moderate risk, i.e., $HQ-TEC > 1 \geq HQ-PEC$, and bioassays indicate toxicity, then the benthic assessment may be the deciding factor. However, if chemistry indicates high risk, i.e., $HQ-PEC > 1$, and bioassays indicate toxicity, then the benthic assessment is not likely robust enough to outweigh the evidence of risk and may be omitted. Furthermore, sites where the

aquatic chemistry is likely to change dramatically, such as for a dam removal project, may render Component C irrelevant.

On the contrary, negative toxicity for samples with high risk potential according to Component A should be considered cautiously. Prior to accepting the results, the assessor should exclude reasons for false negatives, .e.g., poor choice in test organism.

C. Conduct an assessment of community integrity

A community assessment must involve a field evaluation of the sediment community. Specifically, it is necessary to conduct a sediment biological community survey at the sampling site and compare the results with those from an appropriate, less adversely impacted reference site. The composition and structure of the benthic community will be characterized at the sample location and compared to a survey or surveys at a reference location of similar habitat but subject to less of the chemical contaminants. Standard ecological community metrics will be used to characterize the biota at both locations. The methods for benthic biological survey shall be reviewed and approved by DES in advance.

The reference location is used as a comparison to determine the level of actual risk to the site. The reference is a location that is neither impacted by the site nor by other sources. The comparison of contaminant spatial distributions for Component A may aid in locating the reference. For a river, brook, or stream, it is preferably upstream of the site. If such a location cannot be found near the site, then the reference location should be chosen from a similar watershed and metrics extrapolated to the site. If results of this comparison suggest the site is in fact impaired, a nearby location that is not impacted by the site, despite its impairments from other sources, should also be characterized as a control site so that the risk manager may make an informed decision about the relative increase in risk that is posed by the site. The risk at the site may not warrant remedial actions if nearby locations are just as impaired from other sources. Nevertheless, it is still important to understand the level of risk at hand as determined by comparison to the reference site.

II. Bioaccumulation Risk Potential (addresses Env-Ws 1703.21)

Sediment contamination can have adverse ecological effects on the benthic community and on shellfish, finfish, avian, amphibian, reptile, and/or mammal communities that are linked to benthic communities via the food web structure. Free-swimming organisms may bioconcentrate contaminants directly from the water column. However, they may also bioaccumulate contaminants via direct or indirect sediment exposure or diet.

Through the ecological processes of *bioaccumulation* (organism intake of contaminants via both water column and diet) and *biomagnification* (increased organism body burden of persistent contaminants as we move to higher trophic levels in ecosystems) contaminants in the sediments may be transferred to shellfish, finfish, avian, and terrestrial wildlife communities associated with the contaminated aquatic systems. Predator fish, birds, and other wildlife may become contaminated from being linked to bottom-feeding fish or benthic invertebrates that are laden with sediment associated pollutants via food-web transfer. This transfer can continue to human beings if contaminated fish, birds, or mammals are consumed.

The risk of bioaccumulation from sediments increases if the contaminant has low water solubility and high lipid solubility ($\text{Log } K_{ow} > 4.2$). Heavy metals or non-polar organic chemicals, which may bioaccumulate to toxic levels in shellfish, finfish, and birds or render organisms unfit for human consumption, generally will be located in the sediments of aquatic systems. Detailed information on the chemistry and toxicity of many of the most common bioaccumulative contaminants is provided in USEPA EPA-823-R-00-001, 2000c and EPA-823-R-00-002, 2000a.

A sediment contaminant with bioaccumulation potential and, if a TEC is available, $\text{HQ-TEC} > 1$ (determined in Component A of the triad) mandates the evaluation of actual or predicted tissue concentrations for assessment of adverse impact on relevant organisms. Relevant organisms include those species that use the contaminated site for resting, feeding, rearing, or reproduction.

A. Determine contaminant tissue concentrations for relevant organisms

Three alternative methods are available to determine contaminant tissue concentrations for relevant organisms of intermediate to higher trophic levels.

1. Use published **Biota-Sediment Accumulation Factors (BSAFs)** to estimate tissue concentrations of contaminants for relevant organisms.

The National Sediment Quality Survey, 2nd Edition (USEPA EPA-823-R-01-01, 2000c) provides **BSAFs** for fish tissue for numerous heavy metal and non-polar organic contaminants. The Appendix to Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment (USEPA EPA-823-R-00-002, 2000a) contains additional **BSAFs** for finfish, shellfish, birds, invertebrates, plants, and other organisms.

2. Use approved models to predict tissue concentrations for relevant organisms.

Bioaccumulation of heavy metals or non-polar organic contaminants in fish or other organisms can be predicted from sediment concentrations using equilibrium (e.g. Thomann *et al.*, 1992), fugacity (e.g., Burmaster *et al.*, 1991), or other appropriate models approved by DES.

3. Use direct measurement to determine tissue concentration of contaminants for relevant organisms.

Direct tissue measurement is the most confident approach to determine bioaccumulation in aquatic organisms or aquatic-dependent wildlife. Direct determination can be conducted using either laboratory-exposed or field-collected organisms. For organic contaminants with a $\text{Log } K_{ow} > 6.5$, there is a loss of linear relationship between K_{ow} and bioaccumulation. This results in uncertainty in modeled predictions of biological uptake. For contaminants with $K_{ow} > 6.5$, direct measurement is the preferred method for assessing bioaccumulation.

B. Compare tissue contaminant concentrations with published acute and chronic toxicity values and calculate risk ratios for relevant organisms.

Acute and chronic toxicity values for ecological resources are available in numerous publications and databases. TOXNET (<http://www.toxnet.nlm.nih.gov/>) is sponsored by the National Library of Medicine and contains a cluster of databases on toxicology, hazardous chemicals, and related topics. The USEPA developed ECOTOX (http://www.epa.gov/med/databases/databases_text.html). This database integrates AQUIRE, PHYTOTOX and TERRETOX, which are three databases that contain ecotoxicity information for aquatic life, terrestrial plants, and wildlife, respectively. Sample *et al.* (1996) provides toxicological benchmarks for wildlife. The US Army Corps of Engineers developed the Environmental Residue-Effects Database (ERED) (<http://www.wes.army.mil/el/ered/index.html>). It is a compilation of data from 736 studies published between 1964 and 2001 on the biological effects of many environmental contaminants found in tissues of organisms in which the effects were observed.

Risk ratios are calculated by dividing organism tissue concentrations by appropriate acute and/or chronic toxicity levels. Risk quotients of one or greater indicate the possibility of adverse effect of the contaminant on the organism. This latter outcome may indicate a Surface Water Quality violation and necessitate further action, which may be remediation, restoration, or monitoring, depending on the specifics of the site.

TABLE 1: MATRIX OF RISK CHARACTERIZATION ACCORDING TO THE SEDIMENT QUALITY TRIAD AND BIOACCUMULATION POTENTIAL

Triad Components			Bioaccumulation Potential	Outcome
A. Chemistry	B. Toxicity	C. Benthic Community		
+	-	Not Assessed	Not Assessed	Sediment contaminants are not adversely impacting the benthic community.
+	+ (or not assessed)	-	Not Assessed	Weigh the evidence to characterize risk. If sufficient weight to Component C, the benthic community may still be at future risk for adverse impact due to sediment chemistry, requiring continued monitoring to evaluate future impacts. ¹ Contaminant characteristics do not warrant bioaccumulation assessment.
+	+ (or not assessed)	-	-	Weigh the evidence to characterize risk. If sufficient weight to Component C, the benthic community may still be at future risk for adverse impact due to sediment chemistry, requiring continued monitoring to evaluate future impacts. ¹ Contaminant characteristics warrant bioaccumulation assessment but impact to relevant organisms is not expected.
+	+ (or not assessed)	+ (or not assessed)	Not Assessed	Sediment contaminants at the site are adversely impacting the benthic community. ² Contaminant characteristics do not warrant bioaccumulation assessment.
+	+ (or not assessed)	+ (or not assessed)	-	Sediment contaminants at the site are adversely impacting the benthic community. ² Contaminant characteristics warrant bioaccumulation assessment but impact to relevant organisms is not expected.
+	+ (or not assessed)	+ (or not assessed)	+	Sediment contaminants at the site are adversely impacting the benthic community and bioaccumulation of sediment-associated contaminants has the potential to adversely impact relevant organisms. ²
+	-	Not Assessed	+	Sediment contaminants at the site are not adversely impacting the benthic community, but bioaccumulation of sediment-associated contaminants has the potential to adversely impact relevant organisms. ²

¹ A monitoring plan will be presented to DES for approval.

² This outcome indicates a surface water quality violation and necessitates further action, which may be remediation, restoration, or monitoring, depending on the specifics of the site.

GLOSSARY

BCF – Biological concentration factor; ratio of tissue residue to water column concentration at steady state.

BSAF - Biota-sediment accumulation factor; ratio of tissue residue to sediment concentration at steady state normalized to lipid and sediment organic carbon.

Biomagnification - A special case of bioaccumulation where body burdens of contaminants, normalized to an organisms lipid content, increase at successive, higher levels of an ecosystem's food web.

CB – Consensus-based; geometric mean of thresholds from a variety of sources, providing a more statistically based threshold.

COC - Contaminant of concern.

HQ- Hazard quotient; contaminant concentration divided by screening threshold concentration.

PBTs - Persistent, bioaccumulative, and toxic pollutants.

TEC - Threshold effect concentration; screening thresholds below which adverse effects are unlikely.

PEC - Probable effect concentration; screening thresholds above which adverse effects are likely.

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Approved: _____
Harry Stewart, P. E., Director
Water Division
NH Department of Environmental Services

Date: _____

APPENDIX D
NHDPHS LABORATORY'S
CHAIN OF CUSTODY FORM

APPENDIX E

EXAMPLE OF A SAP OUTLINE

SAP OUTLINE EXAMPLE

All SAPs (QAPP Addendums) prepared for complex State lead site investigations which use this generic QAPP, rather than a contractor's QA program, shall include the following information. See the QAPP text and other QAPP Appendixes for examples of Tables identified here to be included in the SAP

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- 3.2 Surface Water Sampling
- 3.3 Sediment Sampling
- 3.4 Pore Water Sampling
- 3.5 Residential Sampling

4.0 QUALITY CONTROL

- 4.1 Equipment Calibration and Maintenance
 - Table listing equipment, maintenance and frequency
 - Table listing equipment, calibration frequency, calibration standards, calibration acceptance criteria and corrective action
- 4.2 Field Quality Control
 - Table listing QC samples, frequency, acceptance criteria and corrective action
- 4.3 Data Verification and Validation
 - Including Data Usability
- 4.4 Quality Assurance Field Audits
 - Including frequency of internal and external assessments

5.0 DOCUMENTATION

5.1 Field Data Management – Documentation of Field Activities

5.2 Chain-Of-Custody Procedures

5.3 Reports

Specify type, number and contents must include a Quality Assurance/Quality Control Section (statements summarizing whether or not the quality control criteria in the SAP & QAPP were met in the field and in the lab. Listing any QA/QC problems and how they were resolved. Noting anything unusual that will affect the quality or usability of the data.

6.0 REFERENCES (as applicable)

FIGURES

Site Lotus

Map(s) of all sampling locations, including residential sampling locations if appropriate

TABLES

1. Chemicals of Concern, Associated Interim Cleanup Levels and Regulatory Standards Criteria (e.g. AGQS, Drinking Water Standards, Soil Standards etc.)
2. Site Analytes, Regulatory Standards and Lab Criteria (for all compounds tested on site)
3. Media and Laboratory Requirements (Media, Analysis, Test Methods, Containers/Sample Volume, Preservation & Hold Time)
4. Summary of Quality Assurance Samples (Trip Blanks, Duplicates, Equipment Blanks, MSDS)
5. Monitoring Well Construction Information / Monitoring Location Information
6. Sampling Locations and Methods

APPENDIXES

- A. Organizational Chart
- B. Sampling Worksheets
- C. Field Instrument Calibration Log(s)
- D. Chain of Custody Forms
- E. Surface Water Sampling Worksheet

APPENDIX F

EXAMPLE TABLE (SAP TABLE 1) -

SITE ANALYTES, REGULATORY STANDARDS AND LAB CRITERIA

**Example Table:
 Site Analytes, Associated Regulatory Standards and Lab Criteria
 GROUNDWATER**

(There should be one Table for each Media: Groundwater, Surface Water, Sediments, etc)

Test Methods / Analytes	NHDES Ambient Groundwater Quality Standards (AGQS) (Env-Or 600)	Lab Reporting Detection Limits (RDLs)	Lab Method Detection Limits (MDLs)
VOC Full List of Analytes for VOCs (NHDES 8260B)	(µg/L)	(µg/L)	(µg/L)
Site Chemicals of Concern			
Benzene	5	2	0.29
Toluene	1000	2	0.344
Ethylbenzene	700	2	0.22
Xylenes	10,000	2	0.23
MtBE	13	2	0.12
TBA	40	10	1
Naphthalene	20	5	0.62
1,2,4-Trimethylbenzene	330	2	0.28
Ethylene Dibromide by EPA Method 8011			
1,2-Dibromoethane	.05	.02	.01
SVOCs by EPA Method 8270			
Extraction Method 3510	(µg/L)	(µg/L)	(µg/L)
<i>Naphthalene</i>	20	10	5.53
Metals by EPA Method 200.7/200.8	(mg/L)	(mg/L)	(mg/L)
Lead	0.015	0.001	0.00015
Iron	---	0.05	0.002
Manganese	0.84	0.01	0.0009
Arsenic	0.01	0.001	0.00018
Nitrate by LACHAT 10-107-04-1-C	10	0.05	0.002
Sulfate (SO4) by LACHAT 10-511-00-1-A	500	1	0.08

Notes:

"---" indicates no standard was available for the analyte.

APPENDIX G

EXAMPLE TABLE (SAP TABLE 2) -

MEDIA AND LABORATORY REQUIREMENTS

**(MEDIA, ANALYSIS, TEST METHODS, CONTAINERS/SAMPLE VOLUME,
PRESERVATION AND HOLD TIME)**

**Example Table of Media and Laboratory Requirements
(Media, Analysis, Test Methods, Containers/Sample Volume,
Preservation and Hold Time)**

Analytes	Analytical Method	Containers (Type and Size)	Preservation Requirements ³	Maximum Holding Time
Groundwater Samples				
VOCs	NHDES VOC Full List (NHDHHS Lab's 8260B)	3-40 MI VOA ⁽¹⁾	HCL. 4°C +/- 2°C	14 days
SVOCs	Method 8270 Extraction Method 3510	2-1 Liter Amber glass bottles	4°C +/- 2°C	7 days to extract, 40 days to analyze
Total As, Pb, Fe, Mn & Se	EPA Method 200.7 / 200.8	1-500 mL Plastic 150 ml minimum amount	HNO ₃	6 months
Chloride	LACHAT 10-117-07-1-B	1-500 mL Plastic	4°C +/- 2°C	28 days
Nitrate	LACHAT 10-107-04-1-C	150 ml minimum amount		48 hours
Sulfate (SO ₄)	LACHAT 10-511-00-1-A			28 Days
Total Kjeldahl Nitrogen (TKN)	LACHAT 10-107-06-2-E	1-250 mL dark plastic	H ₂ SO ₄ 4°C +/- 2°C	28 Days
Surface Water Samples				
VOCs	NHDES VOC Full List (NHDHHS Lab's 8260B)	3-40 mL VOA	HCL. 4°C +/- 2°C	14 days
Total As, Pb, Fe, Mn & Se, Hardness	EPA Method 200.7 / 200.8	1-500 mL Plastic 150 ml minimum amount	HNO ₃	6 months
Field Parameters for Low Flow and Surface Water Sampling				
Temperature, ORP, Dissolved oxygen (DO), specific conductivity and pH ⁽²⁾	YSI 600XL or 6820 OR QED MP20 Multi- Parameter Water Quality Meter	N/A	N/A	N/A
Turbidity	Hach 2100P Turbidity Meter	N/A	N/A	N/A
Sediment Sampling				
Total As, Pb, Fe & Se, % Solids	EPA Method 200.7 / 200.8	8 oz plastic	4°C +/- 2°C	6 months
Total Organic Carbon (TOC), % Solids	LLOYD KAHN	1-4 oz glass	4°C +/- 2°C	14 days
Field Parameters for Sediment Samples				
A physical description of the sediment sample				

Notes:

- (1) Trip blanks will be included in each cooler containing VOC samples. Trip blanks will include HCL-preserved blanks for Full List VOC samples (2 VOA vials) and unpreserved blanks for 1,4-Dioxane (2 VOA vials) There will be one temperature blank per cooler.
- (2) The field parameters for temperature, ORP, DO, specific conductivity and pH for surface waters will be collected in-situ.
- (3) Note that the pH requirement for all acid preserved samples is less than 2 units.

APPENDIX H
EXAMPLE TABLE (SAP TABLE 4) -
SUMMARY OF QUALITY ASSURANCE SAMPLES

TABLE OF SUMMARY OF QUALITY ASSURANCE SAMPLES EXAMPLE

Sampling Media	Associated Sampling Equipment	Sample ID	Designated NOTE to be used on Chain-of-Custody	Analyses
EQUIPMENT BLANK SAMPLES				
Lab provided DI Water (collected prior to sampling)	DI Water	EQUIP BLANK	“DI Water”	VOCs, SVOCs, Total As, Fe, Mn, Se & Pb, TOC
Groundwater	Water level	EQUIP BLANK	Water Level	VOCs, SVOCs, Total As, Fe, Mn, Se & Pb
Surface Water	Filter and syringe set up for dissolved metals samples	EQUIP BLANK	“Metals Filter/Syringe”	Dissolved As, Fe, Mn, Se & Pb
Surface Water	Glass jar or stainless steel sampling container to collect surface water VOCs	EQUIP BLANK	“SW Container”	VOCs
Pore Water	Pore water samplers	EQUIP BLANK	"Pore Water Sampler"	Total As, Fe, Se & Pb
Sediment	Ponar/Eckman dredge, core device, stainless steel bowl and utensils	EQUIP BLANK	"Sediment Equip"	TOCs, Total As, Fe, Se & Pb
DUPLICATE SAMPLES				
Groundwater	Bladder Pump	GIL_HA-5-A DUP	N/A	VOCs, SVOCs, Total As, Fe, Mn, Se & Pb
Groundwater	Bailer	GIL_T-24-1 DUP	N/A	VOCs, Total As, Fe, Mn, Se & Pb
Groundwater	Barcad	GIL_T-12-4 DUP	N/A	VOCs, 1,4-Dioxane, Total As, Fe, Mn, Se & Pb
Surface Water	N/A	GIL_SWSED-2A DUP	N/A	VOCs, Total As, Fe, Mn, Se & Pb, Hardness, Dissolved As, Fe, Mn, Se & Pb, Hardness
Pore Water	N/A	GIL_PORE-2B DUP	N/A	Total As, Fe, Se & Pb
Sediment	N/A	GIL_SED-4 DUP	N/A	TOCs, Total As, Fe, Se & Pb

TABLE OF SUMMARY OF QUALITY ASSURANCE SAMPLES

Sampling Media	Associated Sampling Equipment	Sample ID	Designated NOTE to be used on Chain-of-Custody	Analyses
LABORATORY MS/MSD SAMPLES				
Groundwater	Bladder Pump Collect a total of four 1-Liter bottles for SVOCs instead of two (This is separate from any duplicate sample)	GIL HA-5-B	“MS/MSD”	SVOCs
TRIP BLANK/TEMPERATURE BLANK SAMPLES				
Aqueous VOCs (1 per cooler with aqueous VOCs samples)	N/A	TRIP BLANK	Identify all Sample IDs associated with Trip Blank in notes section of COC	VOCs
Temperature Blank	N/A	TEMP BLANK	Include in notes section of COC that a temperature blank has been included in the cooler	Temperature

APPENDIX I
CROSSWALK BETWEEN ORCB MASTER QAPP
AND USEPA REQUIREMENTS

Crosswalk between ORCB Master QAPP and USEPA Requirements

USEPA REQUIRED INFORMATION	NHDES QAPP
A1 Title and Approval Page	Title Page and Approval Page (Page 2)
A2 Table of Contents Program Information	Table of Contents (Page 3) 1.0 Introduction (Page 7) 1.1 Overview of Oil Remediation and Compliance Bureau (Page 7)
A3 Distribution List Project Personnel Sign-off Sheet	Distribution List (Page 5) Project Personnel Log Sheet (Appendix H)
A4 Project Organizational Chart / Communication Pathways / Personnel Responsibilities & Qualifications A8 Special Training Requirements / Certification	Program Organization and Responsibility, Organizational Chart (Appendix A) 1.2 Program Organization, Responsibility and Communication Pathways (Page 9) 1.5 Training, Personal Protection and Safety (Page 12)
A5 Project Definition/ Site History and Background Project Planning	Project definition, site description and background information shall be addressed in site specific SAPs
A6 Project Description	1.0 Introduction (Page 7) 1.3 Project Description (Page 10)
A7 Project Quality Objectives	1.4 Quality Assurance Objectives (Page 10)
B1 Sampling Process Design	Sampling process design is site specific and shall be addressed in site specific SAPs
B2 Sampling Procedures Cleaning and Decontamination of Equipment/Sample Containers B7 Equipment Calibration B6 Equipment Maintenance, Testing and Inspection Requirements Sampling Container, Volumes and Preservation	Standard Operating Procedures (Appendix C) 2.2 Sampling Equipment and Decontamination (Page 17) 2.3 Instrument Calibration and Maintenance (Page 18) 2.4 Field Screening Instruments (Page 18) 2.7 Sampling Volume, Containers and Labeling (Page 19) 2.8 Sampling Preservation and Holding Times (Page 19)
B3 Sample Handling, Tracking and Custody Requirements Sample Collection Documentation	2.7 Sample Volume, Containers and Labeling (Page 19) 2.9 Chain of Custody Procedures (Page 19) 2.10 Laboratory Sample Management (Page 20) 1.6 Documentation and Records (Page 14)
B4 Analytical Method Requirements Analytical Methods and SOPs B7 Laboratory Instrument Calibration B6 Laboratory Instrument/ Equipment Maintenance, Testing and Inspection B8 Laboratory Inspection and Acceptance for Supplies	Analytical services shall be provided by laboratories which are currently accredited under the National Environmental Laboratory Accreditation Conference (NELAC) standards and have their own quality assurance manual and standard operating procedures (SOPs) that meet the NELAC standards.
B5 Quality Control Requirements	2.11 Sample Quality Control (Page 21)
A9, B10 Documentation, Records and Data Management	1.6 Documentation and Records (Page 11)
C1 Assessments and Response Actions	1.7 Data Assessment (Page 15) 1.8 Corrective Action (Page 16)
C2 QA Management Reports	See Response to B4 above
D1 Verification and Validation Requirements	See Response to B4 above
D2 Verification and Validation Procedures	See Response to B4 above
D3 Data Usability/Reconciliation with Project Quality Objectives	1.7 Data Assessment (Page 15)

APPENDIX J

ORCB MASTER QAPP PERSONNEL LOG SHEET

(Found only in the original QAPP that is kept with the QA Coordinator)

QAPP Project Personnel Log Sheet

Project Personnel	Position	Signature	Date
Sarah Yuhas Kirn	Administrator		
Margaret Bastien	Supervisor of Petroleum Remediation Section		
Robert Bishop	Supervisor of the Spill Response and Complaint Investigation Section		
Stan Bonis	Hydrogeologist		
David Degler	Environmentalist		
Jason Domke	Environmentalist		
Suzanne Connelly	Environmentalist		
Steven Croce	Civil Engineer		
Thomas Fargo	Hydrogeologist		
Jason Fopiano	Hydrogeologist		
Andrew Fuller	Hydrogeologist		
Andrew Fulton	Hydrogeologist		
Erin Holmes	Civil Engineer		
Eric Johnson	Environmentalist		
David Leathers	Environmentalist		
Jennifer Marts	Hydrogeologist		
Todd Piskovitz	Hydrogeologist		
Joyce Sawicki	Environmentalist		
Jeremy Slayton	Environmentalist		
Zachary Taylor	Environmentalist		
Gardner Warr	Environmentalist		
Christopher Wood	Environmentalist		
Lisa Kammer	Weston		
Jim Ricker	Nobis Engineering		

This form must be signed by ALL ORCB Project Managers that do site work and project personnel along with the contact person for each contractor approved by NHDES to perform work for the ORCB, to indicate that they have reviewed the ORCB Master QAPP and will implement the QAPP as described