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Sampling Guidance for Unknown Contaminants in Drinking Water

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EPA personnel conducting any field activities described in this document must comply with the EPA QA Field Activities Procedure (QAFAP; CIO 2105-P-02) and all other EPA QA policies and requirements. Consult your organization's Quality Management Plan and QAFAP SOPs for guidance.

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Section 1.0 Introduction

This *Sampling Guidance for Unknown Contaminants in Drinking Water* provides comprehensive guidance that integrates recommendations for pathogen, toxin, chemical, and radiochemical sample collection, preservation, and transport procedures to support multiple analytical approaches for the detection and identification of potential contaminants in drinking water. The guidance is intended to support sampling for routine and baseline monitoring to determine background concentrations of naturally occurring contaminants, sampling in response to a contamination event, and sampling in support of remediation or decontamination efforts. The primary intended audience of this guidance document is drinking water utilities, but it may also be a useful reference for emergency response personnel, water teams, and laboratories.

- **Water utilities** – This guidance document can be used to supplement a drinking water utility's emergency response plan (ERP) by providing detailed recommended sampling procedures for use by utility personnel in response to a potential contamination event. The sample collection procedures described may also be used to support monitoring and surveillance activities for specific contaminants or classes of contaminants, in preparation for a potential contamination incident.
- **Emergency responders** – Given the complexity of a drinking water response, the effort may quickly surpass the capabilities of most utilities. In these cases, utilities are likely to call upon emergency responders for support. The information in this document can be used to provide emergency responders with an understanding of water utility responsibilities, capabilities, and sampling activities and analytical needs. Information is also provided to support and encourage communication between utilities, emergency responders, and supporting laboratories.
- **Water teams** – Depending on the incident type/size and response role type/size, a U.S. Environmental Protection Agency (EPA) regional water team may become involved (generally at the request of the state). Water team members include regional water and wastewater program staff and other subject matter experts, some of whom are trained in field response. The procedures described in this document provide the water teams with guidance for the collection, preservation and transportation of samples to support detection and identification of potential contaminants in drinking water. This information should also support communication between water teams and utilities, emergency responders, and supporting laboratories.
- **Laboratories** – By understanding the role of sampling and analysis, utilities can better plan what analytical capabilities they should use, and when. For example, a utility may elect to use an in-house laboratory and suite of methods for baseline monitoring or during the early phases of contaminant investigation, but choose to use partner laboratories during remediation and recovery phases of confirmed contamination when the sample load might exceed in-house capacity. A utility might also use a laboratory partner for confirmation of a suspected contaminant or for highly specialized analyses such as chemical warfare agents (CWAs) or select pathogen agents. The information in this document should assist with establishing coordination between sample collectors and laboratories, to ensure collected samples are sufficient to meet the analytical needs of the laboratory.

The specific sampling procedures and information described in this document are provided as guidance and may be leveraged and modified to meet the analytical objectives, scope of event preparedness, or an actual sample collection event. For example, a subset of the sampling procedures could be used to collect samples targeting one or several contaminants while the entire suite of sampling procedures could be used in situations where the presence or nature of the suspected contaminant(s) is unknown. This document also provides guidelines for the development and training of effective and responsive sampling teams. Recommendations for establishing appropriate communication and support networks, information management systems, site characterization procedures, field screening and testing procedures, and personnel safety and protection are included to support the integrated monitoring and surveillance activities of water utilities.

The model presented here to guide sample collection activities in preparation for and following a contamination incident is derived from *Module 3: Site Characterization and Sampling Guide,* of EPA's *Response Protocol Toolbox (RPTB)* (USEPA, 2003). This document is available at https://www.epa.gov/waterutilityresponse/module-3-site-characterization-and-sampling-guide-drinking-water-utilities. The recommendations and suggestions provided are not mandated, and capabilities of water utilities are expected to vary. Many small and medium sized utilities will not have the resources to implement most of the measures discussed in this guidance. To increase preparedness, these utilities should take initial steps to prepare for a contamination incident, including:

- Become aware of and understand the response capabilities of the utility.
- Contact local Hazardous Materials (HazMat) response units, and familiarize them with the layout and procedures of the utility.
- Research the capabilities of the local laboratories.
- Become aware of the resources offered for emergencies by the Centers for Disease Control and Prevention (CDC) Laboratory Response Network (LRN) and EPA's Environmental Response Laboratory Network (ERLN) and Water Laboratory Alliance (WLA), as well as other members of the Integrated Consortium of Laboratory Networks (ICLN).
- Conduct tabletop exercise(s) to determine how the utility would respond to a variety of contamination scenarios with the resources at hand. Invite representatives from the local HazMat response unit to these exercise discussions. Ask for their recommendations, and establish lines of communication for use during a response. Information regarding planning a tabletop exercise can be found at https://www.epa.gov/waterresiliencetraining/develop-and-conduct-water-resilience-tabletop-exercise-water-utilities.

1.1 Additional Related Guidance and Information

The Public Health Security and Bioterrorism Preparedness and Response Act of 2002, amended the Safe Drinking Water Act (SDWA, see https://www.epa.gov/laws-regulations/summary-safe-drinking-water-act) by adding, among other requirements, requirements for community water systems serving populations greater than 3,300 to conduct a vulnerability assessment and either prepare or revise an ERP that incorporates the results of the assessment. The ERP must include "plans, procedures, and identification of equipment that can be implemented or utilized in the event of a terrorist or other intentional attack" on the community water system, and must also include "actions, procedures, and identification of equipment which can obviate or significantly lessen the impact of terrorist attacks or other intentional actions on the public health and the safety and supply of drinking water provided to communities and individuals" (https://www.gpo.gov/fdsys/pkg/PLAW-107publ188/pdf/PLAW-107publ188.pdf). In 2004, Homeland Security Presidential Directive 9 (HSPD 9) directed the EPA to demonstrate an effective system for timely detection and appropriate response to drinking water contamination incidents that would have broad application to the nation's drinking water utilities. Below are additional resources to assist utilities with developing ERPs and responding to potential contamination incidents:

- EPA's Water Quality Surveillance and Response System (SRS) – An SRS provides a systematic framework for enhancing distribution system monitoring activities and using the collected information to better manage the system. One application of an SRS is for detection and response to natural, accidental, and intentional contamination incidents. Additional information on design and implementation of an SRS is available at https://www.epa.gov/waterqualitysurveillance. An SRS has two response components: Consequence Management and Sampling and Analysis.

  - Consequence Management (CM) - Consists of actions taken to plan for, investigate, respond to, and recover from drinking water contamination. To learn more about developing a Consequence Management Plan for responding to distribution system contamination refer to: https://www.epa.gov/sites/production/files/2015-06/documents/consequence_management_primer.pdf
  - Sampling and Analysis (S&A) – S&A is one of the earliest utility-led response actions to confirm or rule-out contamination. To learn more about building field and laboratory capabilities for responding to contamination threats and incidents refer to: https://www.epa.gov/sites/production/files/2015-06/documents/sampling_and_analysis_primer.pdf

- EPA's Water Security Initiative (WSI): Guidance for Building Laboratory Capabilities to Respond to Drinking Water Contamination – Provides planning guidance for water utilities on identifying contaminants, methods, and laboratories for responding to intentional threat contaminants. This guidance is available at: https://www.epa.gov/sites/production/files/2015-06/documents/guidance_for_building_laboratory_capabilities_to_respond_to_drinking_water_contamination.pdf
- All-Hazard Consequence Management Planning for the Water Sector (CMP) – Describes how drinking water and wastewater utilities can incorporate all-hazard consequence management concepts into their existing emergency preparedness, response, and recovery planning. It also provides customizable lists of preparedness, response, and recovery actions that should improve resiliency across all hazards. The document is available at https://www.epa.gov/waterutilityresponse/develop-or-update-drinking-water-or-wastewater-utility-emergency-response-plan or http://www.awwa.org/legislation-regulation/issues/utility-security.aspx.
- Homeland Security Exercise and Evaluation Program (HSEEP) – Exercises allow homeland security and emergency management personnel to train and practice prevention, protection, response, and recovery capabilities, and are a valuable tool for assessing and improving performance. The intent of HSEEP is to provide common policy and program guidance as a national standard for all exercises. Access to HSEEP information can be found at https://www.fema.gov/media-library/assets/documents/32326.

1.2 Document Organization

The remaining sections of this document describe the following aspects of collecting drinking water samples to be analyzed for unknown contaminants:

- **Section 2.0: Overview of Sampling Approach.** This section presents an overview of the activities that should be performed during sample collection.
- **Section 3.0: Utility Roles and Responsibilities.** This section presents an overview of the roles and responsibilities that drinking water utilities should have in place to establish appropriate sampling capabilities and procedures.
- **Section 4.0: Safety and Personal Protective Equipment.** This section provides general guidelines on the use of personal protective equipment (PPE) for sampling teams**.**
- **Section 5.0: Preparation for Sample Collection Activities.** This section presents an overview of the quality assurance/quality control (QA/QC) samples that should be used for sample collection.
- **Section 6.0: Sample Collection Documentation.** This section describes sample collection documentation that should be completed before and during the sampling procedure.
- **Section 7.0: Sample Collection Procedures.** This section describes recommended sample collection procedures.
- **Section 8.0: Sample Packaging and Shipment.** This section describes recommended packaging and shipping procedures for sample containers.

Section 2.0 Overview of Recommended Sampling Approach

This document is provided as guidance to outline an ideal level of preparedness for a sample screening and collection response. Depending on the capabilities of the utilities, the responses to specific events could vary. Guidance provided in this document is intended to prepare utilities for an overall sampling approach by:

- defining sampling capabilities for pathogen, chemical, toxin, and radiochemical analytes,
- developing on-site sample screening capabilities,
- establishing sampling team requirements, such as personnel, training, etc.,
- establishing a laboratory support network and chain of communication for the sampling teams,
- establishing baseline contaminant occurrence and method performance data for pre-defined field and laboratory methods, and
- establishing an information management system.

After a potential contamination incident has been identified, a site characterization should be conducted to obtain samples and other evidence to help determine the level of threat. Site characterization activities include the site investigation, field safety screening, rapid field testing of the water, and sample collection. The investigation site is the focus of site characterization activities and is the location where it is suspected that the contaminant was introduced into the system. In addition to the investigation site, other sampling sites potentially impacted by contamination might be identified, if it is suspected that the contaminant might have spread.

The type of containers, sample size, preservation and holding time requirements, and shipping requirements are specific to each type of contaminant and are often provided in the analytical methods that will be used by the laboratory receiving the samples. Figure 2-1 provides a conceptual flow chart of the sampling process once a potential pathogen, chemical, toxin, and radiochemical contamination occurs. Basic screening refers to the use of routine methods or techniques to screen samples for unknown contaminants; expanded or exploratory screening refers to the use of methods or techniques that may not be used routinely. Samplers should work with identified receiving laboratories to determine these requirements prior to initiating sampling activities.

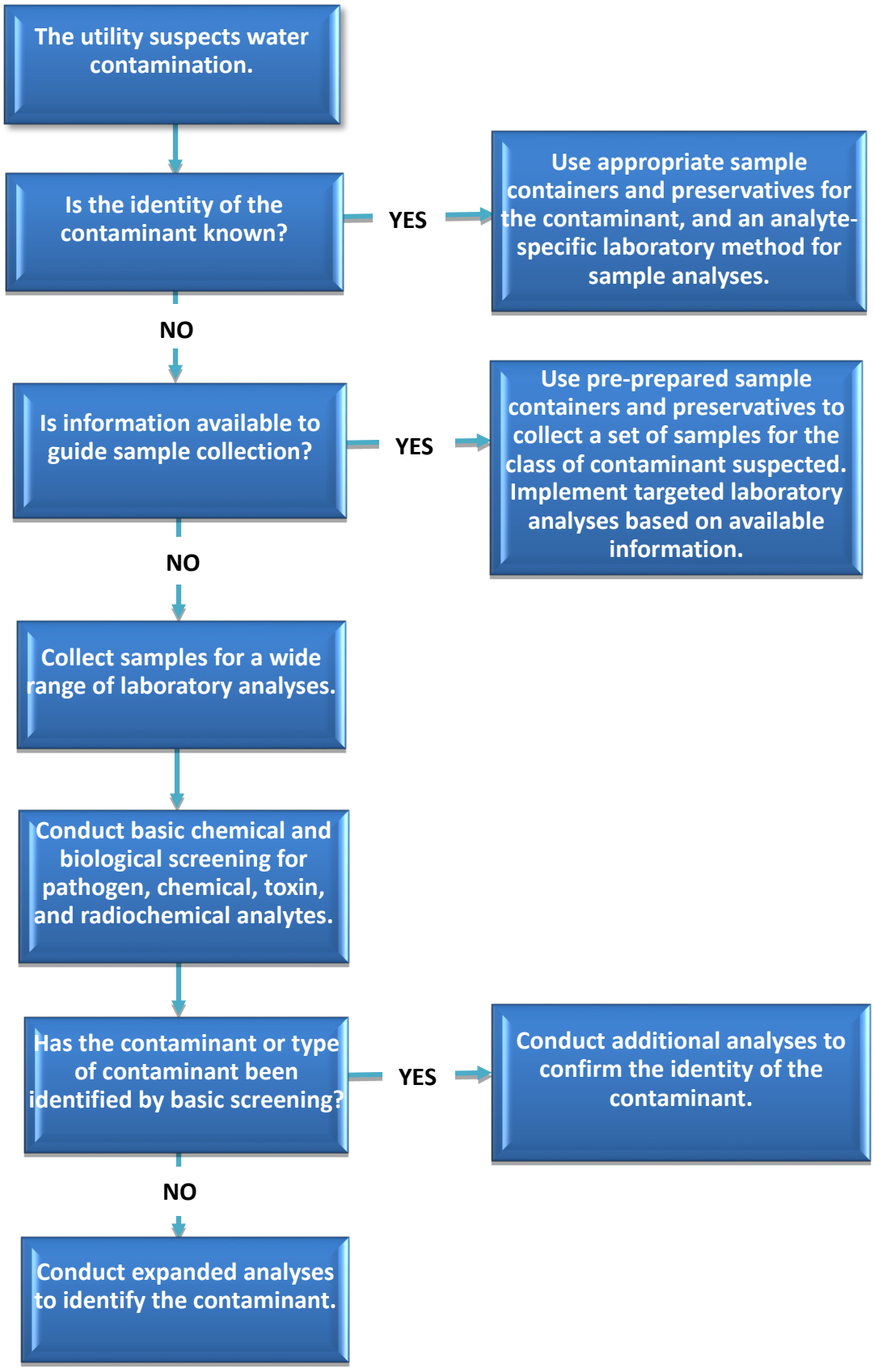
The objective of sampling from the site of a suspected water contamination event is to preserve a sample of the water at a particular time and location, such that it can be analyzed if deemed necessary. To do this effectively, an initial sampling plan should be developed prior to sample collection activities.

Field activities can be practiced during routine or baseline sampling. Baseline sampling is a constructive exercise for utilities to undertake in order to understand the range of contaminants that exist in the drinking water under normal operations.

Below are some resources that could assist utilities in conducting rapid screening and preliminary identification of contaminants:

- Rapid Screening and Preliminary Identification Techniques and Methods – Companion to Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM), Revision 5.0. Available at https://www.epa.gov/homeland-security-research/rapid-screening-and-preliminary-identification-techniques-and-methods.
- Selected Analytical Methods for Environmental Remediation and Recovery (SAM) - some of the laboratory approaches for toxin analysis listed may be appropriate for field use, e.g. lateral flow devices. Available at: https://www.epa.gov/homeland-security-research/sam
- SAM Companion Documents and Sample Collection Procedures - provides analyte-specific sample collection information Available at: https://www.epa.gov/homeland-security-research/sam-companion-documents-and-sample-collection-procedures

Figure 2-1. Recommended Decision-Making Process for Analyses of Unknown Contaminants in Drinking Water



Section 3.0 Utility Roles and Responsibilities

Drinking water utilities are strongly encouraged to establish appropriate and standardized sampling capabilities and procedures. Ideally, each utility should have "in-house" sampling teams that should be capable of collecting and providing samples to the appropriate analytical laboratory for baseline contaminant monitoring and in response to an event. The following sections provide guidelines to assist utilities in the preparedness planning, implementation and integration of these critical response elements.

3.1 Defining Sampling Requirements: Capabilities and Capacity

In preparation for baseline contaminant monitoring and response to an event, the utility should evaluate its sampling capabilities to ensure that all required sample collection activities can be performed. The utility manager should evaluate sampling capacity to ensure that adequately trained personnel and sufficient sampling equipment are available. Ideally, a utility may wish to respond only with its own personnel to a suspected contamination. If there is evidence or information suggesting a harmful contamination, discovery of HazMat conditions, or a possible threat to the life of the utility personnel, the utility should request a trained HazMat emergency response team. Ideally, the utility ERP should include pre-established lines of communication with the HazMat emergency response team. HazMat may also be accessed via a 9-1-1 call, but pre-establishing communication with HazMat may enable HazMat to better understand the particular needs associated with water contamination.

3.1.1 Sampling for Baseline Monitoring

Once standardized sampling capabilities and procedures are in place, the utility should focus on establishing a utility-specific profile or baseline levels of contaminants, standard chemical parameters (chlorine, pH, oxidation reduction potential [ORP], etc.), and radiological activity. This baseline profile is critical to distinguish background or naturally occurring levels of each contaminant from higher levels that may be observed following a contamination incident. For many contaminants, the baseline is expected to be below the detection limit of the corresponding analytical methods.

To address spatial and temporal variables within the treatment and distribution systems, baseline monitoring should involve the collection and analysis of multiple types and numbers of samples.

Baseline monitoring should use the same sample collection and analysis procedures that would be used in an event. This way, the utility should have an idea of what the analytical results for drinking water are under normal conditions. This should eliminate unnecessary suspicion during an event for low level detections that are seen regularly. Baseline monitoring can also serve as practice for the sampling teams and the utility's network of laboratories, so investigation of potential contamination incidents should go more smoothly.

Baseline monitoring may be either a very extensive activity, or a simple evaluation of data that the utility normally collects. Naturally, the more extensive the baseline monitoring, the more confidence the utility should have when evaluating data during a response event. EPA drinking water methods using mass spectrometry are routinely used for drinking water compliance monitoring (e.g., Methods 200.8, 524.3 and 525.3). Some of these methods can tentatively identify contaminants that are not included in the calibration standards. In this case, the laboratory may wish to obtain an authentic standard of the contaminant in order to enable it quantitative, quality controlled analysis. This may be beneficial to avoid a false negative or false positive detection during response to a contamination incident.

3.2 Sampling in Response to a Contamination Incident

Adaptation of routine sampling and analysis procedures is important if there is a potential hazard present. If the site is characterized as having levels of contamination that are above a low hazard level, a HazMat response team should be available to continue the site characterization activities. The level of PPE and field screening may need to be increased, and all sampling and analysis may become evidence in a future

case. These issues are discussed in Sections 4 and 5. In addition, sampling teams responding to a potential contamination event should be trained and equipped to characterize the site, perform on-site hazard screening using available field-test kits, collect samples, and prepare samples for transport. These functions are similar to those normally provided by a HazMat response team, and utility managers are encouraged to coordinate with local HazMat resources to provide training and support during a contamination incident because HazMat teams will otherwise probably not be familiar with utility needs or specifics involving water samples. Utilities may benefit from establishing relationships with and understanding the capabilities and responsibilities of federal or state HazMat operations that are located nearby. Additionally, states may also have response teams that are part of the state's department of health. These relationships and understanding can facilitate response coordination, and increase preparedness. For example, any utility located near one of the EPA's Environmental Response Team (ERT) offices may want to establish relationships with the office. Utilities also may want to understand and become familiar with the National Response Center within the National Response System (NRS). Information regarding the NRS can be found at https://www.epa.gov/emergency-response/national-response-system.

3.3 Sampling Team Preparation

Sampling teams should be familiar with the utility's operation, including the treatment plant and distribution system, and the utility manager should ensure that sampling teams are continually updated on any changes in facility design or distribution. Sampling teams should be familiar with the utility's ERP, and any other contingency plans that may assist the team in developing an effective sampling strategy. Sampling teams should be familiar with the sample collection kits, sampling techniques and associated activities presented in this document and should use these during all sampling activities. Sampling teams should contact the support laboratory if assistance with sample collection kits is needed. Each drinking water utility should determine the extent of site characterization capabilities that should be performed by either the sampling team or by an external organization. A drinking water utility may choose to develop capabilities for performing site characterization and core field testing in cases where a low hazard exists, but should make arrangements with HazMat responders to provide support during the characterization of a potentially hazardous site. It is critical that the utility plans for in-house site characterization activities and makes arrangements with those agencies that would be called upon in the event that a situation exceeds the utility's resources and capabilities. All utilities should conduct field drills, ideally with local HazMat or other local emergency response resources, to become efficient in carrying out their ERPs.

3.4 Defining Analytical Support Requirements: Capabilities and Capacity

It is critical that utilities evaluate their internal analytical capabilities and incident response capacity. Some contaminants (select pathogen agents and toxins, chemical warfare agents, and radiochemicals) should be analyzed by qualified laboratories using specialized or restricted analytical methods. It is important that utilities are familiar with analytical support networks. They are encouraged to look into the resources offered by EPA's ERLN and WLA, such as the WLA Response Plan (WLA-RP), as well as other members of the ICLN including the CDC LRN. Information regarding the WLA-RP, which provides the Water Sector with a structure for a systematic, coordinated response to water contamination incidents, can be found at https://www.epa.gov/waterlabnetwork/water-laboratory-alliance-response-plan. More information about the WLA can be found at: https://www.epa.gov/waterlabnetwork. Internal and external analytical support networks should be in place and operational prior to initiating any baseline sampling and analysis activities and in preparation for an event.

3.4.1 Establishing Analytical Support Networks

Establishing a support network of laboratory analytical capabilities and capacity helps ensure that samples can be processed properly and expeditiously. To assist in locating laboratories capable of providing the necessary support, the EPA's Compendium of Environmental Testing Laboratories (Laboratory

Compendium) provides users with real-time data related to laboratory contact, capability and capacity information, and ERLN/WLA Membership status, through a secure, web-based tool. The Laboratory Compendium is available to federal, state, and local emergency response, laboratory and water utility personnel. Access is secured through an application process at https://cfext.epa.gov/cetl.

Utilities may be able to access support for collection and analysis of samples through mutual aid and assistance agreements with other utilities. If the utility is part of a Water/Wastewater Agency Response Network (WARN), they should reach out to other utilities within their WARN to determine the capability of these utilities to support their request. In order to standardize the method of requesting support through the WARNs, the American Water Works Association (AWWA) has developed the Water & Wastewater Mutual Aid & Assistance Resource Typing Manual (AWWA, 2008). More information about WARN can be found at http://www.awwa.org/resources-tools/water-knowledge/emergency-preparedness/warn-resources.aspx and https://www.epa.gov/waterutilityresponse/mutual-aid-and-assistance-drinking-water-and-wastewater-utilities. For WARN contacts, see http://www.awwa.org/resources-tools/water-knowledge/emergency-preparedness/water-wastewater-agency-response-network.aspx.

Each EPA Region maintains an EPA regional laboratory, which may be able to analyze samples or help identify potential analytical support. Access the list of EPA regional laboratory contacts at https://www.epa.gov/emergency-response/erln-regional-labs-contact-information.

LRN laboratories have response teams available 24 hours a day/7 days a week/365 days a year who may be able to assist with sample collection needs after routine business hours. Usually the closest LRN laboratory should be the state's Department of Health laboratory; also, consider contacting the local public health laboratory. For more information, CDC can be contacted at (800) CDC-INFO, (888) 232-6348 (TTY) or www.cdc.gov/info. More information on the LRN is also available at: https://emergency.cdc.gov/lrn/. Another resource for state laboratory contact information is maintained by Association of Public Health Laboratories (APHL) at https://www.aphl.org/membership/Pages/memberlabs.aspx.

EPA Headquarters may also be able to provide help in identifying support for analysis and collection of samples. The ERLN/WLA Helpline may be reached at (703) 461-2400, Monday-Friday from 8:30 AM to 5:00 PM ET, except for federal holidays. The WLA may also be reached at WLA@epa.gov. Outside of regular business hours, the EPA Emergency Operations Center (EOC) Hotline may be reached at (202) 564-3850.

3.4.2 Coordinating with Analytical Support Networks

Once appropriate analytical laboratory support has been identified, it is imperative to establish a chain of communication between and among the utility and the supporting laboratories. The WLA-RP provides a mechanism to coordinate and communicate between the utility and laboratories to meet the analytical needs. The WLA-RP addresses relevant issues such as sample brokerage, analytical methods selection, and secure data transfer. The WLA-RP document and an associated online training module may be found at https://www.epa.gov/waterlabnetwork/water-laboratory-alliance-response-plan. Also, WLA-RP Appendix C, Help Sheet for Requesting Analytical Support during an Emergency Response, here https://www.epa.gov/sites/production/files/2015-08/documents/water_laboratory_alliance_response_plan.pdf is designed to help communications by ensuring all critical information is exchanged.

Support laboratories should be consulted regarding specific sample collection, container, volume, preservation, holding time, and shipping requirements. In some cases, support laboratories should train sampling teams in specialized sample collection procedures (e.g., ultrafiltration). The support laboratory may also provide the utility with, or assist with the preparation of, sampling kits to ensure that the samples are properly prepared and preserved for the required analyses, including for sampling unknown or tentatively identified contaminants. It is important to follow specific laboratory requirements because this may impact the quality of the analytical results. Additional information regarding collection of samples for specific chemical, radiochemical, toxin, or pathogen contaminants also can be found in

EPA's SAM Companion Sample Collection Information Documents at https://www.epa.gov/homeland-security-research/sam-companion-documents-and-sample-collection-procedures. Depending on the method and incident, laboratories might request specific quality control (QC) samples, perhaps in addition to any specified in the method, and may require specific chain of custody (COC), notification, and shipping procedures. Information regarding COC techniques can be found at the WLA Training Center https://www.epa.gov/waterlabnetwork/water-laboratory-alliance-training-center.

3.5 On-site Sample Screening Capabilities (Field Kits and Procedures)

Prior to initiating any sampling activities, each utility should evaluate their on-site sample screening capabilities. Sample screening procedures should be well defined and specific protocols should be established for use by appropriately trained personnel prior to sample screening. More specific detail on sample screening procedures is located in Section 5.2 of this document. EPA's Response Protocol Toolbox (RPTB), Module 3: Site Characterization and Sampling Guide at https://www.epa.gov/waterutilityresponse/module-3-site-characterization-and-sampling-guide-drinking-water-utilities (USEPA, 2003) should also be referenced for guidance related to on-site sample screening parameters. Additional information on preliminary screen and identification is provided at https://www.epa.gov/homeland-security-research/rapid-screening-and-preliminary-identification-techniques-and-methods.

3.5.1 Baseline Monitoring/Routine Monitoring: On-site Screening

During baseline or routine monitoring, sample screening should provide laboratories with information regarding conditions in the environment and the water quality at the time of the sampling event. Screening activities may include the use of instrumentation or equipment to measure water quality parameters (e.g., pH, conductivity, chlorine residual, hardness, and temperature that may indicate the presence of harmful contaminants or substances or conditions that may interfere with analyses. Screening may also include establishing a utility-specific profile or baseline levels of radiological contaminants.

3.5.2 Incident Monitoring: On-site Screening

During an event, water quality parameters should be measured after a site characterization has been performed (EPA RPTB, Module 3) and after it has been determined that it is safe to enter the site. The information provided by field test results can be valuable in making decisions early in the response to a contamination threat, particularly during the transition from the "possible" to the "credible" stage. Results from the on-site screening can also be used to refine the sampling plan.

Assuming that the threat has not been dismissed as "not credible" upon completion of the on-site investigation, samples should be collected as a precaution such that they are available for analysis if necessary. Negative field test results are not a good reason to forgo sampling at this stage, because field testing is limited in scope and there is a potential for false negative results. The decision to send samples to a laboratory for analysis should be based on the outcome of the entire threat evaluation, including site assessment, evidence evaluation, and sample screening. Specifically, if a threat is determined to be "credible," samples should be immediately delivered to the laboratory for analysis.

Section 4.0 Safety and Personal Protective Equipment

Disclaimer: EPA is including this section on safety and PPE for general informational purposes. For up-to-date information and more specific details about safety and PPE requirements and recommendations, please refer to the Occupational Safety and Health Act and implementing regulations, directives, and guidance found at https://www.osha.gov/.

Utilities are not expected to handle a contamination incident on their own when hazardous materials are believed to be present in high concentrations. However, they are expected to coordinate closely with local HazMat response teams. If there is evidence or information suggesting the presence of harmful contamination, then there is a possible threat to the life or safety of utility, first responder, and remediation personnel. The utility should request a trained HazMat emergency response team. Ideally, the utility ERP should include pre-established lines of communication with the HazMat emergency response team. However, in most situations, contacting the local or state emergency operations center (or equivalent) or calling 9-1-1 should also work, but may result in less effective interactions with HazMat if communications are not established in advance. Such advance planning should lead to a better understanding by HazMat of utility expectations and needs.

Utilities also are encouraged to establish relationships with any nearby EPA ERT offices within EPA's emergency response programs, which are well versed in Occupational Safety and Health Administration's (OSHA) Hazardous waste operation and emergency response regulations at 29 CFR 1910.120.

The information in this section is provided to introduce utilities to HazMat safety considerations. It does not necessarily represent expected or required capabilities on the part of the utility. Many utilities do not have personnel trained in hazardous waste operations and emergency response (HAZWOPER; 29 CFR 1910.120). Utilities without (a sufficient number of) HAZWOPER-trained personnel should focus on collaboration with local HazMat response units. Some material in this section (e.g., Level A and B PPE, confined space entry, etc.) should not be attempted by personnel who are not trained to 29 CFR 1910.120 requirements. HazMat response units should receive a level of training that far exceeds the material covered in this section. As previously stated, the information in this section is provided to introduce utilities to HazMat safety considerations.

Proper safety practices are essential to minimize the risks to the site teams and should be established prior to an incident. Training for all team members should conform to appropriate regulations, such as OSHA's Hazardous waste operations and emergency response regulations, 29 CFR 1910.120. PPE for a low level contamination should consist at a minimum of safety gloves, safety glasses with side shields, covering of extremities, and safety shoes. Additional levels such as clothing protection and respiratory protection may also be necessary but require additional training, and may require that a specialized program be present (e.g., for some types of respirators). All PPE should be treated as contaminated until the sample results are known.

The level of personal protection necessary to perform site characterization or other activities should depend on the assessment of site hazards that might pose a risk to the site characterization team. The results of the field safety screening and initial site evaluation should be used to assess the site hazards, and are intended to confirm the absence (or presence) of certain acute hazards prior to site entry.

The sampling team should follow good safety practices, including:

- Do not eat, drink or smoke at the site.
- Do not smell or taste the water sample.
- Avoid contact with the sample or water flow.
- Minimize volatilization or aerosolization of contaminants into the air.
- Minimize contact time with expected contamination by proper and efficient assessment and sampling.
- Conduct response at sites using proper hazards signs and properly trained personnel and equipment, such as HazMat teams, EPA (or other federal) OSCs, or other hazardous material response support.

This section provides some general guidelines in the use of PPE that are typically followed by HazMat Response Teams, and are recommended for sampling environmental material in response to an unusual or suspicious contamination event. This section also provides summary information regarding the types of hazards that should be considered.

4.1 Personal Protective Equipment

The level of PPE used should be determined by the level of potential risk associated with the respective incident as assessed by the utility management, including the utility health and safety plans. Most utilities have only the basic Level D PPE available for use by their staff, and are therefore expected to coordinate sample collection with local HazMat units, who would arrive in response to an incident requiring higher levels of PPE. Specific guidance for selection of additional PPE is provided in Appendix B to 29 CFR 1910.120. Factors that should be considered during selection include: contaminant identification, routes of exposure (e.g., inhalation, skin absorption, ingestion, and injection), performance of PPE in protecting against exposure, activity duration, and stress induced by work requirements. Because the use of PPE can also cause hazards to workers (e.g., heat stress, impaired vision and mobility), care should be taken to provide a level of protection that is sufficient to prevent exposure yet is not too high so as to create other unnecessary hazards.

The following information about PPE is quoted directly from Appendix B to 29 CFR 1910.120:

Part A. Personal protective equipment is divided into four categories based on the degree of protection afforded. (See Part B of this appendix for further explanation of Levels A, B, C, and D hazards.)

I. *Level A*—To be selected when the greatest level of skin, respiratory, and eye protection is required. The following constitute Level A equipment; it may be used as appropriate;

1. Positive pressure, full face-piece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH).
2. Totally-encapsulating chemical-protective suit.
3. Coveralls.[1]
4. Long underwear.[1]
5. Gloves, outer, chemical-resistant.
6. Gloves, inner, chemical-resistant.
7. Boots, chemical-resistant, steel toe and shank.
8. Hard hat (under suit).[1]
9. Disposable protective suit, gloves and boots (depending on suit construction, may be worn over totally-encapsulating suit).

II. *Level B*—The highest level of respiratory protection is necessary but a lesser level of skin protection is needed. The following constitute Level B equipment; it may be used as appropriate.

1. Positive pressure, full-facepiece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls and long-sleeved jacket; coveralls; one or two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.[1]
4. Gloves, outer, chemical-resistant.

[1] Optional, as applicable.

5. Gloves, inner, chemical-resistant.
6. Boots, outer, chemical-resistant steel toe and shank.
7. Boot-covers, outer, chemical-resistant (disposable).[1]
8. Hard hat.[1]
9. [Reserved]
10. Face shield.[1]

III. *Level C*—The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air purifying respirators are met. The following constitute Level C equipment; it may be used as appropriate.

1. Full-face or half-mask, air purifying respirators (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.[1]
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots (outer), chemical-resistant steel toe and shank.[1]
7. Boot-covers, outer, chemical-resistant (disposable).[1]
8. Hard hat.[1]
9. Escape mask.[1]
10. Face shield.[1]

IV. *Level D*—A work uniform affording minimal protection: used for nuisance contamination only. The following constitute Level D equipment; it may be used as appropriate:

1. Coveralls.
2. Gloves.[1*]
3. Boots/shoes, chemical-resistant steel toe and shank.
4. Boots, outer, chemical-resistant (disposable).[1]
5. Safety glasses or chemical splash goggles.[1*]
6. Hard hat.[1]
7. Escape mask.[1]
8. Face shield.[1]

[1] Optional, as applicable. *Although according to Appendix B to 29 CFR 1910.120, gloves and safety glasses are optional, their use during sampling is highly recommended.

4.2 Health and Safety Plans

Health and Safety Plans (HASPs) and the required level of PPE that should be used to collect samples during an emergency response will vary depending on the site, the response event, and the responsible organization. The purpose of these plans is to ensure maximum protection to workers, the environment, and surrounding communities, in a way that is consistent with requirements needed to perform operational activities.

When collecting samples that potentially contain unknown pathogen, chemical, or radiochemical hazards, responders should follow the HASP that is specific to their organization or to the event. HASPs should include, at a minimum, instructions and guidelines regarding:

- Names, positions and contact information of key personnel and health and safety personnel
- Site or event-specific risk analysis
- Training requirements for specific events
- PPE on site and usage requirements
- Medical surveillance requirements (maintain confidential documents properly and securely)
- Contact information and location of the nearest medical facility; directions (and map) to the facility
- Site or event control
- ERP
- Entry procedures
- Spill containment
- Decontamination procedures.

In the case of emergency response, these plans also should ensure protection of potential evidence, criminal or forensic (see discussion in Section 5.4).

4.3 Confined Space Entry

Many utility infrastructures contain areas that qualify as confined spaces. OSHA defines a confined space as having "…limited or restricted means for entry or exit, and it is not designed for continuous employee occupancy (https://www.osha.gov/SLTC/confinedspaces/index.html). Confined spaces include, but are not limited to underground vaults, tanks, storage bins, manholes, pits, silos, process vessels, and pipelines. OSHA uses the term 'permit-required confined space' (permit space) to describe a confined space that has one or more of the following characteristics: contains or has the potential to contain a hazardous atmosphere; contains a material that has the potential to engulf an entrant; has walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant; or contains any other recognized safety or health hazard, such as unguarded machinery, exposed live wires, or heat stress."

One of the greatest risks associated with confined spaces is that the entrant will be working in an area that does not have a sustainable atmosphere for life. This could be due to very poor ventilation, displacement of oxygen by another gas, or a poisonous/corrosive atmosphere. "Permit-required confined spaces" (29 CFR 1910.146) outlines entry requirements. Training regulations for persons entering confined spaces are contained in 29 CFR 1910.146(g). Confined space training is commercially offered as a 12-hour training course. The training ensures that personnel entering confined spaces are aware of the ventilation and air monitoring requirements necessary for entering confined spaces.

4.4 Personal Safety Considerations

The following general guidelines should be considered and followed by first responders and sample collectors in the aftermath of an event that may involve pathogen or chemical agents:

- Stop and assess the situation
- Contact the appropriate trained personnel
- Remove all non-essential personnel from exposure but do not allow them to leave the site
- Wear appropriate PPE
- Approach the site upwind of the suspected source or contamination area
- Handle contaminated materials with minimum manipulation
- Maintain decontamination and contamination free zones properly
- Contain all contaminated PPE and sampling equipment for disposal or decontamination.

This guidance is general, and site-specific procedures should be followed on a case-by-case basis.

4.5 General Safety Guidance

The following general guidelines should be considered and followed prior to sample collection (Note: this pertains to sampling in response to an incident, not routine sampling):

- It is recommended that at least two personnel be involved in sample collection. The primary sampler has control of the sampling activity and is responsible for physical sample collection, filling the containers, and cleaning the outside of the containers. The second sample collector or technician is responsible for labeling, packaging, record keeping and communication with the personnel outside of the contaminated area. If site geography or the contamination warrants, a third person with the sole task of record keeping should accompany the sampling team. This third party should carry any cameras and should stay in frequent radio communication with others outside of the contaminated area.
- Be aware of potential safety hazards associated with ignitable or explosive environments. Equipment that could potentially be a source of ignition (i.e., cell phones, cameras, radios, etc.) should not be used in these areas.
- Review any available information regarding the site or contamination event to determine if any additional equipment or PPE is needed. It is better to be prepared than to risk exposure to the sampling team.
- Note the full extent of the contamination area including whether the contamination is general or concentrated in areas. If possible, note the migration or potential routes of the contamination.
- Assemble more sampling kits than are expected to be needed. Sampling kits are composed of a sealable bag with the required container(s), documentation forms, storage and transport containers, decontamination materials, and sample collection equipment.
- Complete the sample container labels as much as possible prior to sample collection. A label should be attached to every container and outermost containment bag/container to assist in easy collection. This pre-sampling organization is significantly easier and less time consuming to do while in the comfort of an office, staging location, or vehicle than while sampling in PPE in the field.
- At a minimum, wear safety glasses and two pairs (layers) of nitrile gloves over regular safety equipment. Only the outer gloves need to be changed between each sample as long as the inner gloves remain clear of all contamination. Proper safety practices should always be observed. Potable water should be carried to rinse contamination from skin or eyes.
- Leave the sampling kits at the perimeter of the contaminated area, on the clean side of the contaminated area, preferably in the decontamination area. Sample containers should be treated as requiring custody to eliminate the potential for inadvertent or criminal external contamination, and

should not be left unsupervised. Radio contact should be maintained with someone outside of the contaminated area. This contact provides safety and can assist in identifying the hazard(s) by relaying information to additional members of the assessment team.

- A sampler or technician should be available to record a log of everything the sampling team does, note the time and record other details that might assist in interpreting the analytical data generated by the laboratory or screening facility. Take at least one picture of the area at the entry to the contaminated area and several pictures of the impacted area. Take pictures of the areas to be sampled. If possible, lay a ruler or tape measure by the sampling points to allow the viewers of the pictures to know the scale of the photograph.
- All PPE should be decontaminated (if it is known how to do this for the particular contaminant of interest) or at least contained after use. All decontamination materials and disposable sampling equipment should be contained until the nature of the contaminant is known.
- Leave the sampling site as undisturbed as possible, as it may prove to be of evidentiary value, and return to the decontamination area to gather supplies or additional personnel.

Section 5.0 Preparation for Sample Collection Activities

This section contains information regarding sampling supplies, field test kits, field sampling QA/QC, forensic protection, and interagency cooperation.

5.1 Sample Collection Kits

Sample collection kits should contain all sample bottles, materials, supplies, and forms necessary to perform sample collection activities from a hose bib, faucet, or other sample taps. Other equipment may be needed when collecting samples from fire hydrants, valves, distribution storage tanks, or aquifers. Table 5-1 lists the basic recommended components for a sampling kit as indicated by the EPA's RPTB: Module 3, Site Characterization and Sampling Guide. The following list of suggested equipment for the Field Collection Kit is presented as an example. Some utilities may decide it is appropriate to substitute or include additional items. Utilities should work with their analytical support laboratory(ies) to obtain the proper sample containers and preservatives, as well as an understanding of sample volumes that are needed for the analytical methods that will be used. Some laboratories may assist with sample collection kits.

Table 5-1. Field Collection Kit – Example

Item	Quantity	Notes
FIELD RESOURCES AND DOCUMENTATION		
Field guide	2	Resource for field personnel
Health and safety plan	2	If required for the site
Sample labels	2 times the number of bottles	Waterproof (filled out in advance, if possible)
Sample documentation forms	24	For recording sample information
Custody tape (or seals)	2 rolls	Used on sample or shipping containers
Chain-of-custody forms	24	For documenting sample custody
Lab marker	2	Waterproof, 1 red, 1 black
GENERAL SAMPLING SUPPLIES		
Sample containers	Tables 7-1, 7-2, and 7-3	For collecting samples
Device for grab sampling	1	For sampling large water bodies
10 liter HDPE container	4	For collection of large volume water samples
Lab-grade tape	3 rolls	For temporary labeling in the field
Miscellaneous glassware/labware	N/A	Beakers, graduated cylinders, spatula, etc.
Collapsible cooler	1 or more	For sample storage
Rigid shipping container	1 or more	For shipping by overnight service if needed.
1 quart zippered freezer bags	1 pack/100	For double bagging ice and sample containers
Paper towels	2 rolls	Wiping wet containers and containing spills
PATHOGEN SAMPLING SUPPLIES		
Tubing and clamp	1	For sample tap flushing, etc.
Stopwatch & graduated cylinder	1	For measuring flow rate

Item	Quantity	Notes
Ultrafiltration or membrane filtration apparatus	1	For concentrating pathogen and toxin samples
REAGENTS (may need to be kept separate from the rest of the kit) *Note:* When sampling for unknowns, some samples should be collected without preservation because preservatives may interfere with analyses.		
Reagent-grade water	5 L	For sample processing in the field (chemical and radiochemical analytes only)
Phosphate buffered saline	5 L	For sample processing in the field (pathogen analytes)
Sodium thiosulfate crystals	100 g	For water sample disinfectant reduction
Ascorbic acid	100 g	For water sample disinfectant reduction
Sodium sulfite crystals	100 g	For water sample disinfectant reduction
Potassium dihydrogen citrate	100 g	For carbamate preservation
6 Molar ACS-grade hydrochloric acid (HCl)	25 mL	In dropper bottle for preservation of samples for organic analyses
6 Molar trace metal-grade nitric acid (HNO_3)	25 mL	In dropper bottle for preservation of samples for trace metals analysis
10 Normal sodium hydroxide (NaOH)	25 mL	In dropper bottle for preservation of samples for cyanide analyses
Sulfuric acid (H_2SO_4)	25 mL	In dropper bottle for preservation of samples for pesticide preservation
pH paper in ranges from 0 to 4 and 10 to 14	50 strips	For checking the pH of samples preserved with acid or base (sensitive to 0.5 pH units)
Starch-iodide indicator paper	50 strips	To determine the need to disinfect/reduce with ascorbic acid if analysis for cyanide is expected
SAFETY SUPPLIES		
Splash resistant goggles	2	One per individual (minimum)
Disposable gloves	1 box per size (S, M, L, XL)	Nitrile or polyethylene, powder-free
Disposable shoe covers	2 pairs	One pair per individual (minimum)
Clear, heavy duty plastic trash bags	4	For disposal of lab coat, gloves, etc.
Rinse water	20 L	For general use and first aid
Antiseptic wipes	1 container	For cleaning hands, sample containers, etc.
Squirt bottle	2	For use with rinse water or reagent-grade water
First aid kit	1	For general first aid
Flashlight/headlamp	3	For working at night or in dark locations

5.2 Field Test Kits and Instruments (On-site/Field Pre-screening)

The generic types of screening and detection devices and kits listed in Table 5-2 could be included in a field test kit. The core field test kit should include the equipment necessary to conduct the recommended minimum level of field safety screening and rapid water testing. Additional technologies that might be used to perform expanded field testing are listed in the second section of the table. The target parameter for screening and rapid water testing may be a specific contaminant, a contaminant class, or a general indicator of potential contamination. The class indicates whether the technology is suitable for field safety screening, rapid water testing or both. The methodology describes the general principle of detection for the technology.

Due to the wide range of available field testing equipment, specific devices and vendors are not listed here; however, there are sites that do provide a detailed listing of commercially available detection technologies, such as https://www.epa.gov/homeland-security-research/sam-companion-documents-and-sample-collection-procedures , http://www.nij.gov/publications/pages/publication-detail.aspx?ncjnumber=190747 and http://www.nij.gov/publications/pages/publication-detail.aspx?ncjnumber=184449. Detailed verification reports for detectors that have undergone independent testing through the former Environmental Technology Verification (ETV) program are available at https://archive.epa.gov/nrmrl/archive-etv/web/html/. Note: the ETV program is no longer active and information in the archives may be dated.

5.2.1 Core Field Test Kits

The core field test equipment should include a radiation survey meter capable of detecting alpha, beta, and gamma radiation for field safety screening. It is used to quickly determine if ionizing radiation is present. If detected levels of radioactivity are significantly higher than normal background levels, the site would be characterized as a radiological hazard. A radiation survey is essential to determine whether or not the site has been contaminated with radioactive material. Typically the components that form the detector are sold separately and include a probe (e.g., a pancake Geiger-Mueller [G-M] probe) and a rate meter. Radiation survey meters are an established technology, widely used by responders, simple to operate, relatively inexpensive (<$1,000), and available from a variety of vendors. NRC requires for licensees to have the radiation survey instruments calibrated and to comply with the Standards for Protection Against Radiation regulations (http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/full-text.html). More information on the equipment could be found in the vendors websites.

Water is an effective shield to both alpha and low energy beta radiation, and these weak forms of radiation may not penetrate water at all. Thus, a negative result from a typical pancake G-M probe (designed to detect radiation in air) does not provide assurance that the water is free of radioactive contamination. There are devices, such as sodium iodide probes, that are designed to detect radiation (gamma) in water.

Cyanide detectors should be included in the core field kit to quickly rule out, or tentatively identify, cyanide as a potential contaminant in the water. Most commercially available cyanide test kits are based on either colorimetric or ion selective electrode technologies. Several commercially available cyanide detectors were verified by EPA's ETV program in 2003, and the verification reports can be found at https://archive.epa.gov/nrmrl/archive-etv/web/html/. The technology has not changed much since then.

Chlorine, pH, and conductivity detectors should be included in the core field test kit as general indicators of water quality, and deviations from established baseline values may indicate a potential problem.

Chlorine residual measurements (both free and total) should be of particular interest in distributed drinking water since the absence of a residual disinfectant is undesirable even under non-emergency

Table 5-2. Core and Expanded Field Test Kits

CORE FIELD TEST KIT			
Target Parameter	**Class**	**Methodology**	**Comments**
Radioactivity (alpha, beta, and gamma)	Primarily a Safety Screen	Radiological survey meter, with appropriate probes for alpha, beta, and gamma contamination and dose rate surveys	Probes are held above the water surface (Do not get the probe wet)
Cyanide	Water Testing	Colorimetric or ion selective electrode	Test water for cyanide ion, not combined forms
Chlorine residual	Water Testing	Colorimetric	Absence of residual may indicate a problem
pH/conductivity	Water Testing	Ion selective electrode	Abnormal pH or conductivity may indicate a problem
EXPANDED FIELD TEST KIT			
Target Parameter	**Class**	**Methodology**	**Comments**
General hazards	Safety Screen	HAZCAT (explosives, oxidants, etc.)	Should be performed by trained HazMat responder
Volatile chemicals	Safety Screen	"Sniffer"-type devices	Detects chemicals in air
Chemical agents (VX, sarin, soman, etc.)	Safety Screen or Water Testing	Enzymatic / colorimetric	Many kits may also detect certain pesticides. Some are sensitive enough to use in water
Water quality parameters	Water Testing	Variable (e.g., ion probes, colorimetric)	Kits available for a variety of common parameters
Pesticides (OP and carbamates)	Water Testing	Immunoassays	Semi-quantitative screening method, few steps required
VOCs and SVOCs	Water Testing	Portable GC/MS	Expensive, but expands field capability for chemicals
Toxins (ricin, botulinum, etc.)	Water Testing	Immunoassays	Semi-quantitative screening method, few steps required
Pathogens (*Bacillus anthracis, Francisella tularensis*, etc.)	Water Testing	Immunoassays and PCR	Pre-concentration should increase sensitivity
Toxicity	Water Testing	Inhibition of pathogen activity	Need to establish a baseline

This list has been taken from the EPA Response Protocol Toolbox Module 3 document. It is not meant to be an exhaustive list.

situations. Chlorine residual test kits incorporate established technologies that are widely used in the drinking water treatment industry. Chlorine residual test kits are typically based on colorimetric techniques.

Most pH instruments are based on ion-selective electrodes, and are regularly by most utilities. pH measurement devices should be used according to manufacturer's directions to ensure accurate readings, e.g. with regards to operating conditions of a particular pH meter than may negatively impact its performance and reliability.

Conductivity is another useful indicator of water quality changes (assuming that a baseline for conductivity has been established). Many models of instruments are available that allow measurement of multiple parameters, such as pH, conductivity, temperature, etc., with a single unit.

5.2.2 Expanded Field Test Kits

The equipment listed under the expanded field test kit section is intended to provide an indication of the other types of detection technology that are currently available and which might be considered for inclusion in a field test kit. Additional information regarding these and other field screening technologies is also available in EPA's SAM Companion Rapid Screening and Preliminary Identification Techniques and Methods (https://www.epa.gov/homeland-security-research/rapid-screening-and-preliminary-identification-techniques-and-methods) and All Hazards Receipt Facility Screening Protocol (https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=483614). For the collection of surface water samples, the USGS National Field Manual for the Collection of Water-Quality Data (https://water.usgs.gov/owq/FieldManual/compiled/NFM_complete.pdf) could also be consulted.

These additional detection technologies can provide additional information for characterizing hazards at a particular site or increasing the range of contaminants that can be tentatively identified during rapid field testing of the water. Expanded field testing might include volatile chemicals, chemical warfare agents, additional water quality parameters, pathogens, toxins, and general toxicity. The technologies may be relatively simple and inexpensive, as is the case for many immunoassay test kits, or complex and expensive, as is the case for mobile gas chromatography/mass spectrometry (GC/MS) instruments. Volatile organic compound (VOC) "sniffer" devices may warrant special consideration as they are commonly used in environmental monitoring, are relatively easy to use, and can provide a rapid indication of potential volatile hazards. They can also be subject to a variety of interferences from substances commonly present at their point of use (https://archive.epa.gov/nrmrl/archive-etv/web/html/). Many of the technologies available for pathogens are not sensitive enough for use with drinking water.

False positive or false negative results from field testing can result in inappropriate decisions with potentially significant consequences. Some utilities may choose to perform their own evaluation of a field testing technology to characterize the performance of the detector so that it can be used with great confidence during a site characterization activity (e.g., to understand if any interferences are commonly present at a particular location where the detector will be potentially used).

As with sample collection kits, field test kits should be maintained so that the equipment and chemical reagents are in proper working order when the kits are needed. This generally includes proper calibration of instruments, ensuring that all reagents are fresh, checking batteries, and conducting any other maintenance or operational checks recommended by the equipment manufacturer. Standard Operating Procedures (SOPs), including QA/QC requirements, should be developed and approved for all reagents, standards, and each piece of equipment contained in the field test kits. Furthermore, it is critical to provide staff training in the actual use of any field technology that should be used to support site characterization activities in response to contamination threats. This can be accomplished through field exercises or incorporation of the field testing technology into routine monitoring activities. The latter should also provide an opportunity to develop baseline information for the monitored parameters. Such baseline data are important for interpreting field testing results in the event of a threat.

5.2.3 Examples of Field Testing Equipment

Below is a list of the examples of field testing equipment used along with brief summaries of the procedures for use, strengths, and weaknesses for the equipment types. Please note that residual disinfectant can adversely affect the outcome of some field tests (e.g. chemiluminescence toxicity), therefore, depending on the field test used, a disinfection reducing agent may need to be added prior to testing. More information on field measurements, protocols, standard procedures, and guidance for sampling surface water is available in the USGS *National Field Manual for the Collection of Water-Quality Data* https://water.usgs.gov/owq/FieldManual/compiled/NFM_complete.pdf

Turbidity

Turbidity is the measurement of how many solid particles are suspended in a given volume of water. Most turbidimeters measure the ratio of scattered light to determine how turbid the water is, and usually

cost about $800–900. A sample of water is put into a cell which is then placed in the instrument to determine turbidity. A daily calibration is usually required, with a more in depth calibration periodically (e.g., quarterly). After calibration, it is best to perform the turbidity measurement at the sampling site very soon after sampling. If this is not possible, it should be done within 24 hours.

pH, ORP, and Conductivity

Many commercial screening instruments are available that can measure pH, oxidation ORP, and conductivity of water samples using multiple electrodes contained in one instrument. These instruments cost about $700. Measurements are taken by filling small cells with sample, and then submerging the instruments electrodes into the sample cell. Conductivity and pH checks usually should be performed at the beginning of each day before taking the multi-parameter probe into the field. ORP electrodes rarely give false readings unless there are problems with the reference electrode. For this reason, and because calibration solutions for ORP are highly reactive and potentially hazardous, most multi-parameter probes have an electronic ORP calibration. Caution should be taken in ORP interpretation since the measurement has inherent interferences and limitations that must be understood and considered.

Cyanide and Chlorine

Cyanide and chlorine can both be detected in the field using colorimeters. These instruments usually cost about $1,000. There are separate procedures for cyanide and chlorine. The most common cyanide procedure utilizes reagents that react with cyanide to form strongly absorbing compounds. The measurement is performed by mixing the water sample with specific reagents, and then placing the sample in a cell which is inserted into the colorimeter. Note that this "field" procedure reports only free cyanide ion and not total cyanide (which includes free ions as well as cyanide complexes). Chlorine is also measured by mixing the sample with reagents, and then placing the sample in the colorimeter.

The colorimeter should be calibrated periodically, and the instrument should be recalibrated before expiration of calibration period.

Sample Headspace VOC Measurement

A photoionization detector (PID) that can detect VOCs down to part per billion levels can be used to measure VOCs volatilizing from a drinking water sample or liberated from the sample by shaking or agitation. The PID is a nonspecific total organic vapor detector. It does not give the concentration of any single, specific chemical in the headspace. The PID measures VOCs in the range 1 to 9999 ppb. There are two calibration checks to be performed, a fresh air calibration, and a span gas calibration. Generally, the fresh air calibration or "instrument zeroing" should be done each time the instrument is turned on. Calibration of the PID with span gas is generally performed once a month. After calibration is performed the measurement of VOC concentration in a sample container headspace can be performed.

M272 Water Testing Kit for CWAs

M272 kits were originally developed by the U.S. Army, but currently many commercial vendors manufacture identical kits. These kits cost about $650 each, and can analyze only about 20 samples. The testing is somewhat time-consuming, so these kits are often used only as a backup analysis if CWAs are suspected. M272 kits screen water samples for CWAs (Lewisite, nerve agents, sulfur mustard, and cyanide) using a series of color changing chemical reactions. The test kit should also respond to less toxic substances with similar chemical properties as CWAs. Some of the substances are relatively common, so it is important to remember that a positive result on the M272 does not always mean that a chemical warfare agent is present. The lower detection limit of the tests are 20 mg/L for cyanide, 2 mg/L for mustard, 2 mg/L as arsenic for Lewisite, and 0.02 mg/L for G and V nerve agents. The test is qualitative and does not distinguish between different compounds within a class. The procedure varies depending on which test is performed.

Field Site Atmosphere Safety Screening: VOC, Oxygen, Combustibles, and Toxic Gases

Several brands of multi-gas meters are commercially available. The most common type of multi-gas meter contains detectors for VOCs, oxygen (O_2), combustibles, and toxic gases (carbon monoxide [CO] and hydrogen sulfide [H_2S]). Their main purpose for sampling activities is to monitor the atmosphere in the vicinity of a drinking water sampling location. The instrument requires periodic calibrations or calibration checks. There are three calibration checks to be performed; fresh air calibration, multi-sensor calibration, and PID VOC calibration. Generally, the fresh air calibration or "instrument zeroing" should be done each time the instrument is turned on. Calibrations of the multi-gas sensors and the PID are generally performed once a month. After calibrations have been performed, readings can be made with the multi-gas monitor. The instrument readouts are updated about every second.

Field Site Safety Radiation Measurement and Water Sample Testing

A kit containing multiple radioactivity detectors for alpha, beta, and gamma radiation is much more sensitive than a standard G-M detector, but also costs significantly more (about $2,300). Although the multiple detectors cannot be used to identify or measure individual radionuclides or isotopes, the results can be used to determine the presence of alpha, beta, or gamma radiation and a general measurement of the extent of the radiation. These detectors respond to naturally occurring, background radiation. The background level varies by location and should be considered in interpreting instrument readings. Radiation detection instruments should be maintained with a periodic (usually annual) factory calibration procedure, and frequent QC checks (usually with every use) with radiation check sources are also important.

Some pancake-type detectors can detect alpha, beta, or gamma radiation, whereas the Gamma Scintillation detector and Gamma Survey Detector are used only for gamma radiation. A scanning survey determines the levels of contamination in an area, whereas a point survey determines the level of contamination of a certain object (such as a bottle of water) in an area or before being shipped off site. Never contact the surface of the detector with the contaminated area, as to prevent the transfer of radioactive contamination to the detector. After each instrument is calibrated and checked, measurements can be made.

Rapid Toxicity via Chemiluminescence

Chemiluminescence water test kits, specifically arsenic tests and rapid toxicity tests via a chemiluminescence technique, referred to as "Chemiluminescence Toxicity (CT)" are overall indicators of whether toxic chemicals are present in drinking water. The results of the chemiluminescence technique can be significantly influenced by factors such as turbidity, rust, and even normal, small, day-to-day variation in processing at the water treatment plant. Accordingly, establishing the instrumental response baseline before leaving to respond to an incident may result in data important in interpreting the test results.

The CT test can be time consuming, so the timing of performing this test must be managed. The luminometer for the CT test should be formally calibrated before each use. CT reagents used for calibration and for measuring samples, can be temperature sensitive. If diluted reagents (described in the instrument manual) are not refrigerated, they should be remade every 72 hours. Reagents should remain stable for 1 year if refrigerated. After calibration, measurements can be made.

5.3 Quality Assurance/Quality Control

The sampler should employ a QA/QC program. The following general protocols for quality control should not be considered to be exhaustive. The program should include the collection of equipment blanks, field blanks, and field replicates, when available and as appropriate for the intended analyses. Field QA/QC requirements should be specified in sampling or site plans and analytical support laboratories should be included in the discussion as analytical QA/QC requirements should greatly impact field sampling. This program should also include the routine calibration of all field instrumentation used

for rapid on-site testing. The frequency of performing these QA/QC samples is dependent on the data quality needs and objectives.

The purpose of any QA/QC protocol is to ensure that 1) the laboratory receives samples that accurately represent the conditions existing at the sample site, 2) appropriate method-specific controls are provided to the analytical laboratory, and 3) the results of the analyses are traceable to the specific sample location or event. The following QC procedures should be included, as appropriate:

- Decontamination of Sampling Equipment: The field sampling plan should address the extent of decontamination and specify the procedures to prevent sample contamination that could be introduced from contaminated collection equipment. Sampling may be performed using separate laboratory cleaned equipment for each sample location.
- Sample Container Cleanliness Requirements: The field sampling plan should also address the extent and type of sample container cleaning, to prevent sample contamination from containers. Pre-cleaned containers meeting EPA method-specific cleanliness protocols are available from many suppliers. If pre-cleaned containers are used, the serial number and QA batch number of each container should be recorded in the Field Log Book/Notes or Field Form. If sample containers are re-used, they should be decontaminated, and field blank samples should be submitted to the laboratory to verify container cleanliness.
- Field Duplicates and Split Samples: Field duplicates are two separate samples taken from the same source and are used to determine data repeatability based on field conditions. Field duplicate samples are assigned different sample numbers, specified in the Field Log Book/Notes or on the Field Form, distinguished from the regular field samples on the COC form, and often submitted blind to the laboratory to provide objectivity. The comparability of the results provides information on the repeatability of the field extraction and analytical procedures. Split samples are two or more representative portions taken from one sample and submitted to different laboratories for identical analyses to obtain information on inter-laboratory repeatability.
- Equipment Decontamination Blank: These samples provide information on the levels of cross-contamination resulting from field or laboratory sample preparation actions. The equipment blank is reagent water that is free of the analytes of interest, transported to the site, opened in the field, and poured over or through the sample collection device, collected in a sample container, and returned to the laboratory and analyzed. Equipment blanks are collected for each type of equipment used in sampling during the day. Equipment blanks are assigned sample numbers and are not distinguished from regular field samples on the COC form.
- Field Blanks: Field blanks check the cleanliness of sample containers, environmental contamination, purity of reagents, or solvents used in the field. A sample container is filled with laboratory grade reagent water, preserved, and submitted for analysis for the same parameters as the regular field sample.
- Trip Blanks: A trip blank is used when collecting VOC samples, and serves as a check on sample contamination during sample transport and shipping. A blank may consist of two 40-mL VOC vials filled at the laboratory with laboratory grade reagent water, transported to the sampling site, and returned to the laboratory without being opened.
- Matrix Spike/Matrix Spike Duplicates (MS/MSD): Some analytical methods require that the laboratory spike a portion or duplicate portions of the sample matrix with a predetermined quantity of analytes prior to sample extraction/digestion and analysis. A spiked sample is processed and analyzed in the same manner as the sample. The results of the spike compared with the non-spike sample indicate the ability of the test procedures to repeat recovery of the analyte from the matrix and also provides a measure of the performance of the analytical method. Additional containers may be specified to provide enough material for this procedure. The sample containers are assigned the same sample number as the regular field sample and are designated MS/MSD on the COC form.

5.4 Forensic Protection and Interagency Cooperation

When collecting samples following a contamination event, sampling activities should be conducted with the cooperation of any and all agencies investigating the incident. Such cooperation should help ensure that the necessary steps are taken to preserve a potential crime scene and that proper evidence is collected and protected. Special care should be taken to avoid moving any evidence until adequate documentation is conducted and the appropriate officials are notified. The following general protocols for maintaining crime scene integrity are provided as guidance only, and should not be considered to be exhaustive. The agency or agencies responsible for site investigation should be consulted for information regarding evidence requirements.

- Collection of environmental samples is time sensitive due to the public health and sample preservation implications. Thus, collection of samples may precede collection of physical evidence, and care should be taken not to disturb the crime scene while performing these activities.
- Physical evidence should be collected in cooperation with the appropriate law enforcement agency. Specially trained teams from the law enforcement community (e.g., the HazMat Unit) are best suited (and may be required) for the collection of physical evidence from a contaminated crime scene.
- Samples collected during a criminal investigation should be monitored by the local, state, or federal authorities and may be confiscated. All actions taken within a criminal investigation should be documented. Copies of all documentation should be maintained by all agencies present.
- Special care should be taken to avoid moving or disturbing any potential physical evidence or spreading the contaminant. Substantial physical evidence of a contamination event might include discarded PPE, equipment (such as pumps and hoses), and containers with residual material.
- Samples may be considered evidence, and thus could be subject to security measures. These measures may include keeping samples under the control of designated personnel at all times. When these samples are not in the possession of designated personnel, the samples should be secured (e.g., locked in a secure area) and accessible only by designated personnel. In the field, samples may need to be locked in a vehicle.
- It may be necessary to collect duplicate samples for law enforcement and to take photographs of the samples at the site of collection as an additional form of sample documentation.
- The samplers should, when possible, take pictures of the sample location and the sample container(s) at the location where the sample was collected. If appropriate, Global Positioning System (GPS) coordinates should be obtained for sample locations. Law enforcement should be consulted for proper handling during and after taking photographs/videos to ensure integrity of the evidence. Information concerning the times and locations of photographs taken or video recorded should be noted in a site logbook. A COC form should be maintained for all film development to ensure proper handling and tracking.

  Note: Photographs or video taken in areas of high sensitivity or security, as well as notations and information collected regarding the area, may need to be discussed with the law enforcing agency prior to entry. Videos and pictures may not be possible in areas of high security; as a result, drawings and written descriptions may become critical documentation.
- Sample COC documentation should be initiated immediately after sample collection.
- Because analytical results may be considered to be evidence, it is important to use a qualified laboratory for analytical support and to gain written authorization to release documentation.
- Before exiting the site, samplers should practice the following, in consultation with participating agencies:
  - Verify that the perimeter has been properly secured before leaving the site. Verify that hatches, locks, etc., are properly secured.
  - Remove all samples, equipment, and materials from the site. Remove all PPE at site perimeter and place disposable PPE and other trash into a heavy-duty plastic trash bag.

- Verify that all samples are in a transport container and properly seal the container.
- Ensure that all documentation has been completed.
- Comply with any other site control measures required by participating agencies.

Section 6.0 Sample Collection Documentation

Thorough documentation of sample collection and identification is important to ensure the validity of samples and corresponding analytical results. This documentation is used to ensure that samples are representative, protected from tampering, have been collected in accordance with any applicable collection requirements, and have not been exposed to compromising conditions. Sample collection documentation should include:

- Sample identification and label
- Records of sample collection operations and procedures
- COC form.

Training on how to handle criminal investigation samples can be found at https://www.epa.gov/waterlabnetwork/water-laboratory-alliance-training-center.

6.1 Sample Identification Numbers

Each sample consists of all the material collected from a given location at one time and of one matrix. A sample identification number that is unique for each sample should be created by the sample collector, the receiving laboratory, or a program or project manager. Sample identification numbers often consist of elements describing the sample type, matrix, location, and date and time of collection. This number is unique to each sample. It is generally included in the sample documentation, and used to identify the sample in field reports and log books, COC forms, and sample containers and labels. The number can also be used on corresponding analytical data reports or evaluations.

6.2 Sample Container Labels

Each sample container should have a label that clearly provides information identifying and describing the sample. Ideally, sample container labels should provide the following information:

- Site name
- Sample identification number
- Date and time the sample was collected (including time zone)
- Sampling location (e.g., site name or address)
- Container size
- Container type
- Type of sample (grab or composite)
- Analysis (Emergency response personnel may not know what analyses should be assigned to a sample. This line may not always be filled out.)
- Preservatives added, if applicable
- Dechlorination method, if applicable
- Name or initials of sample collector(s)
- Hazard warning labels. Samples should be properly labeled based on the U.S. Department of Transportation (DOT) requirements for the transport of hazardous contaminants.
- Gamma reading or any additional radiological screening/survey results of the sample or sample container, if available.

All of the information on the sample label should be identical to the information on the COC form. The sample collector should be able to recollect where and when the samples were taken in case additional sampling or analysis is necessary.

To facilitate sample collection activities and ensure proper labeling, sample containers should be pre-labeled as much as is practical prior to sample collection. Sample labels should be completed with a waterproof pen and securely affixed to each sample container to identify each sample clearly. If a waterproof pen is not used, it is recommended that the sampler cover the label(s) with clear packaging tape after writing the sampling information onto the label. An example sample label is provided in Figure 6-1.

Figure 6-1. Example Sample Container Label

Site Name: _____
Sample ID Number: _____
Date: _____ Time: _____
Location: _____
Container Size: _____
Container Type: _____
Sample Type (e.g., grab, composite):
_____
Analysis: _____
Preservative: _____
Dechlorination: _____
Collected by (initials): _____

6.3 Standard Operating Procedures (SOP)

All field activities should be performed in accordance with SOPs. Utilities should prepare SOPs for the entire sampling process.

6.4 Records of Sample Collection Operations

Field report forms should include any details that might assist in the interpretation of the data/results from laboratory analyses and in the overall assessment of the contamination situation. Notes on changes to flows, coloration, field data, field conditions or unexplained flora/fauna can assist in understanding the analytical data. The "Generic Sampling Checklist" (Appendix C) provides a guideline to ensure that all information is captured during a sampling event. This includes site location, conditions, field screening that was performed, and relevant observations.

The field reporting forms (Sample Event Report Form and Field Testing Report Form) should prominently show the sample identification number, date and time of collection, sample location, and sample collector name(s). An example of a Sampling Event Report Form is provided in Appendix D, and a Field Testing Report Form is provided in Appendix E. These reports should also contain a description of the sample and any information the samplers witnessed or know about the sample, including:

- Level of PPE used
- Weather conditions
- Physical or environmental conditions, i.e., fumes, cloud, or odor detected
- Agencies involved in the sampling effort
- Sample amount including units
- Number of people exposed
- Symptoms of those exposed to the sample
- General conditions of exposed flora and fauna (if available)
- Field screening methods, instruments used and their results

- Name and signatures of sample collectors and others present during collection
- Contact information of samplers or agency coordinators or managers

The information contained in the field reports can be used to help the laboratory determine an appropriate screening or analytical strategy. If certain types of sample screening have been performed in the field, laboratory pre-screening may not be necessary and the results may expedite sample analysis in the laboratory. Information regarding any symptoms or environmental effects caused by the contamination should also greatly aid sample recipients in regards to sample handling precautions and the level of PPE needed.

Photographs can be important field documentation, particularly at any site where there are forensic concerns. All site photography should begin with a wide overall view and then progress to more detailed photos. Entry and exit photos should always be included. Always try to provide wide angle, medium, and close-up photographs of the relevant areas of the site. Whenever possible, include a device to measure scale in the photographs. This is best done with a ruler or tape measure displayed visibly in the photograph. Photograph logs should be maintained during the sampling event. An example of a photograph log is provided in Appendix F.

6.5 Custody Seals

Custody seals are attached to each sample over the cap to ensure the sample has not been opened or tampered with after collection. Alternately, the shipping container can be custody sealed by placing a seal over the closed opening making it impossible to open the container without ripping the seal. Two custody seals should be used on each container to maintain the integrity of the sample custody process. Custody seals contain the signature of the person responsible for packing the container and the date sealed. The tape should be sturdy to resist incidental contact but able to break when the cap/lid is removed.

6.6 Chain-of-Custody (COC) Form

The COC form should include any available information regarding the potential hazards associated with the sample, handling procedures required for the samples, sample identification number, sample concentration, if known, sampling location, sample date and time, sample matrix, names and signatures of the samplers, and signatures of all individuals who had custody of the samples. A COC form should remain with the samples from collection to laboratory receipt. If samples are split into two or more shipping containers, copies of the COC form should be placed with each container and directly indicate the contents.

A COC form creates an accurate written record that can be used to trace the creation, possession, and handling of the sample from the moment it is collected through analysis. A COC form is used and required, without exception, for the tracking and recording of on-site or off-site sample collection, transport and analysis. An example COC form is provided in Appendix G. A COC form accompanies each sample or group of samples as custody of the sample(s) is transferred from one custodian to another. One copy of the form is retained by the original sample collector, and the original is obtained by the receiving laboratory. If multiple laboratories are receiving a sample, individual COC forms should be submitted; each COC form represents the contents of the sample shipment. Each laboratory or facility representative who accepts an incoming sample shipment signs and dates the COC form. It is typically the laboratory or facility's responsibility to maintain internal logbooks and custody records throughout sample preparation and analysis. Sample custodians are typically responsible for initiating, maintaining, and completing COC tracking. A sample custodian is the person responsible for the custody of a sample or samples at a particular time, until custody is transferred to another person (and so documented), who then becomes the new custodian. A sample is under a person's custody if:

- It is in that person's possession,
- It is in that person's view, after being in that person's physical possession,

- It was in that person's physical possession and then he/she locked it up to prevent tampering, or
- It was in that person's physical possession and then he/she placed it in a designated and identified secure area.

Handling of COC forms during sample transportation depends on the method of transport. If the laboratory is within driving distance, the sample containers can be couriered to the laboratory. In this case, then the courier should sign off on the COC. It is important to note that common commercial carriers will not usually accept responsibility for handling and completing COC forms. This often necessitates packing the COC form in the shipping container (enclosed with other documentation in a plastic zipper-type bag). As long as COC forms are sealed inside the shipping or transport container and the container's custody seals are intact, commercial carriers are not required to sign the COC form. Using a computer and the Web, the tracking information generated by a common carrier can be obtained if complete COC tracking is required. This documentation is attached to the COC form to show that the sample container was in the possession of the carrier during the missing COC time. This time period should be noted as "common carrier" on the COC form between the final custodian at the sample site location and laboratory receipt.

Although COC forms vary in style, format, and detail, the forms should contain the same minimal information required to identify the sample. Procedures for filling out other styles of COC forms should be very similar. It is best for the samplers to fill out the COC form provided by the party receiving the samples. The COC form provided in Appendix G assumes that the samplers do not know what analyses to request for the sample. Sample screening can influence the strategy used for sample analysis.

The following information should be provided and the following steps should be followed to complete COC forms:

- General incident information (sample owners, contact information, site name)
- Sample specific information for each sample that will be traveling in the same cooler/transport container (i.e., sample identification number, sample type [matrix], grab or composite, number and type of sample containers, and date and time sample was collected)
- Contact information and affiliation of the sampler or responsible party
- Sign, date, and enter the time under "Relinquished by" entry. Have the person receiving the sample sign the "Received by" entry. If shipping samples by a common carrier, print the carrier to be used in this space (e.g., Federal Express, UPS).
- If a common carrier is used, a copy of the airbill is to be kept for recording purposes by both the sender and recipient.
- Place the original signed copy of the COC form in a plastic zipper-type bag or other appropriate waterproof sample shipping package. Retain a copy with the field records.
- Complete carrier-required shipping papers.
- If possible, fax or scan and email a copy of the COC form and field report to the party receiving the samples.

Section 7.0 Sample Collection Procedures

The two most common types of environmental samples are grab samples and composite samples. A grab sample is a discrete aliquot representative of a specific location at a given point in time. The sample is collected all at once and at one sample location. A composite sample is composed of more than one specific aliquot collected at various sample locations or different points in time. In general, it is recommended that only grab samples be collected from distribution systems; however, in some situations it may be necessary to composite samples over time or position.

Samples with pathogen, chemical, toxin, and radiochemical contaminants are generally collected by grab sampling. Grab samples for pathogen analyses should be collected when water samples are expected to contain sufficiently high levels of a contaminant(s) for analysis or the presence of particulates (turbidity) precludes field concentration of the sample. If the contaminant is unknown, it may be necessary to provide the analytical laboratory with a complete set of samples for pathogen, chemical, toxin, and radiochemical analyses (see Tables 7-1 to 7-3). This requires anywhere from 125 mL to more than 100 liters of sample (in the case of pathogen analyses of dilute pathogens) and almost 20 liters of sample for the chemical and radiochemical analyses. Because pathogen contaminants present in water systems are likely to be dilute, large volumes of sample are often needed. In these cases, samplers, in consultation with the analytical laboratory, should either collect large volumes of water for concentration in the laboratory or be prepared to concentrate large sample volumes on site. All sampling equipment and containers used for collection of pathogen contaminants should be sterile prior to use. Pre-cleaned equipment and containers should be used for collection of chemical, toxin, and radiochemical contaminants.

Examples of Sampling Procedures

The following are examples of common utility sampling locations, and some of the basic nuances to sampling these locations. An important consideration in the general guidelines below is the amount of time that the sampling location is flushed (i.e., the water is allowed to run before the sample is taken). While flushing times are sometimes included in analytical methods and are consistent with collecting samples suitable for compliance monitoring, for the purpose of collecting samples that may arise from contamination incident, these flushing times may be excessive and lead to undesirable loss of contaminant (e.g., in cases where most of the contaminant "slug" has passed through the system, leaving small amounts in various sampling locations). It is important for samplers to coordinate with incident managers to utilize appropriate flushing times.

Sampling from Accessible Water Taps: Remove the aerator, if present; aeration would remove VOCs from the sample. Maintain a steady flow of water until the water temperature is constant, and then hold the sample container under the discharge at an angle so that the sample flows down the inside wall of the sample container. This also minimizes aeration. Fill the container(s) to the fill line (if present) or to the top of the container lip.

Sampling from Fire Hydrants: Remove the small cap from the low-pressure side of the hydrant, adjust the flow down to a manageable level for sample collection, and collect the sample as if from a tap.

Sampling from Water Towers: Allow the water to run for at least 20 to 30 minutes to clear the plumbing leading to the sample port before sampling. If there is no sampling port, then a pump should be used. Lower the pump into the water reservoir to depth(s) prescribed by the routine sampling plan or by the person in charge of the investigation.

Sampling from Underground Tanks or Reservoirs: If there is a sampling port, allow the water to run for at least 20 to 30 minutes, and then collect the sample. If there is no sampling port, use a decontaminated submersible pump and set the flow on the pump to about 500 mL/minute; then collect the water samples for analysis.

The sampling equipment listed below may be used in a general sampling kit. However, utilities should consult with their support laboratory regarding analyte and site specific sample collection, container, volume, preservation, and holding time requirements. Some laboratories may assist with sample collection kits.

7.1 Equipment for Pathogen Sampling

The following materials should be used to collect grab samples (125 mL – 10 L) from water that may contain high levels of pathogen contaminants, as well as certain toxins, or particulates (e.g., wastewater, brackish water, etc.).

- Sterile plastic bottles (125-mL, 1-L) with lids or sterile containers (10-L)
- Sampling pole (aluminum pole with clamp to hold sample bottle)
- Gallon-sized, self-sealing bags
- Storage or biohazard bags for contaminated waste/PPE
- Transporting container (e.g., coolers) with ice and proper labels
- Sealing tape
- PPE (including clean, disposable nitrile gloves)
- Individually wrapped disposable bleach wipes
- Potable water (to flush any materials from skin, eyes or other surfaces that have come into contact with contaminated water)
- Tools to open taps or other sample locations
- Chlorine test kit (0.1-1.0ppm range or equivalent)
- Disinfectant reducing agent (sodium thiosulfate solution, 10% w/v, sterile)
- pH meter or pH indicator paper (see Table 5-1)
- Turbidity meter
- Thermometer
- Pump and pump tubing.

7.2 Equipment for Chemical, Toxin, and Radiochemical Sampling

The following materials should be used to collect grab samples (125 mL – 10 L) from water that may contain high levels of chemical, certain toxins, or radiochemical contaminants or particulates (e.g. wastewater, brackish water, etc.):

- Certified clean sample containers
- Graduated cylinder
- Stop watch
- Paper towels
- Storage bags for contaminated garbage/PPE
- Transporting container with ice and proper labels
- Sealing tape
- PPE (including clean, disposable nitrile gloves)
- Individually wrapped disposable bleach wipes
- Potable water (to flush any materials from skin, eyes or other surfaces that have come into contact with contaminated water)

- Tools to open taps or other sample locations
- Sampling pole (i.e., aluminum pole with clamp to hold sample bottle)
- Extra bottles for dipping
- Depth sampling devices
- pH meter or pH indicator paper (see Table 5-1)
- Radiological survey meter.

7.3 General Sample Collection Guidance

When collecting samples, it is important to take many aspects of the collection process into consideration. The following sections provide additional guidance that may be helpful to the collection of samples:

- Drinking water samples may require pH adjustment or other chemical preservation, as specified in the analytical method. Preservation should be performed immediately upon collection of the sample for each analysis. Sample containers with appropriate preservatives may be obtained from the analytical laboratory or other supplier. When it is necessary to perform a sample pH adjustment, unless otherwise specified in the analytical method, the acid or base should first be added to a separate and equal volume of water collected from the same sample location. This separate sample should be tested with either pH paper or a pH meter to determine how much acid or base needs to be added. The separate sample volume can now be disposed of. Then, the same amount of acid or base should be added to the investigative sample that will be sent to the laboratory. This sample should not be tested for pH, so there is no risk that the pH testing imparts contamination to the sample.
- The sample locations should be clean of all debris and attachments such as hoses or clamps, which should be removed to allow for proper collection.
- Proper PPE (e.g., outer gloves) should be worn and changed prior to each sample collection point to reduce potential carry-over contamination.
- The sampler should have all required sample containers and preservatives at the sample location prior to sampling.

For the collection of surface water samples, the USGS *National Field Manual for the Collection of Water-Quality Data* (https://water.usgs.gov/owq/FieldManual/compiled/NFM_complete.pdf) could also be consulted.

7.3.1 Grab Sampling Procedures for Pathogen, Chemical, Toxin, and Radiochemical Contaminants

The following guidance should be considered whenever sampling for pathogen, chemical, toxin, or radiochemical contaminants is performed:

- Determine the exact sampling point (including depth if necessary) and obtain proper sampling equipment. Depth collection requires discrete sampling equipment, such as a peristaltic pump or an adjustable-rate, positive displacement submersible pump, that can be used to suction water from a desired depth.

Note: A peristaltic pump cannot be used if samples need to be drawn from depths greater than 25–30 vertical feet.

- When sampling from a tap, remove the aerator or screen from the tap.
- Purge the sample point prior to collection if practical. The amount of purge water necessary varies depending on the sample location (immediate valve location vs. potential static location). If it is anticipated that the purged water might be analyzed in support of decision making or may need to be contained for proper disposal, the purged water should be collected in containers, and the containers should be labeled and stored until the analytical data is assessed.

- Adjust the flow from the tap to about a ¼ inch diameter flow (i.e., the stream width should resemble the width of a pencil). Fill the containers directly from the tap.
- If the sample is being collected from a non-tap location such as an open pit or stream, a clean 1-L glass container should be used to dip the sample and fill the sample containers. If a sample is to be collected at a specified depth, a "weighted bottle sampler" can be used to submerge a bottle to the correct depth and open it to sample at the desired location with the pull of a trigger.
- If applicable, preservation is added to each sample container without touching the sample or container to reduce cross contamination. Do not mix sample preservatives, as these chemicals are not compatible and may rapidly increase in temperature, spontaneously produce toxic fumes, cause additional hazards, or compromise sample integrity and analytical objectives.
- Open the sample container, being careful not to contaminate the inside of the cap, the inside of the bottle, or the bottle threads.
- Fill the sample containers to ¼ inch from the top and cap the bottles unless otherwise indicated in the method (e.g., volatiles and carbamate pesticide samples).
- Wipe off the entire exterior of the container.
- Record the sample identification number, date and time of sample collection, sample location, and any other pertinent information on the sample label with a permanent marker and complete appropriate sample documentation form(s).
- Ensure that the appropriate sample label(s) is permanently or securely affixed to each sample container. It is often easier to fill out the labels and attach them to the containers before mobilizing to the field. Do not populate the date and time until sampling has occurred, as the date and time should be entered on the container label in the field. After labeling is complete, the label should be covered with clear tape so that the fresh ink should not wash off or smear.
- Complete all sample documentation and shipping forms (see Section 6.0) and pack the sample containers for shipment (Section 8.0).
- Handle all PPE and waste as contaminated waste and place into a garbage bag or other secure storage until the analytical data are assessed and proper disposal procedures are determined.

Additional, detailed information and procedures for collection of samples is also provided in the analytical methods, as well as among the documents at https://www.epa.gov/homeland-security-research/sam-companion-documents-and-sample-collection-procedures.

7.3.2 Other Chemical Contaminant Samples

After a sample has been collected, preserved, capped, and inverted for mixing, the sample should be checked to determine if pH adjustment is required. This is performed by pouring a small amount of sample into the vial or bottle and measuring the sample pH using the appropriate range (0–4, 6–10) pH indicator (Table 5.1). If pH adjustment of the sample is appropriate, adjust by dropwise addition of acid or base (as appropriate) to the sample, mix, and repeat pH measurement. Appropriate sample pH adjustments (amount of acid or base additive) should be determined on a separate and equal volume of water collected from the same sample location prior to collecting and adjusting the pH of the sample.

For collecting volatile and carbamate pesticides samples, the following additional guidance should be considered:

- Sample collection vials for volatiles should contain ascorbic acid (0.25–0.5 g) prior to the addition of the sample to act as a disinfectant reducing agent. Sample collection vials for carbamate pesticides should contain sodium thiosulfate (~12.5 mg) prior to the addition of the sample to act as a disinfectant reducing agent.
- Sample vials should be completely filled so that the sample forms a convex meniscus at the top prior to pH adjustments. Hydrochloric acid is then added to the volatile sample vials (typically 5–7 drops)

to adjust the final volume to a pH of less than 2. Potassium dihydrogen citrate is added to the carbamate pesticide sample vials to adjust the final pH to 3.8.

- When it is necessary to perform a sample pH adjustment, the amount of acid or base to be added to each sample container should be determined on a separate and equal volume of water collected from the same sample location prior to collecting the investigative sample (see first bullet of 7.4 for more detail).
- Ensure the vial contains no head space.

7.4 Pathogen, Chemical, Toxin, and Radiochemical Sample Container and Preservative Guidelines

Tables 7.1 through 7.3, listed below, summarize typical specifications for collecting samples that are contained in the analytical methods for each of the various contaminants and contaminant categories described in this guidance. Since analytical methods are periodically revised, the information on analytical methods, collection procedures, and suggested preservatives may change over time. The latest available information regarding the analytical methods for specific contaminants can be found in EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM)* at https://www.epa.gov/homeland-security-research/sam. Collection information for specific contaminants can be found in the analytical methods and in the EPA's SAM Companion Sample Collection Information Documents at https://www.epa.gov/homeland-security-research/sam-companion-documents-and-sample-collection-procedures.

Table 7-1. Pathogen Collection Guidelines [1]

Contaminant Class/Type	Container Volume and Type	Sample Concentration Volume	Disinfection Reducing Agent	Preservative	Holding Time	Analytical Technique
Fecal coliforms, *E. coli*	125 - 250 mL, Plastic	None	Sodium thiosulfate (0.005% final)	Transport on ice; Store ≤10°C, do not freeze	24 – 30 hours	Culture
Bacteria	500 mL - 2 L, Plastic	Method-specific	Sodium thiosulfate (0.005% final)	Transport on ice; Store sample concentrate ≤10°C, do not freeze Samples analyzed for *Vibrio cholerae* should be transported and stored at room temperature	Minimize transport and storage time	Culture, PCR and immunoassay
Virus	300 - 1500 L	Method-specific	Sodium thiosulfate (method-specific)	Transport on ice; Store filters/cartridges at ≤10°C, do not freeze	24 – 72 hours	Culture and PCR

[1] Please refer to the EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM)* at https://www.epa.gov/homeland-security-research/sam for the latest information on analytical methods, collection procedures and suggested preservatives.

Contaminant Class/Type	Container Volume and Type	Sample Concentration Volume	Disinfection Reducing Agent	Preservative	Holding Time	Analytical Technique
Protozoa	≥10 L, Plastic	None	Sodium thiosulfate (0.005% final)	Transport on ice; Store at ≤10°C, do not freeze	Elution must begin within 96 hours from collection/ filtration	EPA Methods 1623.1, 1623, 1622
Concentrated by Ultrafiltration						
Bacteria	10 - 100 L, Plastic	250 - 500 mL (retentate from ultrafiltration)	Sodium thiosulfate (0.005% final)	Transport on ice; Store sample retentate at ≤10°C, do not freeze Samples analyzed for *Vibrio cholerae only* should be transported and stored at room temperature	Minimize transport and storage time. If necessary, retentate may be stored up to 24 hours.	Culture, PCR and immunoassay
Virus						Culture and PCR
Protozoa						PCR and immunoassay
Toxin						Immunoassay

Table 7-2. Chemical and Toxin Collection Guidelines [2]

Contaminant Class/Type	Container Volume and Type	No. of Containers	Disinfection Reducing Agent	Preservative	Holding Time	Analytical Technique
Toxin	100 mL - 1 L; refer to analytical method and/or SCID for toxin-specific requirements	Method-specific	None	Transport on ice or at (-) 20°C (on dry ice); refer to SCID for toxin specific requirements	Minimize transport and storage time. If feasible, analyze or extract immediately upon receipt at the laboratory.	Varies
Volatiles (Methods 502.2, 8021B, 524.3, 8260B)	40 mL, Glass w/ PTFE-lined septa	5	Ascorbic acid (0.25–0.5 g)	1:1 HCl to pH ≤2 Store at <4°C	14 days	P&T - GC/MS
						P&T - GC/PID/ELCD
Carbamate Pesticides (Methods 531.1, 531.2)	40 mL, Glass w/ PTFE-lined septa	4	Sodium thiosulfate (12.5 mg)	Potassium dihydrogen citrate; adjust sample pH to ~3.8 Store at ≤4°C	28 days	HPLC-fluorescence

[2] Please refer to the EPA's *Selected Analytical Methods for Environmental Remediation and Recovery (SAM)* at https://www.epa.gov/homeland-security-research/sam for the latest information on analytical methods, collection procedures and suggested preservatives.

Contaminant Class/Type	Container Volume and Type	No. of Containers	Disinfection Reducing Agent	Preservative	Holding Time	Analytical Technique
Unknown organics (volatile)	40 mL, Glass w/ PTFE-lined septa	5	None	None - mark samples not preserved Store at <4°C	7 days	P&T - GC/MS
Metals/ Elements (Methods 200.7, 200.8, 200.9)	500 mL, Plastic (i.e., HDPE)	2	None	Trace metal grade nitric acid to pH ≤2	6 months	ICP-MS ICP-AES AA
Organometallic compounds	125 mL, Plastic (i.e., HDPE)	2	None	Nitric acid to pH ≤2	30 days	AA - cold vapor manual AA - cold vapor automated
Toxicity	125 mL, Glass	2	Consult manufacturer's instructions	Consult manufacturer's instructions	Consult manufacturer's instructions	Rapid toxicity assay (several vendors)
Cyanide (Methods 335.2, 335.3, 335.4)	1 L, Plastic	2	Ascorbic acid (0.06 g); for samples that test positive using starch-iodide indicator paper	Sodium hydroxide to pH ≥12 Store at ≤4°C[3]	14 days	Titrimetric Spectrophotometric
Quaternary nitrogen compounds (Method 549.2)	1 L, Amber PVC or silanized glass	4	Sodium thiosulfate (100 mg)	Sulfuric acid to pH ≤2; for samples known to be pathogenically active Store at ≤4°C	7 days	SPE HPLC – UV
Semi-volatiles (Methods 525.2, 8270D/3535A)	1 L, Amber w/ PTFE-lined screw caps	4	Sodium sulfite (40 – 50 mg)	6M HCl to pH ≤2 Store at ≤4°C	7 days to extraction, 28 days to analysis	SPE GC/MS
Unknown organics (general)	1 L, Amber glass	4	None	None - mark samples not preserved Store at ≤4°C	7 days to extraction, 28 days to analysis	Prep: SPE, SPME, micro LLE, direct aqueous injection, headspace Analysis: GC/MS, GC, HPLC, LC-MS
Unknown inorganics	1 L, Plastic	2	None	None - mark samples not preserved	28 days	ICP-MS
Water quality: Chemistry	1 L, Plastic or Glass	1	None	None - mark samples not preserved	Immediate to 14 days	Conductivity, pH, alkalinity, hardness, turbidity
CWAs	1 L Amber glass, 60-mL VOA vial	1 – 2	TBD	4°C ± 2°C	Extract immediately, 14 days to analysis	Prep: Microscale extraction Analysis: GC-MS

Preservation is recommended at the time of collection for metals; however, some methods allow samples to be preserved in the laboratory, if certain procedures are followed. However, these procedures sometimes result in an additional, comparatively length delay prior to analysis.

When mass spectrometry methods are used during a response event, the utility may consider requesting that the laboratory report all tentatively identified compounds, as applicable based on the type of analysis. This may result in the initial identification of the contaminant, even if it is not calibrated. However, this may result in false positive or false negative identifications, so the utility should be prepared to deal with such identifications.

Table 7-3. Radiochemical Collection Guidelines

Contaminant Class/Type	Container Volume and Type	No. of Containers	Disinfection Reducing Agent	Preservative	Holding Time	Analytical Technique (or Instrumentation)
Radiochemical	1, 5-L cubitainer or 4, 1-L plastic containers	2	None	Trace metal grade HCl to pH ≤2	65 hours – 6 months (isotope specific)	Gross alpha, gross beta, gamma isotopes, specific radionuclides

The analytical method and any applicable state requirements are both factors in determining the preservation method to use for samples intended for radiochemical analyses. Preservatives for radiochemicals can be added at the analytical laboratory within 5 days of collection, but the analysis cannot begin until 16 hours after acidification. This practice is not encouraged, as it delays the analysis time by as much as 16 hours. If the laboratory agrees to add the preservative, then no preservative is needed for the sample.

7.5 Pathogen Sample Concentration Procedures

For some sampling methods, it is necessary to concentrate the sample before testing. The following are two methods for concentrating samples so that a contaminant may be detected.

7.5.1 Ultrafiltration Procedure

A potential difficulty of confirming the presence/absence of a pathogen contaminant in a water source is that a pathogen warfare agent can be very dilute in a large amount of water and yet still have health related consequences. In such cases, a large sample volume may be required to thoroughly analyze the sample for pathogen agents. Large volumes of water are concentrated prior to analysis using an ultrafiltration device that concentrates viruses, bacteria, toxins, and protozoa. Ultrafiltration devices should concentrate more than 10 to 100 liters of water and result in a 250-mL concentrated sample. Ultrafiltration can be performed by a laboratory in the LRN or through the use of EPA's automated, field-portable ultrafiltration device. Certification and training are generally needed to complete these procedures, and additional guidance for this process can be obtained from the CDC or a local LRN laboratory. Information and training for the automated ultrafiltration device can be found at https://www.epa.gov/waterlabnetwork/water-laboratory-alliance-training-center. National Homeland Security Research Center's (NHSRC) ultrafiltration protocol used to concentrate *Bacillus anthracis* spores can be found at https://www.epa.gov/homeland-security-research/protocol-detection-bacillus-anthracis-environmental-samples.

7.5.2 Membrane Filtration

The use of membrane filtration for the concentration and subsequent analysis of bacterial contaminants for baseline and incident monitoring may provide an alternate sampling approach for targeted monitoring of these agents. Slight modifications of conventional membrane filtration-culture techniques have been used to recover bacteria from the membrane for subsequent analysis by polymerase chain reaction (PCR)-

based or immunoassay techniques. This procedure may be used in situations where the contaminant is suspected to be bacterial or the concentration of the bacterial contaminant is suspected to be relatively low.

The following procedure describes the recommended process for filtration of a drinking water sample and the subsequent recovery of bacterial contaminants from the membrane filter:

- Drinking water (1–2 L) is collected using the sample collection procedures in Section 7.3 in a suitable container. Reduce the disinfectant using sodium thiosulfate.
- The sample is filtered using a commercially available, sterile, disposable filtration assembly containing a 47 or 90 mm diameter, 0.45 micron pore size, mixed cellulose ester membrane filter.
- Following sample filtration, the membrane filter is removed from the filtration assembly and placed in a sterile, disposable polystyrene centrifuge tube (15 mL or 50 mL) containing 2–4 mL of a phosphate buffered saline (PBS), usually containing surfactant (0.05 %).
- The tube containing the sample filter is capped and subjected to vigorous mixing using a vortex mixer to wash bacteria from the filter.
- The filter is removed and discarded, and the filter eluate, containing bacteria (or protozoa), is processed for analysis by PCR or immunoassay.
- The concentrated sample (2–4 mL) represents a 250- to 1000-fold concentration of the original drinking water sample.

Section 8.0 Sample Packaging and Shipment

This section describes recommended procedures for properly packaging and shipping environmental or drinking water samples collected from a sampling site. These procedures should be performed after all samples have been collected and placed in the proper containers, and if necessary, sealed in containment bags. Biohazards should be communicated through properly labeling and biohazards signs based on the U.S. Department of Transportation (DOT) requirements for the transport of hazardous contaminants. Where biologically active substances and wastes are used, handled or stored, sampling personnel should be trained and certified to handle hazardous waste.

The following information provides guidelines for proper packaging, labeling and shipping of sample containers. Additional information and applicability can be obtained from common carriers' Hazardous Material Center hotlines or from a Federal Motor Carrier Safety Administration (FMCSA) State or Regional hazardous material contact here: https://www.fmcsa.dot.gov/regulations/hazardous-materials/fmcsa-stateregional-hazardous-materials-contacts. Utilities should consult with their support laboratory regarding specific sample container, packaging, labeling, and shipping requirements. Additional packaging and shipping information can be found in EPA's SAM Companion Sample Collection Information Documents at https://www.epa.gov/homeland-security-research/sam-companion-documents-and-sample-collection-procedures, and the CDC laboratory information website at https://emergency.cdc.gov/labissues/.

8.1 Packaging – Low Hazard Samples

Samples defined as "Low Hazard" should be packaged and shipped as follows:

- Samples requiring cooling preservation should be placed in a cooler/overpack with ice immediately to ensure the sample temperature does not exceed preservation requirements until analysis is performed. Note: Shipping containers should be sealed shut.
- Each sample bottle should be securely wrapped with bubble-wrap.
- A picnic type cooler or overpack can be used as a shipping container. Only hard plastic, impact resistant coolers in good condition should be used. In preparation for shipping samples, if present, the drain plug should be taped shut from the inside and outside, and a large, new, clean plastic bag should be used as a liner for the cooler.
- Sample containers should be placed upright and can be sealed in individual plastic water-tight sealable bags in the lined cooler in such a way that they do not touch and should not touch during shipment. Place bubble-wrap, or other suitable material that should retain its integrity if it gets wet, between each sample bag to take up any void space and to prevent the containers from touching. Place a temperature blank, if needed, in close proximity to the samples.
- As required, chemically preserved samples should be shipped to the laboratory on ice and chilled to 4°C. The most common temperature to preserve pathogen samples is 10°C, but this may vary slightly by method. Place ice inside a double layer of water-tight sealable bags. Place the bagged ice around, among, and on top of the sample bottles to assure samples should arrive at the laboratory or screening facility at the appropriate temperature. The liner bag should then be secured with a twist-tie or knot.
- The paperwork (e.g., original copy of COC form) going to the laboratory should be placed inside a plastic bag. The bag should be sealed and taped to the inside of the cooler lid. The last block of the COC form should indicate the overnight carrier and the associated air bill number. A copy of the COC form should be retained with the project document files. The air bill should be filled out before the samples are handed over to the carrier.
- The cooler should be closed and taped shut with appropriate strapping tape (e.g., filament-type) by running the tape around both ends of the cooler at least two times.
- At least two signed custody seals should be placed on the cooler, one on the front and one on the side, to maintain the integrity of the sample custody process.

- A copy of the COC form and the air bill should be faxed or scanned and emailed to the receiving laboratory to assist in tracking of potentially misrouted coolers.

8.2 Shipping – Low Hazard Samples

When the cooler is handed over to an overnight carrier, a standard air bill is necessary for environmental samples. The air bill is affixed to the top of the cooler and should contain both the shipped-from and ship-to address. The shipper's copy of the air bill should be retained with project document files as evidence. The laboratory or receiving facility should document the common carrier information upon receipt. However, if the laboratory is within driving distance, the coolers can be sent via courier to the laboratory, and the courier would sign off on the COC form.

8.3 Hazardous Sample Packaging and Shipment

Hazardous samples require additional packaging and shipping guidance due to their possible adverse health effects. The following precautions should be followed when shipping these samples. The following subsections 8.3.1 through 8.3.4 are purely informational for utility personnel. These activities should be performed by a HazMat unit.

8.3.1 Packaging for Pathogen Samples

Packing requirements and procedures for pathogen samples have been developed by the CDC to facilitate safe shipment of the samples to LRN laboratories. In summary, "triple" (primary receptacle, water tight secondary packaging, and durable outer packaging) packaging is required for a pathogen agent of human disease or materials that are known or suspected of containing them. This packaging requires the "Infectious Substance" label on the outside of the package.

8.3.2 Packaging for Chemical Samples

If the sample has a known hazardous component, it should be packaged and shipped in accordance with any applicable regulations (e.g., 49 CFR 173.24 and 173.24a). The type of container, correct labeling, proper naming of the hazardous material, proper labeling and transportation type are required.

Samples containing high levels of contamination should be shipped as Environmental Hazardous, Class 9 or by the proper shipping name of the contaminant. The package may consist of one or more receptacles, absorbent materials and devices for cooling or absorbing mechanical shocks. The conveyance, tie-down system, and auxiliary equipment may sometimes be designated as part of the packaging. Trained HazMat responders should make the selection of the most appropriate packaging for the specific hazard. Transporters should be contacted prior to an event to ensure authorized transportation can be made if required. Transporters typically have a license to transport hazardous materials.

8.3.3 Packaging for Radiochemical Samples

In the case of a sampling event, radioactive materials should be packaged in accordance with any applicable regulations (e.g., as a class 7 material regulated by 49 CFR 173.401–173.476). The type of packaging is typically dependent on the nature of the radioactive hazard (specific radionuclide and amount of radioactivity), and the selection of the most appropriate packaging for the specific radioactive hazard should be made by trained HazMat responders.

8.3.4 Shipping

All containers and outside containers should contain labeling corresponding to the particular hazard class as follows:

- Class 1 Explosives
- Class 2 Flammable and Nonflammable Gas

- Class 3 Flammable Liquid
- Class 4 Solids
- Class 5 Oxidizers and Organic Peroxides
- Class 6 Poison
- Class 7 Radioactive
- Class 8 Corrosives
- Class 9 Miscellaneous.

Labeling requirements for sample and shipping containers for U.S. Department of Transportation (DOT) Hazardous Materials are described in 49 CFR 172.400. Most HazMat teams licensed to transport hazardous materials have additional requirements for labeling packages. These may include such things as:

- Shipper's address
- Recipient's address
- Proper shipping name as designated by DOT
- The sample description.

Most small businesses use a commercial transporter to ship hazardous waste. These transporters can give advice on specific requirements for placarding, labeling, marking, and packaging; however, the sample owner remains responsible for compliance. For guidance on DOT regulations (49 CFR Parts 172 and 173), call the DOT hazardous materials information line at 202-366-4488 or visit the Pipeline and Hazardous Materials Regulations Website at http://www.phmsa.dot.gov/regulations.

Section 9.0 Resources

APHL, Members Laboratories List. https://www.aphl.org/membership/Pages/memberlabs.aspx

AWWA. *Water & Wastewater Mutual Aid & Assistance Resource Typing Manual*, April 2008. Available at http://www.awwa.org/resources-tools/water-knowledge/emergency-preparedness/warn-resources.aspx

CDC, Laboratory Response Network (LRN) Website, https://emergency.cdc.gov/lrn/

CDC, Laboratory Information Website, the CDC laboratory information website at https://emergency.cdc.gov/labissues/

DOT, Hazardous materials information, Pipeline and Hazardous Materials Regulations Website, http://www.phmsa.dot.gov/regulations

OSHA, Hazardous waste operation and emergency response regulations, https://www.osha.gov/law-regs.html

U.S. Congress. *Public Health Security and Bioterrorism Preparedness and Response Act of 2002*. PL 107-188. June 2002. https://www.gpo.gov/fdsys/pkg/PLAW-107publ188/pdf/PLAW-107publ188.pdf

USEPA. *All Hazards Receipt Facility Screening Protocol*, September 2008, EPA/600/R-08/105 and DHS/S&T-PUB-08-0001. https://cfpub.epa.gov/si/si_public_file_download.cfm?p_download_id=483614

USEPA, *Compendium of Environmental Testing Laboratories*, Online Database. https://cfext.epa.gov/cetl

USEPA. *Emergency Response Plan Guidance for Small and Medium Community Water Systems to Comply with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002*, April 2004. https://www.epa.gov/waterutilityresponse/emergency-response-plan-guidance-small-and-medium-community-water-systems

USEPA. *Large Water System Emergency Response Plan Outline: Guidance to Assist Community Water Systems in Complying with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002*, July 2003. https://www.epa.gov/waterutilityresponse/emergency-response-plan-guidance-large-community-water-systems

USEPA. *Rapid Screening and Preliminary Identification Techniques and Methods*, September 2010, EPA/600/R-10/090. https://www.epa.gov/homeland-security-research/rapid-screening-and-preliminary-identification-techniques-and-methods

USEPA. *Response Protocol Toolbox: Planning for and Responding to Drinking Water Contamination Threats and Incidents, Module 3: Site Characterization and Sampling Guide*, December 2003. Interim Final. https://www.epa.gov/waterutilityresponse/module-3-site-characterization-and-sampling-guide-drinking-water-utilities

USEPA. *Sample Collection Information Document for Chemical and Radiochemical Analytes*, September 2014, EPA/600/R-14/215. https://www.epa.gov/homeland-security-research/sample-collection-information-document-chemical-radiochemical-analytes

USEPA. *Sample Collection Information Document for Pathogens and Biotoxins*, June 2010, EPA/600/R-09/074. https://www.epa.gov/homeland-security-research/sample-collection-information-document-pathogens-and-biotoxins-companion

USEPA, *Sample Collection Procedures for Radiochemical Analytes in Environmental Matrices*, July 2012. EPA/600/R-12/566. https://www.epa.gov/homeland-security-research/sample-collection-procedures-radiochemical-analytes-environmental

USEPA, *Selected Analytical Methods for Environmental Remediation and Recovery (SAM) - 2012*, July 2012. EPA/600/R-12/555. https://www.epa.gov/homeland-security-research/sam

USEPA, *Water Laboratory Alliance – Response Plan (WLA-RP)*, November 2010. EPA-817-R-10-002. https://www.epa.gov/waterlabnetwork/water-laboratory-alliance-response-plan

Appendix A Acronyms and Abbreviations

% w/v	Percent weight over volume
AA	Atomic absorption
ACS	American Chemical Society
APHL	Association of Public Health Laboratories
AWWA	American Water Works Association
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
CM	Consequence Management
CMP	All-Hazard Consequence Management Planning for the Water Sector
CO	Carbon monoxide
COC	Chain of custody
CT	Chemiluminescence toxicity
CWA	Chemical warfare agent
DOT	U.S. Department of Transportation
ELCD	Electrolytic conductivity detector
EOC	Emergency Operations Center
EPA	U.S. Environmental Protection Agency
ERLN	Environmental Response Laboratory Network
ERP	Emergency response plan
ERT	Environmental response team
ETV	Environmental Technology Verification
g	Gram
GC	Gas chromatograph
GC/MS	Gas chromatography/mass spectrometry or gas chromatograph/mass spectrometer
G-M	Geiger-Mueller
GPS	Global positioning system
H_2S	Hydrogen sulfide
HASP	Health and safety plan
HAZCAT	Hazardous characterization
HazMat	Hazardous materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	Hydrochloric acid
HDPE	High density polyethylene
HNO_3	Nitric acid
HPLC	High performance liquid chromatography

HSEEP	Homeland Security Exercise and Evaluation Program
HSPD 9	Homeland Security Presidential Directive 9
H_2SO_4	Sulfuric acid
ICLN	Integrated Consortium of Laboratory Networks
ICP-AES	Inductively coupled plasma atomic emission spectroscopy
ICP-MS	Inductively coupled plasma mass spectrometry
L	Liter
LC-MS	Liquid chromatography-mass spectrometry
LLE	Liquid-liquid extraction
LRN	Laboratory Response Network
M	Molar
mg	Milligrams
mg/L	Milligrams per liter
mL	Milliliters
mm	Millimeters
MS/MSD	Matrix spike/matrix spike duplicate
N/A	Not applicable
NaOH	Sodium hydroxide
NHSRC	National Homeland Security Research Center
NIOSH	National Institute for Occupational Safety and Health
NRS	National Response System
O_2	Oxygen
OP	Organophosphate
ORP	Oxidation reduction potential
OSC	On-scene coordinator (EPA or other federal agency)
OSHA	Occupational Safety and Health Administration
P&T	Purge and trap
PCR	Polymerase chain reaction
PBS	Phosphate buffered saline
PID	Photoionization detector
ppb	Parts per billion
PPE	Personal protective equipment
PTFE	Polytetrafluoroethylene
PVC	Polyvinyl chloride
QA	Quality assurance
QC	Quality control

RPTB	Response Protocol Toolbox
S&A	Sampling and Analysis
SAM	Selected Analytical Methods for Environmental Remediation and Recovery
SCBA	Self-contained breathing apparatus
SDWA	Safe Drinking Water Act
SOP	Standard operating procedure
SPE	Solid-phase extraction
SPME	Solid-phase microextraction
SRS	Surveillance and Response System
SVOC	Semi-volatile organic compound
TBD	To be determined
TTEP	Technology Testing and Evaluation Program
U.S.C.	United States Code
UV	Ultraviolet
VOC	Volatile organic compound
WARN	Water/Wastewater Agency Response Network
WLA	Water Laboratory Alliance
WLA-RP	Water Laboratory Alliance Response Plan
WSI	Water Security Initiative

Appendix B Glossary

Composite Sample - a sample composed of several specific aliquots collected at various sample locations or different points in time, which are then combined to form one composite sample.

"Confirmed" - in the context of the *threat evaluation* process, a water contamination incident is "confirmed" if the information collected over the course of the threat evaluation provides definitive evidence that the water has been contaminated.

Contamination Site - the location where a contaminant is known or suspected to have been introduced into a drinking water system. For example, a distribution system storage tank where a security breach has occurred may be designated as a suspected contamination site. The contamination site should likely be designated as an *investigation site* for the purpose of *site characterization*.

Core Field Testing - analysis performed at the investigation site for radiation, cyanide, residual chlorine, and pH. Core field testing is performed as part of *site characterization* and is composed of two elements, *field safety screen* and *rapid field testing*.

"Credible" - in the context of the *threat evaluation* process, a water contamination threat is characterized as "credible" if information collected during the threat evaluation process corroborates information from the *threat warning*.

Emergency Response Plan (ERP) - a document that describes the actions that a drinking water utility would take in response to various emergencies, disasters, and other unexpected incidents.

Expanded Field Testing - analysis of water at the site of a suspected contamination incident for parameters beyond those covered under core field testing (e.g., VOCs, chemical weapons, toxins, etc).

Field Safety Screening - screening performed to detect any environmental hazards (e.g., in the air or on surfaces) that might pose a threat to the *site characterization* team. Monitoring for radioactivity as the team approaches the site is an example of field safety screening.

Grab Sample - a single sample collected at a particular time and place that represents the composition of the water, air, or soil only at that time and location.

Infectious Substance - a material known to contain, or reasonably expected to contain, a pathogen.

Investigation Site - the location where site characterization activities are performed. If a suspected *contamination site* has been identified, it should likely be designated as a primary investigation site. Additional or secondary investigation sites may also be identified due to the potential spread of a contaminant.

Non-target analytes - contaminants that are on the analyte list of a method but have not been targeted for calibration by the laboratory. For example, a laboratory may only calibrate for lead and copper using 200.8 but the method can detect many other elements.

Tentatively identified compounds - unknown contaminants tentatively identified by their mass spectra using a mass spectral library. These may not even be on the analyte list of the method. It is a unique capability of GC-MS methods operated in scanning mode although NIST is also developing LC-MS/MS libraries. Tentatively identified and non-targeted compounds must be confirmed using reference standards

Pathogen - an infectious microbial organism that is capable of causing disease.

Personal protective equipment (PPE) - equipment and supplies designed to protect employees from serious injuries or diseases resulting from contact with chemical, radiochemical, pathogen, or other hazards. PPE includes face shields, safety glasses, goggles, laboratory coats, gloves, and respirators. Additional requirements can be determined after a site specific review for potential contaminants or other safety requirements.

"Possible" - in the context of the *threat evaluation* process, a water contamination threat is characterized as "possible" if the circumstances of the *threat warning* appear to have provided an opportunity for contamination.

Quality Assurance - an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Control - the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the client; operational techniques and activities that are used to fulfill requirements for quality.

Rapid Field Testing - analysis of water during *site characterization* using rapid field water testing technology in an attempt to tentatively identify contaminants or unusual water quality.

Responder - Person or Persons who initially act upon an emergency scene. First responders are typically internal trained personnel, police or fire fighters. These people are generally trained in OSHA First Response.

Site Characterization - the process of collecting information from an *investigation site* to support the evaluation of a drinking water contamination threat. Site characterization activities include the site investigation, *field safety screening*, *rapid field testing* of the water, and sample collection.

Site Perimeter - the boundary of the protective action zone at the site of a suspected contamination incident.

Transporter - person or company who assumes custody of samples between packing and receipt by a certified laboratory. This person or company should sign all documentation or provide written documentation of delivery to ensure that samples have not been tampered with.

Note: A cooler can be custody sealed at the sampling site to provide evidence that it has not been opened and the samples tampered with if a commercial carrier is used.

Ultrafiltration - a filtration process for water that uses a selective membrane to preferentially separate and retain particles that are larger than the membrane's molecular weight cut-off, typically greater than 30,000 Daltons.

Appendix C Example of a Site Characterization and Sampling Plan

Note: Adapted from the RPTB: Module 3.

GENERAL INFORMATION

Date: _____ **Time arrived at investigation site:** _____

Name of Site Characterization Team Leader: _____

Phone No.: _____ **Fax No.:** _____

LOCATION OF INVESTIGATION SITE

Site Name: _____

Type of facility:

- ☐ Distribution main
- ☐ Elevated storage tank
- ☐ Finished water reservoir
- ☐ Treatment plant
- ☐ Ground storage tank
- ☐ Hydrant
- ☐ Pump station
- ☐ Other
- ☐ Sampling Tap
- ☐ Service connection
- ☐ Source water

_____

Address: _____

_____

Weather Conditions at Site: _____

_____

Additional Site Information: _____

_____

APPROACH TO SITE

Time of Approach to Site: _____

Initial Field Safety Screening (as listed in the "Site Characterization Plan"):

- ☐ Biological agents
- ☐ Chemical weapons
- ☐ Other_____
- ☐ HAZCAT
- ☐ None
- ☐ Radiation
- ☐ Volatile chemicals

Report results of field safety screening in "Field Testing Report Form."
If any field safety screening result is above the corresponding reference value, immediately notify incident command and do not proceed further into the site.

Initial Observation and Assessment of Immediate Hazards

- ☐ Unauthorized individuals present at the site
- ☐ Fire or other obvious hazard
- ☐ Signs of a potential explosive hazard (e.g., devices with exposed wires)
- ☐ Signs of a potential chemical hazard (e.g., dead animals, unusual fogs, unusual odors)
- ☐ Unusual and unexplained equipment at the site
- ☐ Other signs of immediate hazard _____

If there are any indicators of immediate hazard, immediately notify incident command and do not proceed further into the site.

Report initial observations and results to incident commander.
Approval granted to proceed further into the site? ☐ Yes ☐ No

SITE INVESTIGATION
Time of Entry to Site: _____

Repeat Field Safety Screening
☐ Pathogen agents ☐ HAZCAT ☐ Radiation
☐ Chemical weapons ☐ None ☐ Volatile chemicals
☐ Other _____

Report results of field safety screening in "Field Testing Report Form."
If any field safety screening result is above the corresponding reference value, immediately notify incident command and do not proceed further into the site.

Signs of Hazard:
☐ None ☐ Unexplained dead animals
☐ Unexplained dead or stressed vegetation ☐ Unexplained clouds or vapors
☐ Unexplained liquids ☐ Other _____

Describe signs of hazard: _____
_____
_____
_____

Unexplained or Unusual Odors:
☐ Bitter almond ☐ New mown hay ☐ Sulfur
☐ Irritating ☐ Pungent ☐ Sweet/Fruity
☐ None ☐ Skunky ☐ Other _____

Describe unusual odor: _____
_____
_____

Unusual Vehicles Found at the Site:
☐ Car/sedan ☐ Flatbed truck ☐ Pickup truck
☐ Construction vehicle ☐ None ☐ SUV
☐ Other _____

Describe vehicles (including make/model/year/color, license plate #, and logos or markings): ___
_____
_____
_____
_____

Signs of Tampering:
☐ Cut locks/fences ☐ None
☐ Facility in disarray ☐ Open/damaged access hatches
☐ Missing/damaged equipment ☐ Open/damaged gates, doors, or windows
☐ Other _____

Signs of sequential intrusion (e.g., locks removed from a gate and hatch)?

☐ Yes ☐ No

Describe signs of tampering: _____

_____

_____

_____

Unusual Equipment:

☐ Discarded PPE (e.g., gloves, masks) ☐ None
☐ Hardware (e.g., valves, pipe) ☐ Pumping equipment
☐ Lab equipment (e.g., beakers, tubing) ☐ Tools (e.g., wrenches, bolt cutters)
☐ Other _____

Describe equipment: _____

_____

_____

_____

Unusual Containers:

Type of container:

☐ Bottle/Jar ☐ Drum/Barrel ☐ Pressurized cylinder
☐ Box/Bin ☐ None ☐ Test Tube
☐ Bulk container ☐ Plastic bag ☐ Other _____

Condition of container:

☐ Damaged/leaking ☐ New ☐ Opened
☐ Intact/dry ☐ Old ☐ Unopened

Size of container: _____

Describe labeling on container: _____

_____

Describe visible contents of container: _____

_____

Rapid Field Testing of the Water

☐ Cyanide ☐ Pesticides ☐ Residual disinfectant
☐ General toxicity ☐ pH / conductivity ☐ Toxins
☐ None ☐ Radiation ☐ VOCs and SVOCs
☐ Chlorine Residual ☐ Other _____

Report results of rapid field testing of the water on the "Field Testing Report Form."
If any field test result is above the corresponding reference value, immediately notify incident command and wait for instruction regarding how to proceed.

Report findings of site investigation to incident commander.

Approval granted to proceed with sample collection? ☐ Yes ☐ No

SAMPLING

Time Sampling was Initiated / Completed: _____ /_____

Implement Sampling Procedures Appropriate for the Hazard Conditions at the Site:

- ☐ Biological hazard
- ☐ Chemical hazard
- ☐ Low hazard
- ☐ Radioactive hazard

If the site is characterized as a biological (pathogen), chemical, or radioactive hazard, then special sampling and safety procedures should be followed.

Safety Checklist:

- ☐ **Do not** eat, drink, or smoke at the site.
- ☐ **Do not** taste or smell the water samples.
- ☐ **Do** use the general PPE included in the emergency water sampling kit.
- ☐ **Avoid** all contact with the water, and flush immediately with clean water in the case of contact.
- ☐ **Slowly fill** sample bottles to avoid volatilization and aerosolization.
- ☐ **Minimize** the time that personnel are on site and collecting samples.

General Sampling Guidelines:

- ☐ Properly label each sample bottle.
- ☐ Carefully flush sample taps prior to sample collection, if applicable.
- ☐ Collect samples according to method requirements (e.g., without headspace for VOCs).
- ☐ Add preservatives or disinfection reducing agents as specified.
- ☐ Carefully close sample containers and verify that they do not leak.
- ☐ Wipe the outside of sample containers with a mild bleach solution if there was any spillage.
- ☐ Place sample containers into a sealable plastic bag.
- ☐ Place samples into an appropriate, rigid shipping container.
- ☐ Pack container with frozen ice packs.
- ☐ Complete “Sampling Event Report Form”.
- ☐ Complete “Chain-of-Custody Form”.
- ☐ Secure shipping container with custody tape.
- ☐ Comply with any other sample security provisions required by participating agencies.

EXITING THE SITE

Time of Site Exit: _____

Site Exit Checklist

- ☐ Verify that hatches, locks, etc., are properly secured.
- ☐ Remove all samples, equipment, and materials from the site.
- ☐ Verify that all samples are in the cooler and properly seal the cooler.
- ☐ Remove all PPE at site perimeter.
- ☐ Place disposable PPE and other trash into a heavy-duty plastic trash bag.
- ☐ Verify that the perimeter has been properly secured before leaving the site.
- ☐ Ensure that all documentation has been completed before leaving the site perimeter.
- ☐ Comply with any site control measures required by participating agencies.
- ☐ Contact incident commander and inform them that the team is leaving the site.

SIGNOFF

Site Characterization Team Leader:

Print name _____

Signature _____ Date/Time: _____

Appendix D Example of a Sampling Event Report Form

Sampling Event Report Form				
Collection Information	Date:		Site Name:	
Sample Owner and/or Collector:	Signature:			
Level of PPE Used:	Weather Conditions:			
Additional Agencies Involved:	Agency Contact Information:			
Signature of Agency Representative(s):	Analytical Service Requestor (ASR):			
Site and Sample Description				
Sample ID	**Sample Location**	**Time**	**Sample Amount (volume or weight)**	**Sample Type (Matrix)**
Matrix: DW = Drinking Water, RW = Reservoir Water, UW=Untreated Water, SD = Sediment, SL = Sludge, SO = Soil, SM = Misc. Solid Material				
Incident Details				
Describe the number of people exposed and the types of symptoms they are experiencing:				
General conditions of exposed flora and fauna (if available):				
Describe the event and reason for sample collection:				

Appendix E Example of a Field Testing Report Form

Field Testing Report Form								
Date of Testing:		Site Name:			Field Tester:		Contact Information:	
Sample ID	Parameter	Units	Screen	Meter/Kit ID	Testing Location	Time	Results	Reference Value
Comments/Additional Information:								

Appendix F Example of a Photograph Log

Example Photograph Log			
Sample Identification Number and Location:			Photographer
Camera:	Video	If Nondigital:	Film Type
	Digital		Film Roll Number
	Nondigital		
Photo #	Date and Time		Location/Description

Appendix G Example of a Chain-of-Custody Form

Chain-of-Custody Form								
Site Name:				Sample Owner/Collector:				
Contact Information:				Signature:				
Sample ID	Collection Date/Time (24 h)	Sample Location	Sample Type (Matrix)	Grab/ Composite	Preservative(s)	No./ of Bottles	Bottle Type	Comments
Matrix: DW = Drinking Water, RW = Reservoir Water, UW=Untreated Water								
Relinquished By:			Received by:			Date/Time:		
Relinquished By:			Received by:			Date/Time:		
Relinquished By:			Received by:			Date/Time:		
Relinquished By:			Received by:			Date/Time:		
Relinquished By:			Received by:			Date/Time:		
Dispatched by:		Date/Time:		Received by:		Date/Time:		
Analytical Service Requestor (ASR):				Contact Information:				
Method of Sample Transport:								
Shipper:		Phone No.:			Tracking No.:			

Attach additional pages as required.