United States
Environmental Protection
Agency

Response Protocol Toolbox: Planning for and Responding to Drinking Water Contamination Threats and Incidents

Interim Final - December 2003

Module 3: Site Characterization and Sampling Guide





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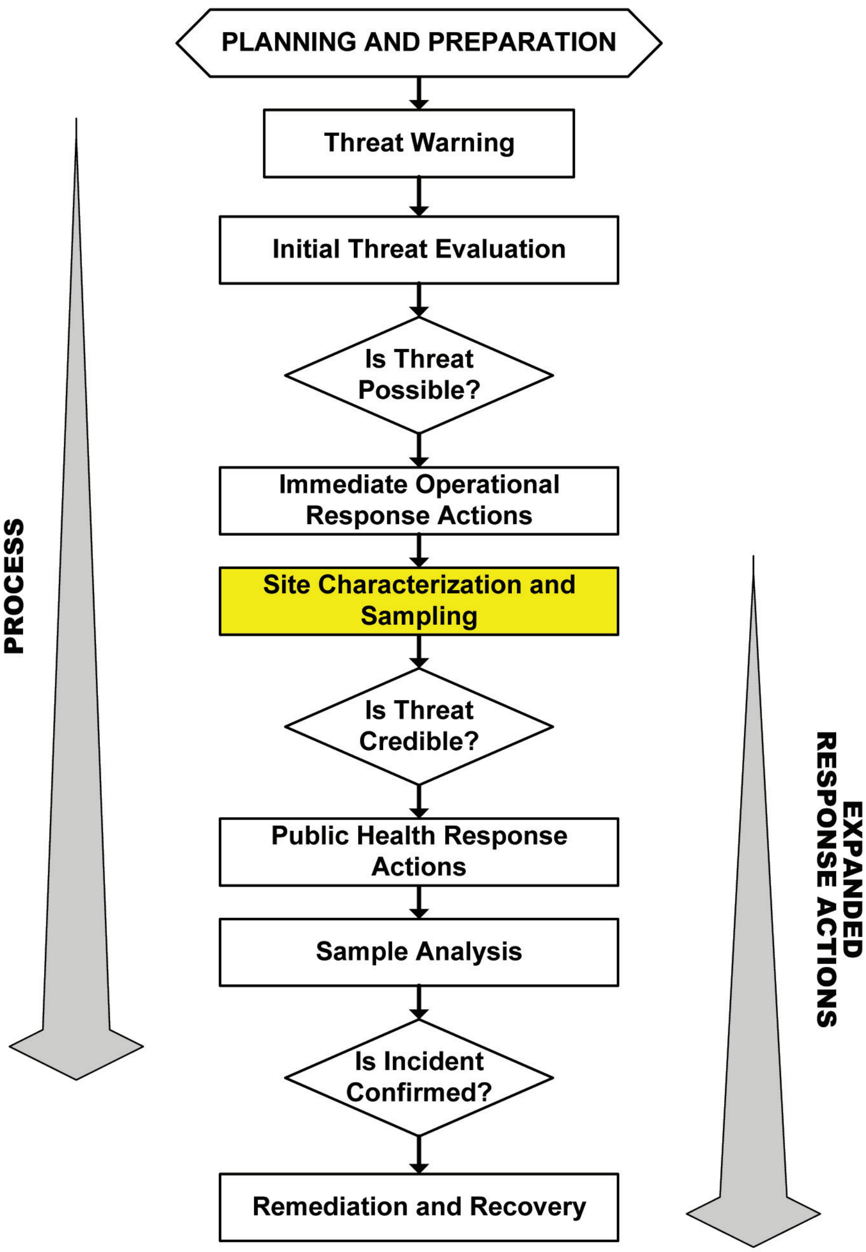

OTHER RESPONSE PROTOCOL TOOLBOX MODULES

Module 1: Water Utility Planning Guide *(December 2003)*
Module 1 provides a brief discussion of the nature of the contamination threat to the public water supply. The module also describes the planning activities that a utility may undertake to prepare for response to contamination threats and incidents.

Module 2: Contamination Threat Management Guide *(December 2003)*
Module 2 presents the overarching framework for management of contamination threats to the drinking water supply. The threat management process involves two parallel and interrelated activities: 1) evaluating the threat, and 2) making decisions regarding appropriate actions to take in response to the threat.

Module 3: Site Characterization and Sampling Guide *(December 2003)*
Module 3 describes the site characterization process in which information is gathered from the site of a suspected contamination incident at a drinking water system. Site characterization activities include the site investigation, field safety screening, rapid field testing of the water, and sample collection.

Module 4: Analytical Guide *(December 2003)*
Module 4 presents an approach to the analysis of samples collected from the site of a suspected contamination incident. The purpose of the Analytical Guide is **not** to provide a detailed protocol. Rather, it describes a framework for developing an approach for the analysis of water samples that may contain an unknown contaminant. The framework is flexible and will allow the approach to be crafted based on the requirements of the specific situation. The framework is also designed to promote the effective and defensible performance of laboratory analysis.

Module 5: Public Health Response Guide *(available March 2004)*
Module 5 deals with the public health response measures that would potentially be used to minimize public exposure to potentially contaminated water. It discusses the important issue of who is responsible for making the decision to initiate public health response actions, and considers the role of the water utility in this decision process. Specifically, it examines the role of the utility during a public health response action, as well as the interaction among the utility, the drinking water primacy agency, the public health community, and other parties with a public health mission.

Module 6: Remediation and Recovery Guide *(available March 2004)*
Module 6 describes the planning and implementation of remediation and recovery activities that would be necessary following a confirmed contamination incident. The remediation process involves a sequence of activities, including: system characterization; selection of remedy options; provision of an alternate drinking water supply during remediation activities; and monitoring to demonstrate that the system has been remediated. Module 6 describes the types of organizations that would likely be involved in this stage of a response, and the utility's role during remediation and recovery.

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ACRONYMS

AWWARF	American Water Works Association Research Foundation
CDC	Centers for Disease Control and Prevention
CHRIS	Chemical Hazards Response Information System
ERP	Emergency response plan
ETV	Environmental Technology Verification
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FRP	Federal Response Plan
HazMat	Hazardous materials
HDPE	High density polyethylene
ISAC	Information Sharing and Analysis Center
LRN	Laboratory Response Network
MWCO	Molecular weight cut-off
OSC	On scene coordinator
PPE	Personal protective equipment
psi	Pounds per square inch
QA	Quality assurance
QC	Quality control
SCADA	Supervisory control and data acquisition
SDWA	Safe Drinking Water Act
SVOC	Semi-volatile organic chemical
TOC	Total organic carbon
URL	Uniform resource locator
US EPA	United States Environmental Protection Agency
USGS	U.S. Geological Survey
UV	Ultraviolet
VOC	Volatile organic chemical
WCIT	Water contaminant information tool
WUERM	Water utility emergency response manager

GLOSSARY

Definitions in this glossary are specific to the Response Protocol Tool Box but conform to common usage as much as possible.

Analytical Approach – a plan describing the specific analyses that are performed on the samples collected in the event of a water contamination threat. The analytical approach is based on the specific information available about a contamination threat.

Analytically Confirmed – in the context of the *analytical approach*, a contaminant is considered to be analytically confirmed if it has undergone analytical confirmation, as defined herein.

Analytical Confirmation – the process of determining an analyte in a defensible manner.

Causative Agent – the pathogen, chemical, or other substance that is the cause of disease or death in an individual.

Composite Sample – a sample composed of several specific aliquot collected at various sample locations and/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 will 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*.

Drinking Water Primacy Agency – the *agency* that has primary enforcement responsibility for national drinking water regulations, namely the Safe Drinking Water Act as amended. Drinking water primacy for a particular state may reside in one of a variety of agencies, such as health departments, environmental quality departments, etc. The drinking water primacy agency is typically the State Health Agency or the State Environmental Agency. The drinking water primacy agency may also play the role of *technical assistance provider* to drinking water utilities.

Emergency Operations Center – a pre-designated facility established by an agency or jurisdiction to coordinate the overall agency or jurisdictional response and support to an emergency.

Emergency Response Plan – 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, biotoxins, 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.

Field Sample Concentrate – the term used for the retentate from the ultrafiltration device used for sampling/concentration of unknown microbial contaminants.

Filtrate – in ultrafiltration, the water that passes through the membrane and which contains no particles smaller than the molecular weight cutoff of the membrane.

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.

Hazard Assessment – the process of evaluating available information about the site for identify potential hazards that might pose a risk to the site characterization team. The hazard assessment results in assigning one of four levels to risk: low hazard, radiological hazard, high chemical hazard, or high biological hazard.

Immediate Operational Response – an action taken in response to a 'possible' contamination threat in an attempt to minimize the potential for exposure to the potentially contaminated water. Immediate operational response actions will generally have a negligible impact on consumers.

Incident Commander – the individual responsible for the management of all incident operations.

Investigation Site – the location where site characterization activities are performed. If a suspected *contamination site* has been identified, it will 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.

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 diseasees resulting from contact with chemical, radiological, biological, or other hazards. PPE includes face shields, safety glasses, goggles, laboratory coats, gloves, and respirators.

'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.

Protective Action Zone – at the site of a hazardous materials incident, this is the zone that is potentially dangerous to life and health, and specialized *PPE* is required to enter and perform work in this zone. This zone may also be referred to as the exclusion zone.

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.

Response Guidelines – a manual designed to be used **during** the response to a water contamination threat. Response Guidelines should be easy to use and contain forms, flow charts, and simple instructions to support staff in the field or decision officials in the *Emergency Operations Center* during management of a crisis.

Retentate - in ultrafiltration, the retentate is the solution that contains the particles that do not pass through the membrane filter. The retentate is also called the concentrate.

Secure Area – a locked space, such as a cabinet or vault, with access restricted to authorized personnel.

Site Characterization – the process of collecting information from an *investigation site* in order 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 Characterization Plan – a brief document that summarizes the activities that will occur during the characterization of an *investigation site*. The plan may be generic in that it covers the general scope of activities, or customized to describe the activities that will occur at a specific investigation site in response to a specific threat warning.

Site Characterization Team – the individual or group that is responsible for the implementation of all site characterization activities, including: the site investigation, *field safety screening*, *rapid field testing* of the water, and sample collection. A site characterization team benefits from expertise in the areas of water quality, security, and operations. Under hazardous conditions, individuals with expertise in responding to hazardous sites should be part of the team.

Site Characterization Team Leader – the individual or group that is responsible for the coordinating the site characterization activities in the field and ensuring that incident command remains informed as those activities progress.

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

Staging Area – location set up outside of the *protective action zone* at the site of a suspected contamination incident where resources can be placed while awaiting assignment and other operations such as personnel decontamination can be safely performed.

Technical Assistance Provider – any organization or individual that provides assistance to drinking water utilities in meeting their mission to provide an adequate and safe supply of water to their customers. The *drinking water primacy agency* may serve as a technical assistance provider.

Tentative Identification – the contaminant identity is hypothesized based on available information from the site characterization report. Examples of situations in which tentative identification might occur include: a specific contaminant named in a threat; tentatively positive results for a specific contaminant during field safety screening or rapid field testing; physical evidence at the site pointing to a specific contaminant; and clinical evidence of the identity of the disease-causing agent.

Threat – an indication that a harmful *incident*, such as contamination of the drinking water supply, may have occurred. The threat may be direct, such as a verbal or written threat, or circumstantial, such as a security breach or unusual water quality.

Threat Evaluation – part of the threat management process in which all available and relevant information about the threat is evaluated to determine if the threat is ‘possible’ or ‘credible’, or if a contamination *incident* has been ‘confirmed.’ This is an iterative process in which the threat evaluation is revised as additional information becomes available. The conclusions from the threat evaluation are considered when making *response decisions*.

Threat Management – the process of evaluating a contamination threat and making decisions about appropriate response actions. The threat management process includes the parallel activities of the *threat evaluation* and making *response decisions*. The threat management process is considered in three stages: ‘possible’, ‘credible’, and ‘confirmatory.’ The severity of the threat and the magnitude of the response decisions escalate as a threat progresses through these stages.

Threat Warning – an unusual occurrence, observation, or discovery that indicates a potential contamination incident and initiates actions to address this concern.

Ultrafiltration – a filtration process for water that uses membranes to preferentially separate very small particles that are larger than the membrane's molecular weight cut-off, typically greater than 10,000 Daltons.

Water Contamination Incident – a situation in which a contaminant has been successfully introduced into the system. A water contamination incident may or may not be preceded by a water contamination threat.

Water Contamination Threat – a situation in which the introduction of a contaminant into the water system is threatened, claimed, or suggested by evidence. Compare *water contamination threat* with *water contamination incident.* Note that tampering with a water system is a crime under the Safe Drinking Water Act as amended by the Bioterrorism Act.

Water Utility Emergency Response Manager (WUERM) – the individual(s) within the drinking water utility management structure that has the responsibility and authority for managing certain aspects of the utility's response to an emergency (e.g., a contamination threat) particularly during the initial stages of the response. The responsibilities and authority of the WUERM are defined by utility management and will likely vary based on the circumstances of a specific utility.

1 Introduction

Site characterization is defined as the process of collecting information from an investigation site in order to support the evaluation of a drinking water contamination threat. Site characterization activities include the site evaluation, *field safety screening*, *rapid field testing* of the water, and sample collection. The *investigation site* is the focus of site characterization activities, and if a suspected *contamination site* has been identified, it will likely be designated as the primary investigation site. Additional or secondary investigation sites may be identified due to the potential spread of a suspected contaminant. The results of site characterization are of critical importance to the *threat evaluation* process described in Module 2. Module 3 describes procedures and protocols for implementing site characterization activities, which should be adapted to a user's specific needs and objectives rather than interpreted as prescriptive guidelines.

There are two broad phases of site characterization: planning and implementation. The *incident commander* is responsible for planning, while the *site characterization team* is responsible for implementing the site characterization plan. This module is intended as a resource for those involved in either the planning or implementation phases of site characterization. While the target audience is primarily drinking water utility managers and staff, other organizations may be involved in site characterization activities. Thus, this module may be useful to first responders (e.g., police and fire departments), HazMat responders, law enforcement (e.g., FBI and EPA criminal investigators), Civil Support Teams, and environmental response teams from EPA or other government agencies.

This module, like the entirety of the "Response Protocol Toolbox," was developed as a planning tool. Individuals involved in planning or implementing site characterization activities are encouraged to review this module in its entirety, as well as the other modules in the "Response Protocol Toolbox," to obtain a more comprehensive understanding of the threat management process. The objectives of Module 3 are to:

- Describe planning and implementation of site characterization activities in response to a water contamination threat.
- Describe procedures for the site evaluation, field safety screening, rapid field testing, sample collection, and sample transport.

This module is organized into eight sections as described below.

Section 1: Introduction: Describes the objectives and overall organization of this module.

Section 2: Overview of Site Characterization Process: Summarizes the process of site characterization, including planning, conducting on-site activities, sample collection and sample shipping to a laboratory for analysis. Detailed information is presented in subsequent sections.

Section 3: <u>Planning for Site Characterization</u>: Describes planning and preparation necessary for the safe and effective implementation of site characterization activities.

Section 4: <u>Site Characterization Protocol</u>: Describes the activities performed under each of the five stages of site characterization: customizing the site characterization plan, approaching the site, characterizing the site, sample collection, and exiting the site.

Section 5: <u>Site Characterization Report</u>: Describes how information from site characterization activities can be documented in order to evaluate the credibility of a threat and make decisions regarding appropriate response actions.

Section 6: <u>Sample Packing and Transport</u>: Describes how samples should be packaged and transported to an analytical laboratory for analysis or archiving.

Section 7: <u>References and Resources</u>: Lists the references cited in this module and additional information resources.

Section 8: <u>Appendices</u>: Provides forms that support this module, which can be used to develop a utility's site-specific *Response Guidelines*.

2 Overview of Site Characterization Process

2.1 Process Overview

Figure 3-1 is a flow chart illustrating the site characterization process, and serves as a roadmap to the rest of the document. The site characterization process is considered in five stages:

1. Customizing the Site Characterization Plan. A site characterization plan is developed for a specific threat (possibly from a generic site characterization plan) and guides the team during site characterization activities (Section 4.1).
2. Approaching the Site. Before entering the site, an initial assessment of site conditions and potential hazards is conducted at the site perimeter (Section 4.2).
3. Characterizing the Site. The customized site characterization plan is implemented by conducting a detailed site investigation and rapid testing of the water (Section 4.3).
4. Collecting Samples. Water samples are collected in the event that laboratory analysis is required (Section 4.4).
5. Exiting the Site. Following completion of site characterization, the site is secured and personnel exit the site and undergo any necessary decontamination (Section 4.5).

These five stages are shown in the center of Figure 3-1. Various activities that may be performed during each of these stages are shown on the right side of the figure.

While site characterization can be considered and implemented as a discrete process, it is important to regard it as an element of the threat evaluation process, as discussed in Module 2. In particular, site characterization is an activity initiated in response to a *'possible'* contamination threat in order to gather information to help determine whether or not the threat is *'credible.'* This is graphically depicted in Figure 3-1 in which the threat evaluation process is represented the large arrow on the left with linkages to the site characterization process at key points. Initially, information from the threat evaluation supports the development of the customized *site characterization plan*. As this plan is implemented, the observations and results from site characterization feed into the threat evaluation. In turn, the revised threat evaluation may indicate that the threat is 'credible,' 'not credible,' or that the site characterization plan needs to be revised in the field to collect more information in order to make this determination. Because threat evaluation and site characterization are interdependent, the incident commander must be in constant communication with the site characterization team while they are performing their tasks.

The first step is to develop a customized site characterization plan, which is based on the specific circumstances of the *threat warning*. This customized plan may be adapted from a generic site characterization plan, which is developed as part of a utility's preparation for responding to contamination threats. The site characterization team will use the customized plan as the basis for their activities at the investigation site. After an initial evaluation of available information, it is necessary to identify an investigation site where site characterization activities will be conducted. During the development of the customized plan, it is important to conduct an initial assessment of site hazards, which is critical to the safety of the site characterization team and may impact the makeup of the team. If there are obvious signs of hazards at the site, then teams trained in hazardous materials safety and handling techniques, such as HazMat, may need to conduct an initial hazard assessment at the site and either "clear" the site for entry by utility personnel, or the HazMat team may decide to perform all site characterization activities themselves. Obvious signs of hazards would provide a basis for determining that a threat is 'credible.' Furthermore, the site might be considered a crime scene if there are obvious signs of hazards, and law enforcement may take over the site investigation.

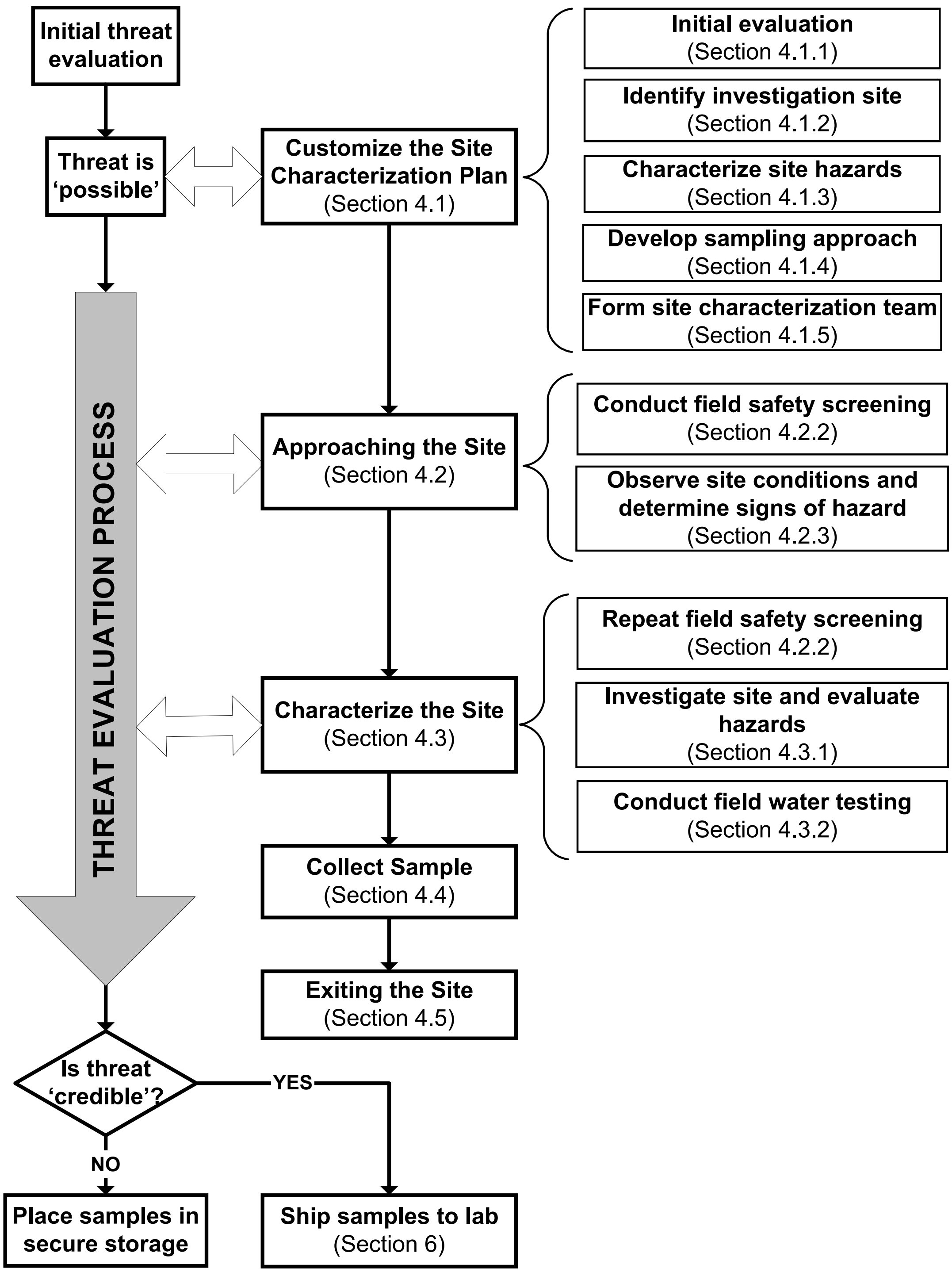

Figure 3-1. Overview of the Site Characterization Process

Upon arrival at the *site perimeter*, the team first conducts field safety screening and observes site conditions. The purpose of field safety screening activities is to identify potential environmental hazards that might pose a risk to the site characterization team. The specific field safety screening performed should be identified in the site characterization plan, and might include screens for radioactivity and volatile organic chemicals (VOCs). If the team detects signs of hazard, they should stop their investigation and immediately contact the incident commander to report their findings.

If no immediate hazards are identified during approach to the site, the incident commander will likely approve the team to enter the site and perform the site characterization. During this stage, the team will continue field safety screeningat the site, conduct a detailed site investigation, and perform rapid field testing of the water that is suspected of being contaminated.

Rapid field testing has three objectives: 1) provide additional information to support the threat evaluation process; 2) provide *tentative identification* of contaminants that would need to be confirmed later by laboratory testing; and 3) determine if hazards tentatively identified in the water require special handling precautions. The specific rapid field testing performed should be identified in the site characterization plan, and might include tests for chlorine residual and cyanide for example. Specific field testing performed should be based on the circumstances of the specific threat and should consider the training, experience and resources of the site characterization team. Negative field test results are **not** a reason to forgo water sampling (see below), since field testing is limited in scope and can result in false negatives.

Following rapid field testing, samples of the potentially contaminated water will be collected for potential laboratory analysis. The decision to send samples to a laboratory for analysis should be based on the outcome of the threat evaluation (Figure 3-1). If the threat is determined to be 'credible,' then samples should be immediately delivered to the laboratory for analysis per the guidance in Section 6. The *analytical approach* for samples collected from the site should be developed with input from the supporting laboratory(ies), based on information from the site characterization and threat evaluation (see Module 4 for guidance on developing an analytical approach). On the other hand, if the threat is determined to be 'not credible,' then samples should be secured and stored for a predetermined period in the event that it becomes necessary to analyze the samples at a later time.

At this point, response actions may be implemented to protect public health, as discussed in Module 2. However, if the threat is determined to be "not credible," then samples may be collected, preserved and stored in the event that it becomes necessary to analyze them later. Sample preservation is discussed below.

Upon completion of site characterization activities, the team should prepare to exit the site. At this stage, the team should make sure that they have documented their findings, collect all equipment and samples, and re-secure the site (e.g., lock doors, hatches and gates). If the site is considered to be a potential hazardous site or crime scene, there may be additional steps involved in exiting the site.

2.2 Roles and Responsibilities

The incident commander and the *site characterization team leader* are key personnel in site characterization. As discussed in Module 1, Section 4.4, the incident commander has overall responsibility for managing the response to the threat, and is responsible for planning and directing site characterization activities. The incident commander may also approve the site characterization team to proceed with their activities at key decision points in the process (e.g., whether or not to enter the site following the approach).

The site characterization team leader is responsible for implementing the site characterization plan in the field and supervising site characterization personnel. The site characterization team leader must coordinate and communicate with the incident commander during site characterization.

Depending on the nature of the contamination threat, other agencies and organizations may be involved or otherwise assume some responsibility during planning and implementation of site characterization activities. Various organizations that may be involved in site characterization are described below, with their potential roles and responsibilities. The incident commander has ultimate responsibility for determining the scope of the site characterization activities and the team makeup. Federal roles and responsibilities are dictated by the Federal Response Plan (FRP), which is described in Module 1, Appendix 6.2.

Water Utility – The water utility will be responsible for incident command(the *water utility emergency response manager* (WUERM) would be designated as the incident commander), unless another organization is designated. As incident commander, the WUERM would be responsible for planning and coordinating site characterization activities. Regardless of the organization responsible for incident command, the utility will be involved in site characterization activities. An employee of the water utility may be designated as the site characterization team leader. In cases where that responsibility is designated to another agency (e.g., HazMat), utility staff should be included on the site characterization team or as technical advisors to the team.

HazMat – Specialized response teams, such as HazMat, may assume responsibility for oversight of site characterization activities in situations where hazardous materials are suspected. In some situations, the HazMat team may limit their activities to characterization of site hazards and "clearing" the site for entry by utility personnel. The HazMat team may also elect to perform **all** site characterization activities with guidance from utility staff. The WUERM should understand how and under what circumstances HazMat teams might support site characterization activities.

Technical Assistance Providers – Other agencies, such as the *drinking water primacy agency*, US EPA hazardous material responders, or other specially trained response teams may assume responsibility for planning, oversight, and implementation of site characterization activities. Furthermore, this may provide the only means of performing site characterization for smaller utilities with limited resources. However, even at the smallest utility, the staff will at least need to play an advisory role during site characterization.

Laboratories – Laboratories will likely be responsible for the rapid analysis of samples collected by the site characterization team in response to a contamination threat. Thus, the laboratory(ies) should be engaged during both the hazard evaluation and site characterization activities if possible. The laboratory may provide the utility with sample kits to ensure that the sample containers are properly prepared and preserved for the methods and techniques that the laboratory would use in their analytical approach for unknown, or tentatively identified, contaminants in water samples. Furthermore, the laboratory will need information from site characterization to support the development of the analytical approach for a specific contamination threat. In some cases, the laboratory may be willing to send their staff to the site to assist with sample collection.

Local Law Enforcement Agencies – A law enforcement agency may assume responsibility for incident command in situations where criminal activity, excluding federal crimes, is suspected. In this case, law enforcement would likely manage the site in order to maintain the integrity of the crime scene while they proceed with their investigation. Local law enforcement and the utility should work together so that site characterization activities can be performed to determine if the threat is 'credible' or not, without compromising crime scene integrity.

Federal Bureau of Investigation (FBI) – FBI will assume responsibility for incident command when a federal crime, including terrorism, is suspected. As with local law enforcement, the FBI will maintain control of the site, and the utility will need to work with the FBI in a technical support role during site characterization. If FBI becomes involved and assumes command of the situation, they will make the credibility determination. Under these circumstances, site characterization is not as critical for threat evaluation but may be critical for determining the identity of the contaminant and the extent of contamination.

The site characterization activities presented in this module range from relatively simple activities, such as evaluating site conditions, to complex activities, such as field testing for unusual contaminants. The drinking water utility will need to decide in advance the extent of site characterization capabilities that they will develop within their own organization and those that would be provided by an external organization. For example, a drinking water utility may choose to develop a capability for performing the site evaluation and core field testing at low hazard sites. The utility may make arrangements with HazMat responders to provide support during the characterization of potentially hazardous site. The utility may also arrange with the contract lab to provide sample kits and sample containers. It is critical that the utility plan for those site characterization activities that they will take responsibility for, and make arrangements with agencies that will support the utility in the event that a situation exceeds the utility's resources and capability.

3 Planning for Site Characterization

This section describes the planning phase of site characterization and is divided into the following five subsections:

- Section 3.1, Safety and Personnel Protection: Summarizes basic safety practices appropriate for site characterization activities under low hazard conditions.
- Section 3.2, Sample Collection and Field Test Kits: Presents example designs for sample collection kits and field test kits, including a detailed discussion of the content of each.
- Section 3.3, Generic Site Characterization Plan: Describes how to develop a generic site characterization plan that may be customized in response to a specific contamination threat.
- Section 3.4, Evaluation of Baseline Water Quality Information: Discusses the importance of baseline data during the interpretation of the results of field testing and sample analysis.
- Section 3.5, Quality Assurance for Field Testing and Sampling: Provides general guidance regarding quality assurance activities that may be appropriate during site characterization activities.
- Section 3.6, Maintaining Crime Scene Integrity: Provides general guidelines for maintaining crime scene integrity during site characterization activities.

Providing training of staff involved in site characterization and sampling activities is critical. Responding to the site of a potential contamination incident is very different from routine inspection and sampling activities performed by utility staff. The equipment and safety procedures used at the site of a potential contamination incident may differ significantly from those used during more typical field activities. Providing staff training in the procedures presented in this module will help to ensure that they are properly and safely implemented during emergency situations (Module 1, Section 4.7 provides additional discussion of training needs).

3.1 Safety and Personnel Protection

Proper safety practices are essential for minimizing risk to the site characterization team and must be established prior to an incident in order to be effective. Field personnel involved in site characterization activities should have appropriate safety training to conform to appropriate regulations, such as OSHA 1910.120 (http://www.osha.gov), which deals with hazardous substances. If planners and field personnel do not conclude that these regulations are applicable to them, they may still wish to adopt some of the safety principles in these regulations. The following guidance is provided to help the user develop their own safety policies and practices. These safety policies should be consistent with the equipment and capabilities of the site characterization team and any applicable regulations.

The appropriate level of personal protection necessary to safely perform the site characterization activities will depend on the assessment of site hazards that might pose a risk to the site characterization team. An initial site hazard assessment will be performed during the development of a customized site characterization plan(see Section 4.1.3). The hazard assessment may be further refined during the approach to the site, based on the results of the field safety screening and initial observation of site conditions. Two general scenarios are considered, one in which there are no obvious signs of immediate hazards, and one in which there are indicators of site hazards.

In **most** cases, the investigation site or suspected contamination site will not present a significant hazard to the site characterization team, and basic equipment and training will be sufficient to conduct site characterization activities safely. Under these conditions, it is presumed that any contaminants that might be present are confined to water and are present at dilute concentrations where the risk to personnel can be minimized through the use of good safety practices, including:

- **Do not** eat, drink, or smoke at the site.
- **Do not** taste or smell the water samples.
- **Do** use general personal protective equipment (PPE) such as splash-proof goggles, disposable gloves, proper footwear (i.e., no open toe or open heel shoes), disposable shoe covers, a chemical resistant, disposable lab coat, and long pants.
- **Avoid** all skin contact with the water, and if incidental contact does occur, immediately flush the affected area with clean water brought to the site for that purpose.
- Fill sampling containers **slowly** to avoid volatilization or aerosolization of contaminants.
- **Minimize** the time that personnel are on the site and collecting samples.

(Note that the PPE described above is only intended to minimize incidental contact with the contaminated water or chemical reagents used during sample collection or field testing).

Basic good safety practices such as those listed above should be incorporated into a set of concise safety guidelines for personnel responsible for performing site characterization activities. These guidelines may be formalized into a health and safety plan (HASP). Information on HASPs is available at http://www.ertresponse.com/health_safety/index.htm, along with an electronic expert system jointly developed by EPA and OSHA (http://www.osha.gov/dts/osta/oshasoft/ehasp/) to help determine the appropriate health and safety hazards necessary for a particular situation.

In some cases, obvious signs of hazard may be observed at the time the threat is discovered or during the approach to the site, as described in Section 4.2.3. Under these conditions, only personnel with proper equipment and training for response to hazardous situations should enter the site and perform characterization activities, such as HazMat teams, EPA On Scene Coordinators (OSCs) and their supporting contractors, or FBI hazardous materials response teams.

Hazardous site conditions may also require the use of specialized sampling techniques in order to manage the risk of incidental exposure during sampling, sample transport, or sample receipt at a laboratory. Furthermore, it may be necessary to develop a site-specific safety plan for work performed on the site. If the specific hazards are known or suspected, such a site-specific plan can be tailored to those hazards, and appropriate *personal protective equipment* (PPE) for specific chemical contaminants can be found at the Chemical Hazards Response Information System (CHRIS) at http://www.chrismanual.com.

While the absence of signs of hazards may indicate that there is minimal risk to the site characterization team, it is not a certainty. There are risks associated with any on-site activities, whether they are related to the threat of intentional contamination or not. It is impossible to eliminate all risks, but risk can be managed through planning, training, and the use of proper techniques and procedures in the field.

3.2 Sample Collection Kits and Field Test Kits

Two types of kits are discussed in this section, sample collection kits and field test kits. Sample collection kits will generally contain all sample containers, materials, supplies, and forms necessary to perform sample collection activities. Field test kits contain the equipment and supplies necessary to perform field safety screening and rapid field testing of the water. Sample collection kits will generally be less expensive to construct than field test kits, and by constructing these two types of kits separately, sample collection kits can be pre-positioned throughout a system while the more expensive field test kits may be assigned to specific site characterization teams or personnel.

The design and construction of sample collection and field test kits is a planning activity, since these kits must be ready to go at a moments notice in response to a 'possible' contamination threat. In addition to improving the efficacy of the site characterization and sampling activities, advanced preparation of sample collection and field test kits offers several advantages:

- Sample collection and field test kits can be standardized throughout an area to facilitate sharing of kits in the event of an emergency that requires extensive sampling.
- Collection of a complete sample set is more likely to be achieved through the use of pre-designed kits.
- Sample collection kits can be pre-positioned at key locations to expedite the sampling process.
- Personnel responsible for site characterization can become familiar with the content of the kits and trained in the use of any specialized equipment.

3.2.1 Sample Collection Kits

Table 3-1 presents an **example** of a sample collection kit, while Table 3-2 provides a detailed listing of the sample containers included in the kit, and which are consistent with the analytical protocols presented in Module 4. The sample collection kit includes:

- Large plastic container for holding sample kit supplies
- Field resources and documentation
- General sampling supplies, including sample containers
- Pathogen sampling supplies
- Reagents
- Safety supplies

The sample collection kit described in this section is intended to illustrate the type of materials and supplies that might be useful during sampling activities; however, the design of a specific kit should be tailored to the needs and sampling objectives of the user. Furthermore, other organizations may need to be consulted in the design of a sample collection kit. For example, the laboratory may wish to provide sample containers and reagents that are consistent with the analytical approach for water samples potentially containing non-target analytes.

Table 3-1. Example Design of an Emergency Water Sample Collection Kit

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	48	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	Table 3-2	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	N/A	Beakers, graduated cylinders, spatula, etc.
Collapsible cooler	1	For sample storage
Rigid shipping container	1	For shipping by overnight service if needed.
1 qt. zippered freezer bags	1 pack100	For double bagging ice and sample containers
Thermometer	2	For checking water temperature
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
Ultrafiltration apparatus	1	For concentrating pathogen samples
Reagents (may need to be kept separate from the rest of the kit)		
Laboratory grade water	5 liters	For sample dilution in the field
Sodium thiosulfate crystals	100 grams	For water sample dechlorination
Ascorbic acid	100 grams	For water sample dechlorination
Sodium sulfite crystals	100 grams	For water sample dechlorination
Potassium dihydrogen citrate	100 grams	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
pH paper in ranges from 0 - 4 and 10 - 14	50 strips	For checking the pH of samples preserved with acid or base (sensitive to 0.5 pH units)
Safety Supplies		
Splash resistant goggles	2	One per individual (minimum)
Disposable gloves	6 pairs	Nitrile or polyethylene, powder-free
Disposable shoe covers	2 pairs	One pair per individual (minimum)
Disposable laboratory coats	2	One per individual (minimum)
Clear, heavy duty plastic trash bags	4	For disposal of lab coat, gloves, etc.
Rinse water	20 liters	For general use and first aid
Antiseptic wipes	1 container	For cleaning hands, sample containers, etc.
Bleach solution (at least 5%)	1 gallon	For decontamination if necessary
Squirt bottle	2	For use with rinse water or lab grade water
First aid kit	1	For general first aid
Flashlight/headlamp	3	For working at night or in dark locations

Table 3-2. Samples Containers for Emergency Water Sample Collection Kit

Sample Type	Container Size	Container Type	No.	Dechlorinating Agent	Preservative	Analytical Technique	Reference Methods
CHEMISTRY - BASIC SCREEN (Established Techniques)							
Organic Analytes							
Volatiles	40 mL	Glass w / Teflon faced septa	5	Ascorbic acid	1:1 HCl to pH < 2 See method.	P&T – GC/MS	EPA 524.2, 8260B
						P&T – GC/PID/ELCD	EPA 502.2, 8021B
Semi-volatiles	1 L	Amber w / Teflon-lined screw caps	4	Sodium sulfite	6M HCl. See method.	SPE GC/MS	525.2, 8270D/3535
Quarternary nitrogen compounds	1 L	Amber PVC or silanized glass	4	Sodium thiosulfate	Sulfuric acid to pH 2	SPE HPLC - UV	549.2
Carbamate Pesticides	40 mL	Glass w / Teflon faced septa	4	Sodium thiosulfate	Potassium dihydrogen citrate sample pH to ~3.8	HPLC-fluorescence	531.2
Inorganic Analytes							
Metals/Elements	125 mL	Plastic (i.e. HPDE)	2	None	Trace metal grade nitric acid. See method.	ICP-MS	200.8
						ICP-AES	200.7
						AA	200.9
Organometallic compounds	125 mL	Plastic (i.e. HPDE)	2	None	Nitric acid to pH ≤2. See method.	AA – cold vapor manual	245.1
						AA – cold vapor automater	245.2
Cyanide	1 L	Plastic	2	Ascorbic acid	Sodium hydroxide to pH 12. See method.	Titrimetric Spectrophotometric	335.2
						Colorimetric UV	335.3
Radiological	2 L	Plastic	2	None	None - mark samples not preserved	Gross alpha, gross beta, gamma isotopes, specific radionuclides	900 Series

Sample Type	Container Size	Container Type	No.	Dechlorinating Agent	Preservative	Analytical Technique	Reference Methods
CHEMISTRY - EXPANDED SCREEN (Exploratory Techniques)							
Unknown organics (volatile)	40 mL	Glass w / Teflon faced septa	5	None	None - mark samples not preserved	P&T-GC/MS	See Module 4
Unknown organics (general)	1 L	Amber Glass	4	None	None - mark samples not preserved	**Prep**: SPE, SPME, micro LLE, direct aqueous injection, headspace **Analysis**: GC/MS, GC, HPLC, LC-MS	See Module 4
Unknown inorganics	1 L	Plastic	2	None	None - mark samples not preserved	ICP-MS	See Module 4
Immunoassays	1 L	Amber Glass	2	Consult manufacturers instructions	Consult manufacturers instructions	Consult manufacturers instructions	None
PATHOGENS - EXPANDED SCREEN (Established and Exploratory Techniques)							
Pathogens - culture	100 mL	HDPE (plastic)	2	Thiosulfate	TBD	Per target pathogens	See Module 4
Pathogens - PCR	100 mL	HDPE (plastic)	2	Thiosulfate	TBD	Per target pathogens	See Module 4
BASELINE WATER QUALITY PARAMETERS (See Section 3.4)							
Water quality: bacteria	250 mL	Plastic	1	Thiosulfate	None	Fecal coliforms, E-coli,	Standard methods
Water quality: chemistry	1 L	Plastic	1	None	None - mark samples not preserved	Conductivity, pH, alkalinity, hardness, turbidity	Standard methods
Surrogates	1 L	Amber glass	2	None	None - mark samples not preserved	Total organic carbon, ultraviolet absorbance, color, chlorine demand	Standard methods
Toxicity	125 mL	Glass	2	Consult manufacturers instructions	Consult manufacturers instructions.	Rapid toxicity assay (several vendors)	None

The field resources and documentation listed in Table 3-1 includes field guides, forms, and labels intended to support sampling activities. The field guide is a resource containing simple flow-charts, checklists, reporting forms, and concise summaries of field protocols to assist the team in performing activities such as field testing and sampling. The guide also includes forms for sample documentation and chain of custody (also see Appendices 8.4 and 8.5, respectively). In some cases, a HASP may be required, and may be generic or site-specific.

The sampling supplies listed in the table include sample containers as well as miscellaneous glassware, and supplies used during sample collection. Several clean 10-liter, high density polyethylene (HDPE) containers, such as collapsible cubitainers, are included in the kit in the event that large volume water samples need to be collected. Other supplies such as tape, spatulas, pipette bulbs, foil, etc., should be included based on experience with other sampling activities. A collapsible cooler can be used to keep samples chilled following collection until they are transferred to a refrigerator, packed for shipment to a laboratory, or delivered to a designated recipient.

Note that shipment to a remote laboratory via an overnight service will require a **rigid** shipping container, such as a cooler; furthermore, certain hazardous samples may only be shipped in approved containers, as discussed in Section 6. If samples will be taken back to the utility prior to shipment, then the rigid shipping container does not need to be included in the sample kit. Frozen ice packs may be included with the sample kit to chill the samples, but a more practical approach may be to fill sealable plastic freezer bags with ice and seal them in a manner to prevent leaking (e.g., double bag the ice and seal with waterproof tape).

Special supplies are required for the field collection of samples for analysis of unknown pathogens. The *ultrafiltration* apparatus is used in the field to concentrate pathogens in a water sample in order to improve method sensitivity and reduce the sample volume to a manageable size (see Section 4.4.3 for a description of the ultrafiltration apparatus). The tubing and clamp may be used to aid in flushing sample taps, but should not be used for the collection of samples for organic analysis, as materials may leach from the plastic and interfere with analysis. The stopwatch and plastic graduated cylinder are used to measure the flow rate from the ultrafiltration apparatus, if necessary. Once the ultrafiltration apparatus is standardized, it may not be necessary to measure flow rates in the field.

The sample containers in the kit are listed in Table 3-2, which describes the container size and type, preservatives and dechlorinating agents, and specific analyses to be performed on the sample. Four subsets of sample containers are shown in Table 3-2 to align with the analytical approach presented in Module 4: a basic chemistry screen, an expanded chemistry screen, a pathogen screen, and general water quality parameters.

Since the analyses used in the basic chemistry screen are based on standard methodologies, the requirements for sample containers and preservation are well documented. The expanded chemistry screen relies on exploratory techniques, and samples for these analyses should be collected without preservation.

The sample containers for pathogen analysis include containers for general bacteriological water quality indicators and 100 mL plastic containers for the collection of concentrated aliquots for analysis of pathogens using culture and PCR techniques. Alternately, one 250 mL sample may be collected for pathogen analysis and split for PCR and culture analysis in the lab. If ultrafiltration is not performed in the field, the alternate approach for pathogen sampling is to collect one or more 10-liter containers such that the water can be transported to the laboratory for filtration, extraction, and analysis. Sample containers for baseline water quality parameters will depend on the specific parameters to be analyzed, and a few examples are shown in the table. Table 3-2 illustrates the types of sample containers that might be included in a sample collection kit; however, the specific containers included in the kit should be determined in consultation with the laboratory that would be analyzing the samples.

The laboratory should be consulted regarding appropriate sample preservation that is consistent with the types of analyses that will be performed. In general, there are three options for sample preservation: no preservation, minimal preservation, and preservation according to a standardized method.

- No preservation – samples are simply collected in clean glass or plastic containers. This approach may be appropriate if the samples will be analyzed within 24 hours of sample collection. The advantage of this approach is that sampling is simplified and maximum flexibility during sample analysis is maintained. The disadvantage is that samples must be quickly analyzed, and some contaminants may degrade even in a short time period. Note that samples collected for the expanded chemistry screen may not be preserved in any case since many of these techniques are not based on standardized methods with documented preservation requirements.

- Minimal preservation – samples are preserved according to some preservation strategy other than that dictated by the method. For example, a dechlorinating agent may be added to all samples. If this approach is used, the laboratory should be asked to confirm that the preservative used does not interfere with the analysis.

- Preservation according to the method – this approach is recommended if the samples are to be held for any appreciable time, or in situations where a particular contaminant is suspected. Table 3-2 lists specific preservatives and dechlorinating agents for analytes sampled according to EPA method specifications. The methods should be consulted for details regarding sample preservation and holding times.

Regardless of the method of preservation used, the preservatives added to a sample must be clearly communicated to the laboratory. If method specified preservation techniques are not used during sample collection, the laboratory may need to consult the method to determine if they need to add a reagent or adjust the sample pH prior to analysis.

The reagents listed in Table 3-1 include preservatives, dechlorinating agents, and laboratory grade water. The kit also includes pH paper that may be used to test the pH of samples that undergo pH adjustment. It is generally recommended that the preservatives and dechlorinating agents, if used, be added to the sample containers in the proper amounts during preparation of the sample kit, as this will simplify sample collection and minimize the number of reagents that need to be taken into the field. Where both a dechlorinating agent and an acid is required for preservation, it is recommended that the dechlorinating agent be added to the empty container before adding the sample, then adding the sample, and finally adding the acid, to avoid a reaction of the acid and dechlorinating agent before sample is added. If it is necessary to take preservatives or dechlorinating agents into the field, it is desirable to store them separately from the rest of the kit since they may expire more quickly than other materials in the kit.

Laboratory grade water (distilled or deionized water) is primarily for sample dilution in the field, if necessary; however, it may have other uses such as conducting field testing. Laboratory grade water should **not** be stored in the kit, but rather collected fresh from the laboratory (or from a commercial source) as the site characterization team departs for the investigation site. Laboratory grade water should only be placed into clean organic-free glass or Teflon containers.

The safety supplies listed in Table 3-1 include splash-proof safety goggles, disposable nitrile or polyethylene gloves (without powder), chemical resistant disposable lab coats, and disposable shoe covers. This basic PPE is intended to protect samplers from strong acids and bases used for sample preservation, as well as to reduce the risk of incidental contact with the water while collecting samples or performing field tests. This PPE is appropriate for sites that are characterized as low hazard (see Section 4.1.3). Upon exiting the site, the heavy-duty plastic trash bag is used to collect any disposable PPE and supplies used on site.

The 20-liter reservoir of rinse water listed in Table 3-1 can be used to rinse skin or other materials accidentally exposed to the suspect water. Tap water collected from an unaffected area can be used for this purpose. This water does not need to be included in the kit, rather the reservoir can be stored in the utility vehicle that would be used by the site characterization team. Rinse water should **not** be used for sample dilution or other activities where laboratory grade water is required. The antiseptic wipes are included for cleaning hands or wiping the outside of sample containers. A one-gallon container of bleach may be included in the kit in case more aggressive decontamination is necessary.

Emergency water sampling kits are likely to receive little actual use and may remain in storage at predetermined locations for extended periods, during which time reagents may expire. To ensure that sample collection kits are properly maintained, it is recommended that they be dated and periodically refurbished on at least an annual basis. At a minimum, sample containers with preservatives should be replaced with fresh containers, and the contents of the kit should be inspected to ensure that it is complete and all items are still functional. Expired kits can be used in field drills, which provides an opportunity to train staff and verify that the equipment is functional.

The sample kit presented in Table 3-1 contains the basic equipment necessary to collect water samples from locations with a hose bib, faucet, or other sample tap. Other equipment may be necessary to collect samples from sites that are not equipped with suitable sample taps. For example, in order to safely sample from fire hydrants, hoses, couplings, pressure reducers, and valves may be needed. Likewise, some distribution system storage tanks may not have sample taps in locations conducive to collecting representative samples from the body of water in the tank. This represents a similar challenge to that of collecting a representative sample from a large body of water, such as a reservoir. Thus the practices and equipment used for source water sampling may be applicable to sampling large tanks and reservoirs in the distribution system. Techniques for sampling from large or deep bodies of water may require the use of a boat, depth samplers, Van Doren samplers, or bacon bomb samplers, among others. Typical equipment for sampling from source waters is listed in the U.S. EPA, Environmental Response Team SOP #2013 (http://www.ertresponse.com/sops/2013-r10.pdf).

3.2.2 Field Test Kits

Two types of field tests will potentially be performed during site characterization: field safety screening and rapid field testing of the water. Field safety screening and rapid field testing procedures are discussed in Sections 4.2.2 and 4.3.2, respectively. This section describes the equipment that is used to support these activities.

While different equipment may be used for safety screening and water testing, it's efficient to construct field test kits that contain equipment for both. The field test kit should include the field detectors used in safety screening or rapid water testing, supporting equipment, reagents, spare parts (including batteries), and documentation necessary to perform field testing. It is also recommended that the field test kits be constructed such that they are separate from sample collection kits, due to relatively high cost of field test kits. This approach allows numerous sample collection kits to be pre-positioned at strategic sites, while a smaller number of field test kits can be assembled and assigned to specific teams or personnel.

Table 3-3 lists the generic types of screening and detection devices and kits that could be included in a field test kit. The core field test kit includes 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 http://www.epa.gov/safewater/security/guide/index.html, http://www.ojp.usdoj.gov/nij/pubs-sum/190747.htm, and http://www.ojp.usdoj.gov/nij/pubs-sum/184449.htm. Detailed verification reports for detectors that have undergone independent testing through the Environmental Technology Verification (ETV) program are available at http://www.epa.gov/etv.

The core field test equipment includes a radiation detector capable of analyzing for alpha, beta, and gamma radiation for field safety screening. This detector is used to quickly identify radiological hazards or eliminate them from consideration. If levels of radioactivity are detected that pose an immediate risk to life or health, the site would be characterized as a radiological hazard (see Section 4.1.3). Without a radiation detector, it may be impossible to determine whether or not the site has been contaminated with radioactive material. Typical the components that form the detector are sold separately and include a probe (e.g., a pancake G-M probe) and a rate meter. Radiation detectors are an established technology, widely used by responders, simple to operate, relatively inexpensive (<$1,000), and available from a variety of vendors. Examples of radiation detectors and related information can be found at www.ludlums.com and www.geigercounters.com.

Water is an effective shield to radiation, and 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. However, there are devices, such as sodium iodine probes, which are designed to detect radiation (beta and gamma) in water.

Cyanide detectors are 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 http://www.epa.gov/etv/.

Table 3-3. Core and Expanded Field Test Kits

CORE FIELD TEST KIT			
Target Parameter	**Class**	**Methodology**	**Comments**
Radioactivity (alpha, beta, and gamma)	Primarily a Safety Screen	G-M probe and meter	May be expanded to water testing with a special probe.
Cyanide	Water Testing	Colorimetric or ion selective electrode	Tests water for cyanide ion, but 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 weapons (VX, sarin, etc.)	Both	Enzymatic / colorimetric	Many kits may also detect certain pesticides.
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	Quick and simple to use.
VOCs and SVOCs	Water Testing	Portable GC/MS	Expensive, but expands field capability for chemicals.
Biotoxins (ricin, botulinum, etc.)	Water Testing	Immunoassays	Quick and simple to use.
Pathogens (tularemia, anthrax, plague, etc.	Water Testing	Immunoassays and PCR	Preconcentration will increase sensitivity.
Toxicity	Water Testing	Inhibition of biological activity.	Need to establish a baseline.

Chlorine residual measurements (both free and total) are of particular interest in distributed drinking water since the absence of a residual disinfectant is undesirable under any circumstance. Chlorine residual test kits and pH meters are established technologies that are widely used in the drinking water treatment industry. Chlorine residual test kits are typically based on colorimetric techniques, while pH instruments are based on ion-selective electrodes. Some pH instruments can also measure conductivity, which is another useful indicator of water quality changes (assuming that a baseline for conductivity has been established). These general parameters are included in the core field test kit as general indicators of water quality, and deviations from established baseline values (see Section 3.4.1) may indicate a potential problem.

The equipment listed under the expanded field test kit section of Table 3-3 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. These additional detection technologies can provide additional information for characterizing hazards at a particular site (see Section 4.1.3) 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 weapons, additional water quality parameters, pathogens, biotoxins, 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 GC/MS instruments. 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.

Many technologies and detectors are commercially available that could be used for expanded field testing. **However, few of these technologies have undergone a thorough and independent performance evaluation. The use of field testing technologies for which performance has not been characterized is strongly discouraged.** 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 in order to characterize the performance of the detector so that it can be used with confidence during a site characterization activity.

EPA's ETV program is planning to evaluate several of these technologies. Toxicity assays were evaluated in the summer of 2003, and there are plans to evaluate immunoassay kits and field PCR systems by early 2004. Potential users of these technologies are strongly encouraged to review the ETV reports prior to making a decision regarding the implementation of any of these monitoring technologies. It is important to note that ETV is **not** a certification program and does **not** approve technologies. Rather it is a program for the independent evaluation of monitoring and detection equipment that simply reports the results of the verification study for a given technology.

As with sample collection kits, field test kits must be maintained so that the equipment and chemical reagents are in proper working order when the kits are needed. This requires 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. Furthermore, it is critical to provide staff training in the actual use of any field technology that will 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 will 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 (see Section 3.4).

3.3 Generic Site Characterization Plan

A site characterization plan is developed to provide direction and communication between the incident commander and the site characterization team, which will facilitate the safe and efficient implementation of site characterization activities. The plan should be developed expeditiously since the site characterization results are an important input to the threat evaluation process. The rapid development of a site characterization plan can be facilitated by the development of a **generic** site characterization plan**,** which is easily customized to a specific situation. While the circumstances of a particular threat warning will dictate the specifics of a **customized** site characterization plan, many activities and procedures will remain the same for most situations, and these common aspects can be documented in the generic site characterization plan. Potential elements of a generic plan include: pre-entry criteria, communications, team organization and responsibilities, safety, field testing, sampling, and exiting the site.

Pre-entry criteria define the conditions and circumstances under which site characterization activities will be initiated and the manner in which these activities will proceed. At each stage of the process (i.e., approach to the site, on-site characterization activities, sample collection, and exiting the site), specific criteria may be defined for proceeding to the next stage. The pre-entry criteria may also specify the general makeup of the site characterization team under various circumstances. For example, under low hazard conditions utility teams may perform site characterization, while specially trained responders might be called upon to assist in the case of potentially hazardous conditions at the site. The criteria developed for a particular utility should be consistent with the role that the utility has assumed in performing site characterization activities.

The generic plan should define communication processes to ensure rapid transmittal of findings and a procedure for obtaining approval to proceed to the next stage of site characterization. It is advisable for the site characterization team to remain in constant communication with the incident commander for the entire time that they are on site. The plan should provide an approval process for the team to advance through the approach and on-site evaluation stages of the characterization, to ensure that the team is not advancing into a hazardous situation. Communication devices (e.g., cell phone, two-way radio, or panic button) can be used to alert incident command of problems/observations encountered in the field. The communication section of the generic plan should also discuss coordination with other agencies (e.g., law enforcement, fire department) and contingencies for contacting HazMat responders.

Field testing and sampling may be handled in the generic plan by presenting a menu that covers all potential options available to the utility, based on both internal and external capabilities. In developing a customized plan, the incident commander can simply check off the field tests and sampling requirements that are appropriate for the specific situation. The site characterization plan may also need to be revised in the field based on the observations of the team.

Many of the elements of a generic site characterization plan are captured in the "Site Characterization Plan Template" (see Appendix 8.1). The plan is customized by simply filling in the form based on the specific circumstances of the threat.

3.4 Evaluation of Baseline Water Quality Information

Baseline water quality information is derived from routine monitoring data and used to characterize typical levels of a particular contaminant or water quality parameter. While there are no requirements to develop baseline water quality information, it can be a valuable resource when interpreting the results from site characterization and laboratory analysis, specifically:

- The results of general water quality parameters, such as pH, chlorine residual, or conductivity, among others, should be compared against a baseline to determine whether or not the results represent a significant deviation from typical levels.
- A positive result for a specific contaminant may need to be compared against typical background levels in order to properly interpret the results.

Since each of these applications of baseline data has different requirements, they are discussed separately in the following subsections.

3.4.1 General Water Quality Parameters

General water quality data collected during the on-site investigation and subsequent sample analysis may indicate water contamination if the results differ from an established baseline or typical water quality values. In order for such a comparison to be made, it is necessary to establish a baseline for the water quality parameter(s) of interest. Some parameters vary as a function of time and position in the system while others may experience seasonal fluctuations. These normal variations should be captured in the baseline data. Two approaches for establishing a general water quality baseline are:

- Evaluate historical water quality monitoring data.
- During site characterization performed in response to a specific threat, baseline monitoring for target water quality parameters may be performed in an area of the distribution system that is not expected to fall within the potentially contaminated area.

Many water utilities routinely collect data that could be used to establish a baseline; however, this data would need to be analyzed and reduced to **information** that can be readily interpreted and used during an emergency situation. Trend charts and statistical summaries are two approaches for summarizing baseline water quality data.

In addition to using historical water quality data to establish a baseline, monitoring of unaffected sites may be used for comparison with water quality data collected from the potentially contaminated area. The unaffected site might be upstream or downstream of the potentially contaminated area, and ideally it would be hydraulically isolated from this area. However, the results of supplemental baseline monitoring must consider typical water quality variations that occur at different locations within a distribution system.

A baseline can be established for any water quality parameter that is routinely monitored. The following list of routinely monitored water quality parameters illustrates factors that may be considered when establishing a baseline:

- <u>pH</u> of the distributed water is determined by the pH of the finished water at the entry point to the distribution system. In well-buffered waters, pH will typically remain fairly constant throughout a distribution system if the water is in equilibrium with the pipe material; however, it may vary if there are corrosion problems.

- <u>Conductivity</u> of the distributed water is determined by the conductivity of the finished water at the entry point to the distribution system. It will typically remain fairly constant throughout a distribution system if the water is in equilibrium with the pipe material; however, it may vary if there are corrosion problems.

- <u>Chlorine/chloramine residual</u> levels vary as a function of temperature, pH, degree of nitrification, pipe wall demand (i.e., from biofilm or corrosion), and distribution system residence time (i.e., water age). The initial residual is established at the plant by the disinfectant dose and oxidant demand of the water. Oxidant demand will vary as a function of water quality, and typically experiences seasonal fluctuations. The use of disinfectant booster stations in the distribution system must also be considered when evaluating baseline residual data.

- <u>Total organic carbon (TOC)</u> levels in the distribution system will remain relatively constant with respect to the finished water TOC. However, use of strong oxidants, such as ozone, can increase the biodegradable fraction of TOC, potentially resulting in greater variability in TOC levels in the distribution system.

- <u>UV absorbance</u> is typically used as a surrogate for TOC, but is more indicative of the aromatic fraction of TOC. UV absorbance will experience variations similar to TOC, and UV absorbance is also impacted by oxidants and disinfectants used in water treatment.

Another factor to consider when establishing a baseline for distribution system water quality is the potential for blending of water quality from different treatment plants. If multiple treatment plants feed the distribution system, the water quality will be a function of the blending ratio of the water from the different plants, in addition to the other factors described above. The task of establishing a baseline for such systems is further complicated by the fact that the blending ratios will vary both spatially and temporally.

3.4.2 Background Levels of Specific Contaminants

The second application of baseline data is to support the interpretation of the site characterization results for a specific contaminant. If a contaminant is tentatively identified or *analytically confirmed*, it may be prudent to compare the results to baseline concentrations of that contaminant in the distribution system. This would be particularly important for typical water contaminants (such as cyanide, arsenic, specific disinfection byproducts, certain pesticides, *E. coli*, etc.). As with general water quality parameters, there are two approaches for estimating baseline levels of a specific contaminant in a distribution system:

- Evaluate historical monitoring results for the specific contaminant, if available.
- During site characterization performed in response to a specific threat, sampling for the specific contaminant may be performed in an area of the distribution system that is not expected to be contaminated.

In general, few contaminants of concern are monitored frequently enough to provide sufficient data to estimate a baseline. Typically, contaminants would only be monitored if required for compliance with drinking water standards, or if unregulated contaminants are known to occur in the finished water and are of significant importance or interest to the utility. When such data are available, it should be compiled and summarized to produce information that can be used to estimate baseline occurrence in the event of an emergency (e.g., using trend charts or statistical summaries). When compiling historic data, the baseline information should also identify any contaminants that are known to **not** occur in the finished water.

Assuming that field test kits are developed during planning for site characterization activities, as discussed in Section 3.2.2, utilities will know those contaminants that will be screened for in the field. In these cases, a utility may choose to integrate field testing for these contaminants into routine monitoring programs in order to generate data that can be used to establish a baseline for the specific contaminant. Additional benefits of routine field testing include exercising the equipment to ensure that it is calibrated and in proper working order and that the staff have an opportunity to become familiar with the operation of this equipment.

If a specific contaminant is identified and historic baseline occurrence data are not available, baseline sampling for the suspected contaminant might be performed to determine if the contaminant is present (and at what concentration) in non-affected areas of the system. Baseline sampling must be performed at a location that is located outside the contaminated area but which is also representative of the area that may be contaminated. For example, if multiple treatment plants feed a common distribution system, baseline sampling might be performed at a location that is fed by the same treatment plant that feeds the potentially contaminated area but in a different pressure zone.

While it may generally be assumed that a contaminant found near typical background levels is just background, this may not always be the case. Another possibility is that sampling only picked up the tail of a transient slug of a contaminant that was introduced at another point in the system at much higher levels. Other information from the threat evaluation process (Module 2) should be considered when making a determination between these two possibilities. For example, there may be physical evidence at the investigation site indicating potential contamination, in which case one might consider the possibility that the low level concentration is the tail of a larger slug. In this case, field testing and/or sampling for the specific contaminant at additional investigation sites may be appropriate.

3.5 Quality Assurance for Field Testing and Sampling

Because of the diversity of potential field testing and sampling activities during site characterization, there may be no specific quality assurance (QA) activities which apply to all sampling procedures. However, the following general QA principles would apply in most cases and are consistent with the QA guidelines published by EPA's Environmental Response Team (http://www.ertresponse.com/sops/2013-r10.pdf):

- All data should be documented on field data sheets or within site logbooks.
- All instrumentation should be operated in accordance with operating instructions as supplied by the manufacturer, unless otherwise specified in the work plan. Equipment checkout and calibration activities should occur prior to site characterization and documented.
- Any relevant QA principles and plans specific to the particular water utility or responding organization should be observed.
- Additional QA principles are contained within the sampling guidelines presented in Section 4.4. It should be noted that these sampling guidelines also have various quality control (QC) elements built in, and these QC elements are often documented in the specific analytical methods.

3.6 Maintaining Crime Scene Integrity

The suspected contamination site that is the focus of site characterization activities could potentially become the scene of a criminal investigation. If law enforcement takes responsibility for incident command because they believe a crime has been committed, they will control the site and dictate how any additional activities, such as site characterization, are performed. In cases in which the utility is still responsible for incident command, it may still be prudent to take precautions to maintain the integrity of the potential crime scene during site characterization activities. The following guidelines for maintaining crime scene integrity are provided, although this should not necessarily be considered an exhaustive list:

- If there is substantial physical evidence of contamination at a site, the threat will likely be deemed 'credible' from a utility and a law enforcement perspective. In this case, law enforcement may take control of the site and limit the activities performed by other organizations at the site.
- Substantial physical evidence of contamination might include discarded PPE, equipment (such as pumps and hoses), or containers with residual material. Special care should be taken to avoid moving or disturbing any potential physical evidence.
- Evidence should not be handled except at the direction of the appropriate law enforcement agency. Specially trained teams from the law enforcement community are best suited (and may be jurisdictionally required) for the collection of physical evidence from a contaminated crime scene.
- The collection of physical evidence is not generally considered time sensitive; however, site characterization and sampling activities are time sensitive due to the public health implications of contaminated water. Thus, collection of water samples may precede collection of physical evidence, and care must be taken not to disturb the crime scene while performing these activities. If samples can be collected outside of the boundaries of the suspected crime scene, it may avoid concerns about the integrity of the crime scene.

- Water samples collected for the purpose of confirming/dismissing a contamination threat and identifying a contaminant could potentially be considered evidence and should be handled accordingly.
- Since the analytical results may be considered evidence as well, it is important to use a qualified laboratory for analytical support (see Module 4). If law enforcement has taken control of the situation prior to sample collection, they may require the collection of an additional sample set to be analyzed by their designated lab.
- Photographs and videos can be taken during the site characterization for use in the criminal investigation. Law enforcement should be consulted for proper handling during and after taking photographs/videos to ensure integrity of the evidence.

Maintaining crime scene integrity during site characterization is largely an awareness issue. If the site characterization team integrates the guidelines outlined above into their on-site activities, they will go a long way towards maintaining the integrity of the crime scene. It is also recommended that the WUERM and site characterization team lead coordinate with law enforcement, as part of emergency response planning, regarding appropriate procedures for activities performed at the site of a potential contamination incident.

4 Site Characterization Protocol

This section presents guidance and procedures for conducting site characterization activities. The site characterization protocol is divided into five stages, which are described in the following subsections and summarized below:

- Section 4.1, Customizing the Site Characterization Plan: Review the initial threat evaluation, review and customize the generic site characterization plan, identify the investigation site, conduct a preliminary hazard assessment, develop a sampling approach, and form the site characterization team.
- Section 4.2, Approaching the Site: Establish the site zone, conduct field safety screening, and observe site conditions.
- Section 4.3, Characterizing the Site: Repeat field safety screening, conduct the detailed site evaluation, and perform rapid field testing of the water.
- Section 4.4, Collecting Samples: Fill sample containers, preserve samples if necessary, and initiate chain of custody.
- Section 4.5, Exiting the Site: Perform final site check, remove all equipment and samples from the site, and re-secure the location.

Documentation of the site characterization activities and findings is an ongoing effort throughout each phase and result in a site characterization report as described in Section 5.

4.1 Customizing the Site Characterization Plan

The first stage of the site characterization process is the customization of the generic plan developed as part of planning and preparation for responding to contamination threats (Section 3.3). In general, the incident commander (most likely the WUERM) will develop the customized plan in conjunction with the site characterization team leader. The steps involved in the development of the plan include: 1) perform an initial evaluation of information about the threat; 2) identify one or more investigation sites; an assessment of potential site hazards; 3) develop a sampling approach; and 4) assemble a site characterization team. Each of these steps is discussed in the following section, followed by three examples that demonstrate customization of the site characterization plan. A template for the development of a site characterization plan is provided in Appendix 8.1.

4.1.1 Initial Evaluation

Figure 3-1 indicates that an initial evaluation of a contamination threat, followed by a determination that the threat is ‘possible’ may lead to site characterization activities. The information used to support the initial threat evaluation (see Module 2, Sections 3.1 and 3.2) is essential to the development of a customized site characterization plan. The initial evaluation should include a review of all available information from the threat warning as well as details about the suspected contamination site. The WUERM and site characterization team leader should review any alarms and security video that may be available from the area of the investigation site, as well as any on-line water quality monitoring data collected in the vicinity of the site. Much of this information should be summarized in the “Threat Evaluation Worksheet” in Module 2, Appendix 8.2.

4.1.2 Identification of Investigation Site

In order to proceed with site characterization activities, it is necessary to identify one or more investigation sites. This may be relatively straightforward or fairly complex depending on the circumstances of the threat. Factors to consider when selecting an investigation site include:

- Whether or not the physical location of suspected contaminant introduction is known.
- Whether or not the affected area was isolated from the rest of the system in time to contain the potentially contaminated water.
- Whether or not baseline monitoring/sampling is necessary (as discussed in Section 3.4).

If a suspected contamination site can be identified, it will likely be designated as the primary investigation site. Examples in which a suspected contamination site would be apparent include a security breach at a specific facility, a witness account of tampering at a particular location, or a verbal/written threat in which the site of contaminant introduction is named.

In the case of a threat warning in which a specific location is not evident, another approach must be taken to select investigation sites. Under this scenario, vulnerable sites, as identified in a utility's *vulnerability assessment*, might be considered as potential investigation sites. However, it may be more prudent to forgo a complete site characterization at an arbitrarily selected site, and instead increase the number of locations and frequency of sampling for water quality parameters routinely monitored and which have established baselines. Other approaches might involve increased monitoring of consumer complaints regarding unusual tastes or odors and/or working with local public health officials to identify unusual cases of disease that may be related to contaminated water. These latter approaches are intended to provide additional information to help determine whether or not the threat is 'credible' in situations where it may not be possible to conduct a thorough site characterization at a meaningful investigation site.

Some activities performed during site characterization depend only on the physical location of the site, such as the evaluation of site conditions and physical evidence. However, selection of sites for rapid field testing and water sampling must consider the potential spread of the contaminant in order to produce meaningful results. If the suspected contamination site is quickly isolated following the discovery of a contamination threat, the potential spread of the contaminant may be minimized, emphasizing the importance of rapidly initiating *immediate operational response* actions (Module 2, Section 3.3.2). If isolation is not possible or cannot assure that the suspect water has been contained to well defined area, then the potential spread of the contaminant should be considered when selecting secondary investigation sites (i.e., investigation sites other than the suspected contamination site).

Secondary investigation sites are selected to characterize the spread of a contaminant through a distribution system, which is a function of:
The suspected location of contaminant introduction.

- The elapsed time between contaminant introduction and water sampling/testing.
- The hydraulic operation of the system during this time period.
- The amount and purity of contaminant introduced.
- Fate and transport processes that might impact the contaminant concentration.

To rigorously address all of these factors when predicting the spread of a contaminant would be a lengthy and complex process in almost any situation. Furthermore, it is unlikely that the time of possible contaminant introduction will be known with a great degree of certainty, unless the tampering incident was directly observed, recorded, or triggered an alarm at a known time. Also, unless the identity of the contaminant is known and its properties well characterized, there will be insufficient information to predict the impact of various fate and transport processes on the concentration of the contaminant.

However, it may be possible to develop a rough estimate of the spread of a contaminant that will be sufficient for the purpose of selecting secondary investigation sites. To develop such an estimate, it will typically be necessary to assume both a location and time of contaminant introduction. As discussed previously, a potential contamination site may be evident from the threat warning, while the time of contaminant introduction will likely be unknown. However, it may be possible to bracket the time of the suspected contamination incident between the last time the site was visited and the time the threat was discovered. Once a location and time have been selected, the spread of the suspected contaminant can be estimated based on the hydraulics of the system.

Two approaches for estimating the spread of a suspected contaminant through a water system are: 1) application of operational knowledge of the system, and 2) application of a hydraulic model of the distribution system. The first approach requires knowledge of pressure zones and typical flow patterns through a distribution system, as well as information derived from SCADA, to estimate the spread of a possible contaminant slug through a system. The second approach involves the use of hydraulic models such as EPA Net, PipelineNet, MWHSoft, Stoner, and Haestad, among others. While this latter approach is more rigorous, these models are sophisticated and require a certain level of skill and a significant amount of time to run; thus, it may not be practical to use such models for the purpose of identifying investigation sites. Furthermore, the first approach may be sufficient for identifying secondary investigation sites for field testing and water sampling.

It is generally assumed that the identity and amount of contaminant introduced into the system will be unknown. In this case, the effect of fate and transport processes on the contaminant might be assumed negligible (i.e., the contaminant is not diluted or degraded), which would produce a conservative estimate of the contaminant concentration in the system. One could also assume an initial concentration of “100%” at the point of contaminant introduction, which would allow the fractional concentration to be tracked through the system as the contaminant is diluted.

Finally, if the contaminant is suspected to have spread through a portion of the system, it may be desirable to identify investigation sites for the purpose of baseline sampling. The analysis described above to estimate the spread of a suspected contaminant through a distribution system might also support the selection of investigation sites for baseline sampling. However, these sites should be **outside** of the potentially contaminated area. Other factors that may impact the baseline, as described in Section 3.4, should also be considered during the selection of secondary investigation sites for baseline sampling.

In all cases, it is critically important to identify investigation sites promptly so that site characterization activities can begin shortly after discovery of a contamination threat. The objective of site characterization is to gather information quickly in order to evaluate whether or not a threat is 'credible.' As discussed in Module 2, it is important to make this credibility determination in a relatively short period of time (**the target time period is less than eight hours from the time the threat warning is received**) such that response actions to protect public health can be implemented if necessary.

4.1.3 Site Hazard Assessment

During the development of a customized site characterization plan, an initial assessment of potential site hazards should be performed. Four hazard categories are considered in the context of site characterization:

1) Low hazard – no obvious signs of radiological, chemical, or biological contaminants are present at the site (i.e., in air or on surfaces). Contaminants that may be present in the water are assumed to be dilute and confined to the water.
2) Radiological – presence of radiological isotopes or emitters tentatively identified at the site or in the water (i.e., through the use of a field radiation detector).
3) Chemical – presence of highly toxic chemicals (e.g., chemical weapons or biotoxins) or volatile toxic industrial chemicals tentatively identified at the site or in the water, with a potential risk of exposure through dermal or inhalation routes.
4) Biological – presence of pathogens tentatively identified at the site, with a potential risk of exposure through dermal or inhalation routes.

The site hazard assessment is integral to the site characterization process and is intended to **minimize the risk to the site characterization team**. Figure 3-2 illustrates how information from site characterization activities may be used to refine the hazard assessment, which in turn may dictate the course of the site characterization. This figure also illustrates the importance of communication between the site characterization team and the incident commander during the course of on-site activities.

At the planning stage, the only information available to perform a site hazard assessment will be from the initial threat evaluation, as discussed in Section 4.1.1. The forms in the appendix to Module 2 that are designed to collect information to support the threat evaluation can also be used to support the initial site hazard assessment. Given the limited amount of information at this stage, it may only be possible to determine whether the site presents a low or high hazard. A 'low hazard' site would have no obvious signs of contaminants present in the environment (air and surfaces), while conditions at a 'high hazard' site would indicate a potential risk to personnel at the site. If the site is initially characterized as a low hazard, the standard safety procedures discussed in Section 3.1 should provide adequate protection to the site characterization team. On the other hand, if the site is characterized as a high hazard, HazMat responders with training and PPE appropriate for the site conditions should be contacted to provide support for site characterization activities.

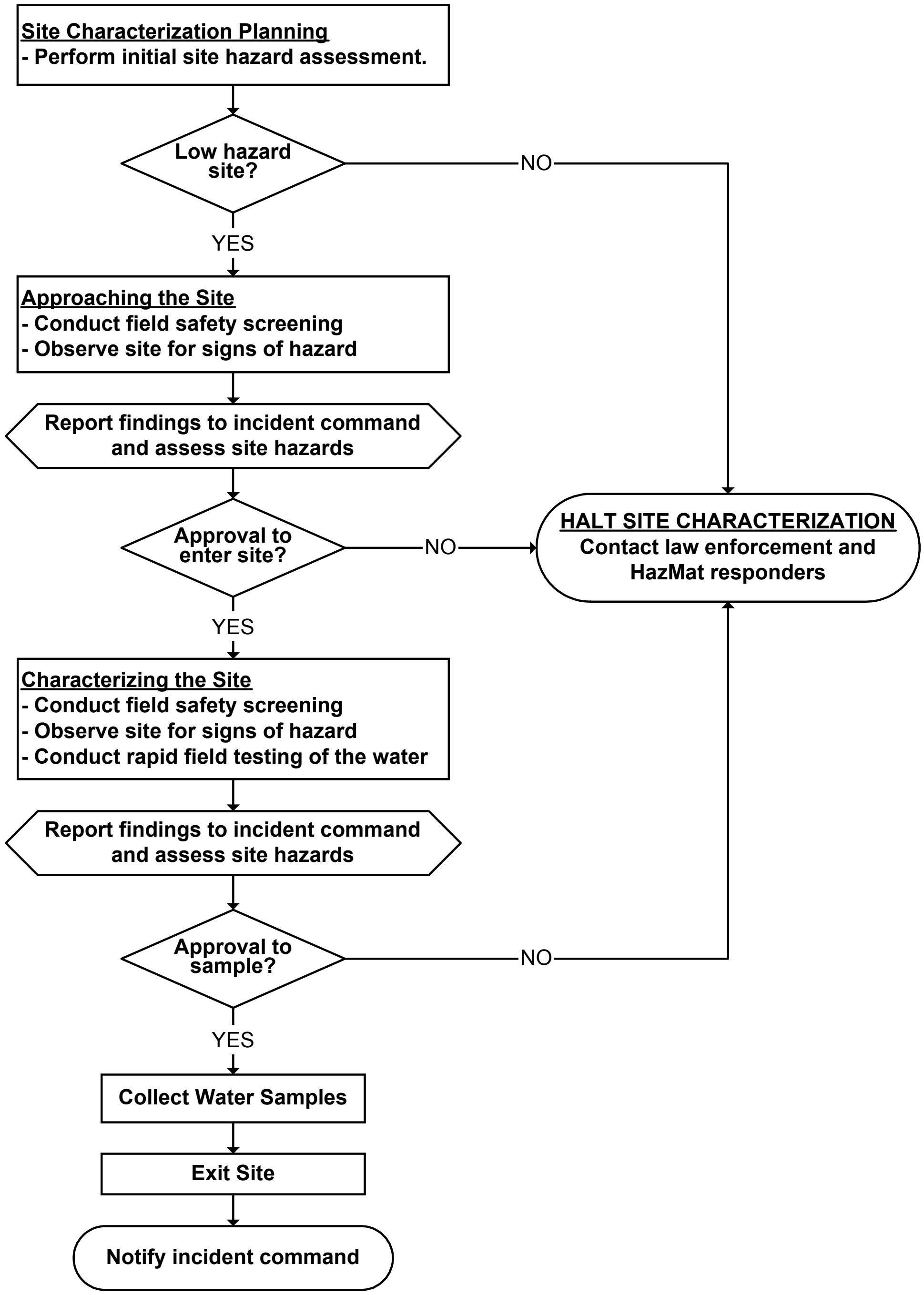

Figure 3-2. Integration of Site Hazard Assessment into Site Characterization Process

During the approach to the site, the team will perform field safety screening and observe the site for potential hazards **from the site perimeter** (see Section 4.2). At a minimum, field safety screening for radiation is recommended since it is a straightforward means of eliminating potential radiation hazards. Detection of excessive levels of radiation would result in the site being categorized as a radiological hazard. If expanded field safety screening techniques are employed, chemical and biological hazards might be tentatively identified at the site. For example, a VOC sniffer might detect certain chemical hazards in the air. While field safety screening is a useful tool, it is just as important to carefully observe the site for potential signs of hazard, as discussed in Section 4.2.3. Due to the limited capability of even the most advanced field safety screening, site observations may be the most reliable indicator of potential hazards.

Upon completion of field safety screening and initial observation of site conditions, the site characterization team leader should report the findings to the incident commander, who will make a decision regarding whether or not it is safe for the team to enter the site. If there are indicators of a potential hazard, then incident command will likely halt the site characterization activities and contact law enforcement, and potentially HazMat, for assistance. In the absence of such indicators, the incident commander may clear the team to proceed further into the site.

Once at the investigation site, the team will commence their detailed site characterization including additional field safety screening, observation of potential site hazards, and rapid field testing of the water. The results of these activities are reported to the incident commander who will use this information to revise the site hazard assessment. If the incident commander determines that the site poses an unacceptable risk to the team, they may be instructed to retreat from the site. If there was the potential for personnel to become contaminated, they may need to retreat to the site perimeter and remain there until additional help arrives. If the site is still categorized as a low hazard, the incident commander may clear the team to proceed with sampling and complete the characterization. If the site is characterized as a chemical, biological, or radiological hazard, special sampling precautions may be necessary, as discussed in Section 4.1.4.

Upon exiting the site, the team leader should notify the incident commander to verify that everyone is safe and accounted for, that all necessary samples have been collected and secured, equipment has been collected, and the site has been secured. Outstanding or unresolved issues at this point should be communicated.

4.1.4 Sampling Approach

The objective of sampling from a suspected contamination site, or secondary investigation site, is to obtain and preserve a sample of the water at a particular time and location, so that it can be analyzed later if necessary. In order to perform sampling effectively, sampling requirements should be considered in the development of the customized site characterization plan. Factors to consider during the development of a sampling approach include:

- Which contaminants or contaminant classes will be sampled?
- What type of samples will be collected (i.e., grab or composite)?
- When and where will samples be collected?
- Are any special precautions necessary during sample collection?

The "Site Characterization Plan Template" in Appendix 8.1 includes a section for documenting the sampling requirements. It is important to consider that the initial sampling approach documented in the plan may need to be revised based on the findings of site characterization activities, as discussed later in this section.

Selection of target contaminants during development of a customized site characterization plan will be based on an initial assessment of information about the threat. Prior to site characterization, it is likely that little will be known about the identity of suspected water contaminants. In this case, the sampling approach may need to be comprehensive and include all analytes covered by the sample kit (see Table 3-2). In some cases, the available information about the threat may indicate the presence of a particular contaminant or contaminant class, and the sample plan may be adjusted accordingly. However, during this initial stage of site characterization, it may still be prudent to plan to collect a complete sample set (i.e., all sample containers in the utility's emergency water sampling kit) from the investigation site.

The two most common types of environmental samples are *grab samples* and *composite samples*. A grab sample is a single sample collected at a particular time and place that represents the composition of the water only at that time and location. The sample is collected all at once and at one particular point in the sample medium. A composite sample is composed of several specific aliquot collected at various sample locations and/or different points in time, which are then combined to form one composite sample. Analysis of a composite sample produces an average value and can, in certain instances, be used as an alternative to analyzing a number of individual grab samples and calculating an average value.

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. An example of a scenario in which it may be necessary to collect composite samples is sampling conducted to characterize a large reservoir where collection and analysis of a large number of discrete samples may be time and cost prohibitive. One disadvantage of composite samples is that they may dilute concentrations of contaminants that would otherwise be detected in discrete grab samples. Another disadvantage is that if a contaminant is detected, it is impossible to know which specific individual sample was the source of the contaminant.

The time and location of sample collection will be addressed by the selection of investigation sites, as discussed in Section 4.1.2. Due to the potential spread of a suspected contaminant through a distribution system, sampling may be performed at secondary investigation sites rather than the primary site.

The need for special precautions during sample collection will likely be determined by the site hazard assessment described in thee previous section. Figure 3-3 illustrates four sampling approaches based on the hazard categories defined in Section 4.1.3. Prior to the initiation of site characterization activities, there may be limited information available to determine which sampling approach is appropriate. However, the results of the site evaluation and field testing may allow for a more precise characterization of the hazards at the site, and thus provide a basis for refining the sampling approach. For example, the site evaluation may indicate the presence of a hazardous chemical (e.g., unexplained dead animals at the site), which may indicate that precautions are necessary during sample collection for chemicals, as shown in Figure 3-3.

Under low hazard conditions, no special sampling techniques are necessary beyond good safety practices as described in Section 3.1. Under this scenario, samples for chemical and pathogen analysis are collected according to the procedures described in Section 4.4.

If the site is characterized as a radiological hazard due to the detection of excessive levels of radioactivity during field safety screening, samples should be collected for radiological analysis by personnel trained and equipped to work at radioactive contamination sites (e.g., Superfund teams). Figure 3-3 also suggests the collection of a large volume water sample using the 10-liter containers listed in Table 3-1, in case it is necessary to perform analyses for additional contaminants following radiological analysis. The large volume water samples should only be handled by the trained responders and stored in appropriate facilities that would minimize the risk of potential exposure to radiation.

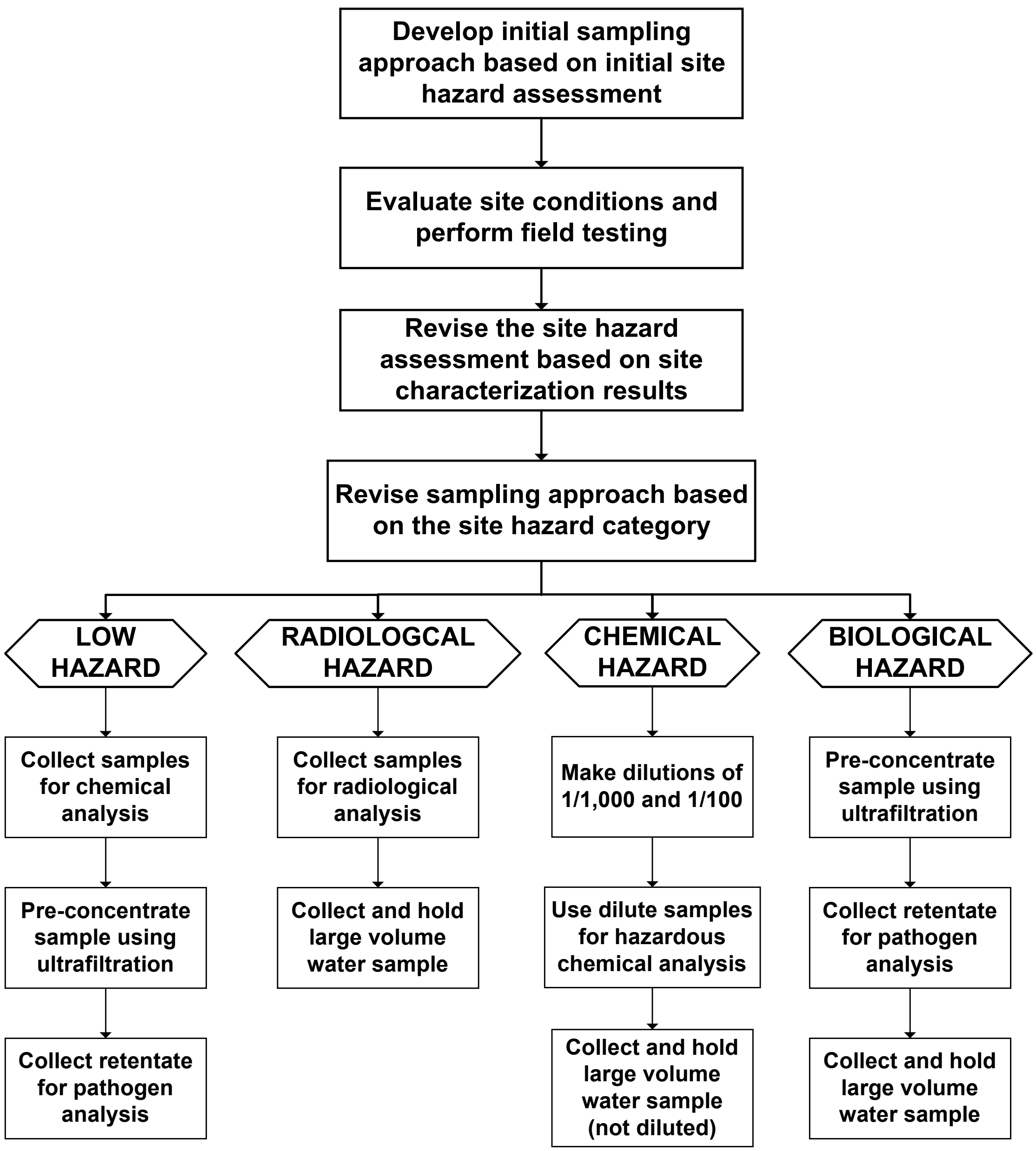

Figure 3-3. Integration of Site Hazard Assessment into the Sampling Approach

If the site is characterized as a chemical hazard, dilution of samples collected for chemical analysis may be an appropriate sampling strategy to reduce the risk during sample transport and analysis. **Dilution does not reduce the risk to personnel collecting the sample since they are working with the undiluted water; thus site procedures appropriate for a chemical hazard should still be followed.** Dilutions of 1/1,000 and 1/100 are appropriate for chemical hazards already present in water (a 1/10,000 would only be appropriate for concentrated material). The most dilute sample (i.e., 1/1,000 dilution) should be delivered to the laboratory for analysis first. The remaining diluted samples should be stored in a safe and secure location and delivered to the laboratory if the result from the analysis of the 1/1,000 dilution turns up nothing unusual. In addition to the diluted samples, it is suggested that a large volume water sample (not diluted) be collected in case it is necessary to perform analyses for additional contaminants following analysis of the diluted samples. The large volume water samples should only be handled by trained responders and stored in appropriate facilities that would minimize the risk of potential exposure to hazardous chemicals.

If the site is characterized as a biological hazard, pathogen sampling should be conducted according to the procedures described in Section 4.4.3. Figure 3-3 also suggests the collection of a large volume water sample in case it is necessary to perform analyses for additional contaminants following pathogen analysis. Another potential strategy for sampling for chemicals from the site of a biological hazard, which is not shown in Figure 3-3, is the use of UV irradiation to inactivate pathogens in the processed sample. UV irradiation will inactivate a majority of the suspected pathogenic organisms and provide a degree of protection for the analysts. **UV irradiation does not reduce the risk to personnel collecting the sample since they are working with the non-irradiated water; thus site procedures appropriate for a biological hazard should still be followed.** Irradiation of the sample can be most effectively accomplished through the use of a flow-through UV irradiation device, but may also be performed in batch mode, although the latter is likely to be less effective or require more time to achieve the desired results. Note that the dose required for the inactivation of most biological agents has not been fully characterized, nor has the effect of UV irradiation on all chemicals of concern. Thus, it is generally recommended that a large volume sample be collected for possible chemical analysis, as shown in Figure 3-3, rather than employing UV irradiation. The large volume water samples should only be handled by the trained responders and stored in appropriate facilities that would minimize the risk of potential exposure to biological hazards.

4.1.5 Formation of a Site Characterization Team

The site characterization team will be responsible for performing the site investigation, field safety screening, rapid field testing, and sampling collection. The makeup of the team may for a specific site characterization activity will depend on the results of the initial site hazard assessment, as discussed in Section 4.1.3. If the site is characterized as anything other than a low hazard, a HazMat response team should be contacted to support site characterization activities. The HazMat responders may ‘clear’ the site for entry by utility personnel or may perform the actual site characterization. Under low hazard conditions, utility personnel may be able to perform site characterization activities if they receive training in basic safety practices and use of any specialized equipment.

For safety reasons, the team should include at least two people, with one person in constant communication with incident command. One member of the team should have experience/knowledge of security investigations, including the analysis of security breaches (e.g., vandalism, opportunistic break-ins) and basic procedures for maintaining the integrity of a crime scene. The other team member should have experience in water quality, sampling, and use of field test equipment. Additional team members may be added as appropriate for a given situation (e.g., an individual from the utility's operations department may be included to support decisions regarding containment of the suspect water). All members of the site characterization team should be capable of performing a critical evaluation of site conditions and documenting the findings from site characterization activities.

4.1.6 Examples of Site Characterization Plan Customization

The customized site characterization plan developed before the team is sent to the site may be very similar to the generic plan due to the limited amount of information that will be available at this initial stage. Customization of the plan may actually occur in the field as the team begins to gather information. In particular, the field testing and sampling activities may need to be revised based on the initial observations at the site. The plan should be revised through collaboration between the incident commander (most likely the WUERM) and site characterization team leader.

The following three examples are intended to illustrate how a customized site characterization plan might evolve from the point that the threat warning is discovered through the conduct of site characterization activities. In these examples, it is assumed that a generalized plan has been developed with the following elements:

- **Sample kits** developed according to the example presented in Table 3-1 and including all of the sample containers listed in Table 3-2. The kit contains a 'Field Guide' with the forms in the appendix to this module, simple SOPs, and other supporting documentation.
- **A field test kit** developed according to the example of the core field test kit presented in Table 3-3, including: a radiation meter, a pH/conductivity probe, a chlorine residual test kit, and a cyanide test kit.
- **A utility site characterization team**, consisting of a security specialist and a water quality specialist, has been formed and trained in basic safety procedures, use of field testing equipment, and use of basic PPE (i.e., the PPE listed in Table 3-1).
- **A communication plan** to keep the WUERM informed during all stages of site characterization.

Example 1: A threat warning is received in the form of an alarm trigger on an access hatch to a distribution system storage reservoir. The operator immediately informs the WUERM, and actions are quickly taken to hydraulically isolate the tank from the system. This immediate operational response is determined to be effective for preventing the water in the tank from spreading to the rest of the system.

The WUERM and site characterization team leader immediately begin to customize the site characterization plan. While there is very limited information about the threat, the suspected contamination site is obvious from the threat warning. Thus, the storage tank is designated as the primary investigation site. There is insufficient information to characterize the potential site hazards; however, the decision is made to treat this as a low hazard site until evidence is collected to indicate otherwise. The reason for this decision is that false alarm triggers do occur with some frequency, and to date, none have presented hazardous conditions. Furthermore, safeties are built into the site characterization process that are designed to minimize the risk to the site characterization team.

At this point, there is insufficient information to further customize the site characterization plan. A decision is made to dispatch the utility site characterization team to the investigation site, equipped with the standard field test kit and two sample kits. The plan will be reevaluated following the site characterization team's initial observations of the site.

Upon arrival at the location of the tank, the team establishes a perimeter at a safe distance from the tank to perform their initial evaluation. From the perimeter, the site characterization team conducts field safety screening using the radiation meter and observes that levels are well below a predetermined trigger level. Their initial observations indicate that the hatch is open, but no other signs of potential hazard are evident. The team leader contacts the WUERM using a two-way radio and reports their initial findings. The WUERM clears the team to proceed with site characterization activities.

At the perimeter, the team dons the PPE in the sample kit and cautiously approaches the site. They observe that the lock on the access hatch is missing, but no other individuals are in the area and there is no obvious evidence of contamination at the site. The team continues the characterization and conducts rapid field testing of the water for pH, conductivity, chlorine residual, and cyanide. The water quality parameters all appear normal, and the results of the cyanide test are negative. The team leader contacts the WUERM to report the results of the site characterization and discuss the need for any modification to the site characterization plan at this point. The sense is that the threat is not 'credible,' but it is decided to collect one set of samples that will be stored at the utility laboratory in case there is a need to analyze the samples later.

The team collects the samples, completes the documentation of the site characterization, and prepares to exit the site. Before leaving, the team places a new lock on the hatch and secures the site (this is important to avoid future false alarms). Upon leaving the site, the team leader contacts the WUERM to report that the team has completed its investigation and is in transit to the utility laboratory to deliver the samples for storage.

Commentary. In this example, customization of the site characterization plan only involved the identification of the suspected contamination site and an initial assessment that the site probably did not pose a significant hazard. The evaluation that the site did not pose a significant hazard was based on previous incidents and the experience of the WUERM. During site characterization, there were no signs of hazard or contamination; thus a decision was made to collect a single set of samples and not pursue any additional site characterization activities at this time. These samples were taken as a precaution and will only be sent to a laboratory for analysis if it is later determined to be necessary. The WUERM may continue the threat evaluation following the completion of these site characterization activities, since other information may be relevant to the evaluation regarding whether or not the threat is 'credible' (see Module 2). Furthermore, the decision to return the tank to normal operation will be based on the outcome of the threat evaluation, not solely on the results of the site characterization. Of course the site characterization provides important information to support the threat evaluation process.

Example 2: A threat warning is received in the form of security breach discovered at a water distribution system tank by a utility crew. Furthermore, evidence at the site indicates that material may have been introduced into the tank. The WUERM is immediately notified and asks the operational staff to review the SCADA data and inspection records for this tank. This evaluation indicates that 48 hours have elapsed between the time the breach was discovered and the most recent inspection that found the site secured, and that the storage tank was feeding the distribution system for at least 12 hours during that period, but it is not known whether or not this occurred before or after the security breach.

The WUERM and site characterization team leader immediately begin to customize the site characterization plan. Since the tank is the site of suspected contamination, it is designated as the primary investigation site. However, due to the potential spread of the suspected contaminant into the distribution system, secondary investigation sites are designated in the distribution system. These secondary sites are selected using operational knowledge of the system, as discussed in Section 4.1.2. Eight secondary sites are selected in the area impacted by the potentially contaminated water, and an additional eight sites are selected outside of this area for the purpose of baseline monitoring. At each investigation site, the standard set of field tests will be conducted and a complete set of samples will be collected. However, only the primary site (i.e., the location of the tank) will undergo a full investigation.

Due to the circumstances of the threat warning, the WUERM notifies utility management, law enforcement, and HazMat. This is in accordance with procedures outlined in the utility's *emergency response plan* (ERP). The incident commander (which may or may not be the WUERM in this case) determines that the secondary sites can be characterized by utility sampling crews trained in the site characterization procedures. HazMat will characterize the primary site due to the presence of suspicious material at the site, but the utility site characterization team leader will support the HazMat team on issues related to water quality and sampling.

The HazMat team takes command of the primary investigation site and implements their procedures for field safety screening and characterizing any potentially hazardous materials at the site, in particular residual materials found in a container. The HazMat team does not detect any hazards during their safety screen, although they do find a suspicious material at the site that is collected for subsequent analysis. At this point, the utility site characterization team leader is cleared to enter the site and provides guidance to the HazMat responders as they perform field testing of the water and collect water samples.

The results of limited rapid field testing performed at all investigation sites showed no obvious signs of contamination; however, there was evidence of potential contamination at the storage tank (i.e., the suspicious material in the container). Based on the collective information and results of the threat evaluation, a decision is made to immediately deliver all samples to the laboratory for analysis.

Commentary. In this example, the site characterization plan was complicated by the fact that there was the potential for potentially contaminated water to enter the distribution system. The plan addressed this by identifying additional sites for field testing and sampling in the distribution system. Secondary sites were selected to look for indicators of contamination in the potentially contaminated area as well as to characterize baseline levels outside of this area. This is particularly important for the non-specific field tests included in the kit, which require comparison to a baseline to effectively interpret the results.

This example also involves a situation in which the discovery of the threat warning yielded information about potential site hazards and evidence of contamination. This information influenced both the threat evaluation as well as the site characterization plan. Implicit in this example is the decision that the threat had some level of initial credibility such that it was necessary to contact law enforcement and HazMat. This in turn impacted the makeup of the site characterization team.

Example 3. A citizen observes a suspicious looking individual hurriedly leaving the fenced area surrounding a distribution system storage tank. The concerned citizen calls 911, but the police do not arrive in time to apprehend the suspect. The responding officer notices that the lock was cut from the perimeter fence and the access hatch was left open. The officer calls dispatch and requests that the water utility be contacted immediately. The WUERM is notified and immediately contacts operations to determine whether or not the storage tank can be isolated. Within an hour, the tank is physically isolated from the rest of the distribution system.

The WUERM and site characterization team leader immediately begin to customize the site characterization plan. As the potential site of contamination, the storage tank is designated as the primary investigation site. It is unclear whether or not the tank was isolated quickly enough to prevent the spread of water into the system; however, for the initial plan it is decided that only the primary site will be characterized. Since no indicators of potential hazard were observed by law enforcement, it is decided to treat this as a low hazard site until evidence is collected to indicate otherwise.

At this point there is insufficient information to customize the site characterization plan further. A decision is made to dispatch the utility site characterization team to the investigation site equipped with the standard field test kit and two sample kits. In addition to the standard field test kit, the team also takes a field detector that the utility recently purchased to expand their capabilities. While some basic testing has been done with the new detector, there has been insufficient time to perform much baseline monitoring or a rigorous performance evaluation.

Upon arrival at the location of the tank, the team establishes a perimeter at a safe distance from the tank to perform their initial assessment. From the perimeter, the site characterization team conducts field safety screening using the radiation detector and observes that levels are well below a predetermined trigger level. There initial observations indicate that the hatch is open, but no other signs of potential hazard are evident. The team leader contacts the WUERM using a two-way radio and reports their initial findings. The WUERM clears the team to proceed with site characterization activities.

At the perimeter, the team dons the PPE in the sample kit and cautiously approaches the site. They observe that the lock on the access hatch is missing, but no other individuals are in the area and there is no obvious evidence of contamination at the site. The team continues the characterization and conducts rapid field testing of the water for pH, conductivity, chlorine residual, and cyanide. The water quality parameters all appear normal and the results of the cyanide test are negative. However, the new detector used for expanded field testing yields a positive result for a contaminant of concern. The team leader contacts the WUERM to report the results of the site characterization, particularly the tentative identification of the contaminant. The WUERM and site characterization team leader realize that this tentative result will need to be confirmed through laboratory analysis, and revise the site characterization plan based on this result.

The operations staff believes that the tank was isolated in time to contain any contaminated water, but since they don't know how long the suspect was at the tank, they cannot be certain. Based on this information, the plan is modified as follows. Two complete sample sets will be collected from the tank and prepared for immediate delivery to the laboratory. In parallel with this activity, two additional utility sampling teams will be sent out to several locations within two specific areas of the distribution system. One team is sent to an area of the distribution system that normally receives water from the suspect tank to evaluate whether or not the contaminant has spread. The other team is sent to an area of system that is hydraulically isolated from the area served by the storage tank in order to conduct baseline sampling. Both teams are equipped with several complete sample kits. They are instructed to conduct expanded field testing at several locations within their assigned areas, and if they observe a positive result, to collect two complete sample sets. Each team is instructed to collect at least one complete sample set from within their target area, even if all field test results are negative.

Commentary. This example illustrates how the results of site characterization, particularly field testing, may be used to revise the site characterization plan in the field. Given the eyewitness account of the intrusion and the positive field test results, this may be considered a 'credible' threat, and additional response measures may be appropriate (see Module 2). However, interpretation of the expanded field test results is complicated by the fact that this technology is relatively new to the utility and there is insufficient baseline data to support interpretation of the results. While expanded field testing can be a valuable tool during site characterization, it is important to evaluate the technology and characterize the baseline **before** the technology is used during an actual site characterization.

Like the previous case, this example illustrates how the potential spread of the contaminant can complicate the selection of investigation sites. The solution in this case was to use the expanded field testing for the purpose of identifying additional sites for sample collection, as well as collecting additional data on the tentatively identified contaminant. The revised plan also specified the collection of at least one set of samples in each zone, which is prudent since the performance of the expanded field test has not been well characterized.

4.2 Approaching the Site

Once the site characterization plan has been customized to a particular situation, the site characterization team will be dispatched to the investigation site. The next stage of the process is the approach to the site, which is primarily intended to ensure that conditions are safe for the team to proceed with the characterization. This stage will also provide information to refine the site hazard assessment, as discussed in Section 4.1.3. During the approach to the site, site zones are established, field safety screening is conducted, and the conditions at the site are observed. These steps are described in this section.

4.2.1 Establish Site Zones

The site area should be defined and secured If the site hazard assessment indicates a potential radiological, chemical, or biological hazard, HazMat officials will likely establish a *protective action zone*. This is the zone where specialized PPE is required and may be further defined by HazMat officials per hazardous materials emergency response guidelines. The boundary of the protective action zone is referred to as the *site perimeter*.

A *staging area* may be established at the site perimeter to control entrance and exit of personnel and perform operations such as personnel and equipment decontamination. If the situation is deemed hazardous, the staging area should be located **far outside** of the protective action zone, and upwind from the investigation site, in an area that does not require specialized PPE. Security, law enforcement, or the fire department can secure the area and can help control traffic into and out of the area. The WUERM should be notified of any site zones that are established at the site of a suspected contamination incident, even if the WUERM is not the incident commander.

4.2.2 Field Safety Screening

The goal of field safety screening is to screen the site for potential hazards to determine if additional safety precautions are necessary as site characterization activities proceed. Field safety screening is conducted using a field test kit (see Section 3.2.2) and involves an evaluation of the environment at the site (i.e., in air and on surfaces). Field safety screening begins at the site perimeter with screening for excessive levels of radioactivity in the vicinity. Expanded field safety screening may be conducted for other hazards, such as volatile chemicals, chemical weapons, and biological contaminants. However, such equipment should only be used by individuals trained in its use, and the performance of the equipment should be validated.

The results of field safety screening should be immediately reported to the incident commander who will instruct the team whether or not to proceed with the site characterization. The results of field safety screening should be documented using a form such as the "Field Testing Results Form" included in Appendix 8.3.

4.2.3 Initial Observation of Site Conditions

Assuming that permission to proceed with site characterization has been granted, the site characterization team should cautiously approach the site, from upwind if possible. The team should begin the investigation by looking for signs that unauthorized individuals might still be at the site. Potential signs of the presence of intruders include visual observation of individuals, unexplained vehicles at the site, voices or other noises coming from the site, or unexplained equipment or materials left at the site. If it is suspected that intruders may still be present, the site characterization team should retreat to a safe location and immediately contact law enforcement. If the team can do so safely, they may want to maintain visual contact with the site until law enforcement arrives (i.e., to observe the activities of the unauthorized individual(s) at the site).

It is recommended that only one member approach the site while the other remains on the perimeter maintaining visual and verbal contact at all times. The person on the perimeter should maintain contact with the incident commander to be able to call for assistance if necessary. The team member approaching the site should continue to perform field safety screening and observe the site for potential hazards as he/she approaches the site. If any signs or evidence indicate hazardous conditions, the team should exit the site, immediately notify the incident commander, and return to the vehicle and remain there until assistance arrives. It is important **not** to leave the site completely since decontamination of personnel and equipment may be necessary. Once the team member approaching the site has completed an initial observation of site conditions and determined that it is safe, the other team member can proceed into the site.

While approaching the site, all team members should look for indicators of contamination. These include general evidence of contamination as well as signs specific to the presence of chemical contaminants.

General evidence of contamination, including chemical, biological, and radiological material, may include:

- Discarded PPE such as gloves, masks, goggles, and protective outerwear.
- Discarded equipment such as tubing, hoses, pumps, sprayers, lab equipment, etc.
- Empty containers unusual for the site (i.e., not litter or other items typically discarded in the area). Be aware of containers with labels for biohazards, radiological hazards, or chemical hazards.
- Unexplained or unusual residual material around the site, such as powders, granules, oily liquids, and metallic debris. Such residual material should be considered a potential hazard and should only be handled or sampled by properly equipped HazMat responders.
- Unexplained or unusual water conditions, such as oily films, foaming, or discoloration.

Signs specific to the presence of chemical contamination include:

- Evidence of dead/dying/sick animals, beyond normal carrion (e.g., road kill).
- Numerous dead insects in a localized area that are not a result of a local pest control program (e.g., spraying for mosquitoes).
- Isolated areas at the site where vegetation (bushes, lawns, trees, shrubs, food crops, weeds), are dead, discolored, or withered (assuming no drought conditions).
- Numerous oily liquid droplets on surfaces or an oily film on the water surface.
- Unusual odors, such as those listed in Table 3-4. It is important to consider whether the particular odor is unexpected or unusual for the surrounding area.

- A low-lying fog that is not explained by current weather conditions.

If any of these obvious signs of chemical contamination are evident, the team should return to their vehicle at a safe distance from the site until additional help arrives and immediately contact incident command. It is important not to retreat beyond the site perimeter since personnel may inadvertently spread a contaminant if they are not properly decontaminated before completely exiting the site.

Specific signs of radiological and biological contamination are less obvious than those associated with chemical contamination; however, the general evidence of contamination listed above still applies. The lack of obvious signs of radiological contamination underscores the importance of including field testing for elevated levels of radioactivity. While there may be no reliable indicators specific to biological contamination, a disinfectant residual can offer protection against many pathogens, thus field testing for disinfectant residual is recommended (see Section 4.3.2).

Table 3-4. Characteristics of Example Chemical Contaminants[1]

Chemical	Physical State	Odor	Color
Aldicarb	Solid or powder	Sulfur	
Chloropicrin	Oily liquid	Sharp and irritating	Colorless
Cyanide	Solid or powder	Bitter almonds	
Dicrotophos	Liquid	Ester	Yellow-brown
Lewisite	Liquid	Geraniums	
Mustard	Liquid	Garlic	
Oxamyl	Crystalline solid	Sulfur	White
Phorate	Liquid	Skunky	Colorless
Sarin	Liquid	Fruity	Colorless
Soman	Liquid	Fruity	Colorless
TEPP	Liquid	Fruity	Yellow
VX	Oily liquid	Sulfur	Colorless

1: These are characteristics of the concentrated chemical and may not be evident if diluted in water.

At this stage, it is critical to rapidly relay information to incident command, thus the team should stay in constant communication with the incident commander and report the findings of the initial site evaluation immediately. The observations made during the approach to the site should be documented using a form such as the "Site Characterization Report Form" included in Appendix 8.2.

4.3 Characterizing the Site

Following approval to enter the site, the team will begin the detailed site characterization process. The purpose of this stage of the process is to continue activities to evaluate potential risks to the team and collect information that will inform the threat evaluation process. During this stage, the team will evaluate site conditions and conduct rapid field testing of the water, as discussed in the following section.

4.3.1 Evaluation of Site Conditions

Upon entry to the investigation site, the team should continue field safety screening. Verbal results should be communicated to the incident commander, and permission to proceed should be obtained once the team has arrived at the actual site.

The team should continue to evaluate the site for indicators of contamination as discussed in Section 4.2.3 and document additional findings using the form in Appendix 8.2. Potential indicators of contamination or other hazards should be verbally reported to the incident commander immediately. If included in the sample kit, a camera and/or video camera can be used to photograph any unusual conditions or findings to assist in the documentation of site conditions. If the site is considered hazardous, or a crime scene, special handling of the equipment and film development will be necessary.

If there are any obvious signs of contamination at the site, the team should return to their vehicle at a safe distance from the site until additional help arrives and immediately contact incident command. It is important not to retreat beyond the site perimeter since personnel may inadvertently spread a contaminant if they are not properly decontaminated before completely exiting the site.

4.3.2 Rapid Field Testing

There are three objectives of field testing the water: 1) To provide additional information to assess the credibility of the threat; 2) To tentatively identify contaminants that would need to be confirmed by laboratory testing; and 3) To determine if hazards tentatively identified in the water require special precautions during sampling. Furthermore, the field test results will support the site hazard assessment process described in Section 4.1.3. Because these results are important for both the threat evaluation and site hazard assessment, they should immediately be reported to the incident commander. Results of rapid field testing of the water can be documented using the "Field Testing Results Form" included in Appendix 8.3.

The field test kit presented in Table 3.3 identifies a core set of rapid field tests for water, which includes chlorine residual, pH, and cyanide (it may also be possible to test the water for radioactivity depending on the probe). Table 3.3 also presents several options for expanded rapid field testing of the water. The decision to include any expanded field testing capability should be made during general planning for site characterization activities. As discussed in Section 3.2.2, any field detectors or kits planned for use during site characterization should be evaluated and characterized with respect to performance, and a baseline established for the monitored parameter.

Use of detectors or equipment that have not been characterized during an emergency may lead to greater uncertainty with respect to how to respond. For example, how would one respond to a positive result from an anthrax test kit without knowledge of the rate of false positive results or information regarding typical background levels?

Field test results should be evaluated in the context of the performance characteristics of the test and should generally be considered tentative until confirmed through some other definitive means. For example, a negative result may not indicate the absence of a contaminant if the field test has a high rate of false negative results or is not sufficiently sensitive to detect the contaminant at levels of concern. Likewise, positive results might be due to interferences or may represent contaminants other than the target. Thus, positive results should generally be confirmed through laboratory analysis. While it is important to consider these limitations, 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, as discussed in Module 2. Results from rapid field testing of the water can also be used to refine the sampling plan, as discussed in Section 4.1.4.

4.4 Collecting Samples

Following field safety screening and rapid field testing, the site characterization team will collect samples for possible laboratory analysis. At this stage of the site characterization, sample collection may be viewed as a precautionary measure to capture the water quality at the location and time of sample collection. If the threat is determined to be 'credible,' then samples may be shipped to the laboratory for analysis, as shown in Figure 3-1. If not, the samples should be held until the investigation is closed.

This section provides general procedures for sampling, as well as procedures specific to chemical and biological sampling. In addition to the guidance presented in this module, EPA and USGS have developed sampling guidance for other purposes that may be relevant to emergency water sampling. Some useful links to additional sampling guidance include:

- A series of standard operating procedures published by EPA's Environmental Response Team at http://www.ertresponse.org/Response_Resrcs/index.htm.
- Training developed for EPA on scene coordinators at http://www.epaosc.org/training.htm.
- USGS field procedures for water sampling at http://water.usgs.gov/owq/Fieldprocedures.html.

4.4.1 General Sampling Procedures

The following general guidelines are applicable to sampling for both chemicals and pathogens, while specific sampling procedures for these two contaminant classes are provided in Sections 4.4.2 and 4.4.3, respectively.

These guidelines are applicable to the collection of samples from investigation sites within the distribution system, including storage tanks, pressurized pipes, and other distribution system elements. In most cases, samples will be collected from a tap connected to the distribution system element. However, it may be necessary to collect samples from a large body of water, such as a finished water reservoir. Sampling from such large bodies of water, whether finished or source water, requires different sampling techniques than those used to sample from distribution systems. Guidance developed for the collection of samples from surface water sources, such as the EPA Environmental Response Team's standard operation procedure #2013, may also be applicable to sampling from large finished water reservoirs (http://www.ertresponse.com/sops/2013-r10.pdf).

General Water Sampling Guidelines

1) Review the site characterization plan prior to sampling to ensure that all samples are collected.
2) Each sample container should be properly labeled using a waterproof marker with the following information: analysis, preservative (if any), dechlorinating agent (if any), sample location, sample identification, sample collection date and time, and sampler's initials. Additional information requested on the sample label should be provided as well.
3) To minimize the time spent on the site during the sample collection stage, it is recommended that sample labels for each container be completed before beginning sample collection.
4) Check for the presence of any in-line filters (e.g., home treatment devices) that might interfere with sampling. Remove such devices if present.
5) Flush sample taps for a time sufficient to displace the water in connecting lines in order to obtain a representative sample from distribution system element of interest.
   a) Keep the flow rate from the sample tap sufficiently low in order to avoid splashing and aerosolizing water droplets. Divert water to a drain if possible.
   b) If the water flushed from the tap might pose a hazard to the discharge area, it may need to be collected for decontamination.
6) Critical information for each sample should be documented:
   a) The same information captured on the sample labels should be transferred to a sample documentation form to serve as a sample inventory (see Appendix 8.4 for an example form).
   b) Sample custody should be closely tracked and documented using a chain of custody form (see Appendix 8.5 for an example form).
7) Samples may be considered evidence, and thus should be subject to appropriate security measures:
   a) Samples should be under the control of designated personnel at all times.
   b) When samples are not in the possession of designated personnel, they should be secured (e.g., locked in a *secure area*) and only accessible by designated personnel. In the field, samples may need to be locked in a vehicle.
   c) Chain of custody should be initiated immediately after sample collection.
   d) If necessary, duplicate samples can be collected for law enforcement.
   e) If necessary, take photographs of the samples at the site of collection as another form of sample documentation.
8) If the decision is made to analyze the samples immediately, the laboratory should be contacted as soon as possible so they can prepare for arrival of the samples.
9) If the decision is made to hold samples rather than send them to the laboratory for immediate analysis, the following precautions should be taken:
   a) Samples should be chilled, but protected from freezing.
   b) Samples should be held until the threat evaluation has been completed and the decision has been made to either analyze the samples or close the investigation.
   c) The shortest holding time for a particular analysis will dictate the maximum time that samples should be held prior to analysis. Holding times for preserved samples are contained in their respective analytical methods (see Module 4), and are typically 7-28

days for properly preserved samples, although the respective analytical method should be consulted for details about holding samples. If it is necessary to store unpreserved samples, the stability of the target analyte in water should be considered when determining how long an unpreserved sample might be stored.

It is important to follow any special laboratory requirements regarding sample collection and transport since this may affect the quality of the analytical results. For example, some procedures or laboratories may require analysis of special QC samples such as field duplicates, field blanks, trip blanks, and field matrix spikes. There may also be specific chain of custody, notification, and shipping requirements. Arrangements should be made with a laboratory prior to an incident so that samplers are aware of, and can prepare for, any special requirements.

It may also be advisable to collect backup samples in case there is a problem with the set that is delivered to the laboratory, or if there is a need for additional samples for confirmation or analysis by another entity (e.g., a specialty laboratory or law enforcement). Backup samples should be properly stored, secured, and tracked such that the integrity of the samples is maintained. While collection of individual backup samples may be appropriate in some cases, it may be logistically simpler to collect a large volume sample in a 10-liter container as a backup.

4.4.2 Chemical Sampling Procedures

The following procedures are appropriate for collecting samples for chemical analysis from drinking water distribution systems. If samples need to be collected from a large body of water without a suitable sample tap, the surface water sampling guidelines referenced in Section 4.4.1 may be used. If the samples are considered to be hazardous, it may be necessary to implement certain hazardous materials sampling techniques, as discussed in Section 4.1.4, in addition to the guidelines presented below.

General Water Sampling Procedures for Chemical Contaminants

1. Carefully fill sample containers with water flowing from the sample tap. Avoid splashing or aerosolizing water droplets during sample collection. Do not use rubber or plastic tubing for the collection of samples for chemical analysis
2. Do not rinse or overfill the sample containers. This is especially important if the sample container contains a preservative or dechlorinating agent.
3. If necessary, add any preservatives and/or dechlorinating agents. Preservatives and/or dechlorinating agents may be added to the sample containers during sample kit preparation, which can significantly decrease the complexity and time required for sample collection. (See note on preparation of pre-preserved sample containers in Section 3.2.1.)
4. If necessary, adjust the pH of the sample per method instructions.
5. When sealing sample containers that have open top caps and septa, make certain that the Teflon side (smooth side) is facing towards the water.
6. VOC samples should be collected with no headspace.
7. For containers with closed top caps (pesticides, etc.) attempt to fill the container to the top leaving very little or no headspace.
8. Wipe the outside of the sealed containers with an antiseptic wipe or a mild bleach solution if deemed necessary.

9. If the sample container is not pre-labeled, place a label on the container and complete the requested information. Transfer the information on the sample label to the sample documentation form (Appendix 8.4).
10. Attach a custody seal to the individual sample container, if required by the organization responsible for sample collection and handling. In some cases, it may be sufficient to place the custody seal on the shipping container rather than the individual sample containers themselves. Record the information on chain of custody record (Appendix 8.5).
11. Place the sample container into a sealable plastic bag (bubble wrap baggies can provide protection against breakage of glass sample containers).
12. Place the sealed plastic bags containing the samples into an appropriate, rigid shipping container and pack with frozen ice packs (preferred) or sealable freezer bags filled with ice. If ice is used, the bag should be thoroughly sealed to avoid leakage. See Section 6 for more details on sample packaging and shipment.

4.4.3 Microbiological Sampling Procedures

Sampling for microbiological contaminants is closely coupled to the analytical approach for pathogens as discussed in Module 4, Section 8. In particular, there are two general approaches to pathogen sampling and analysis that depend on whether or not a pathogen has been tentatively identified, as illustrated in Figure 3-4.

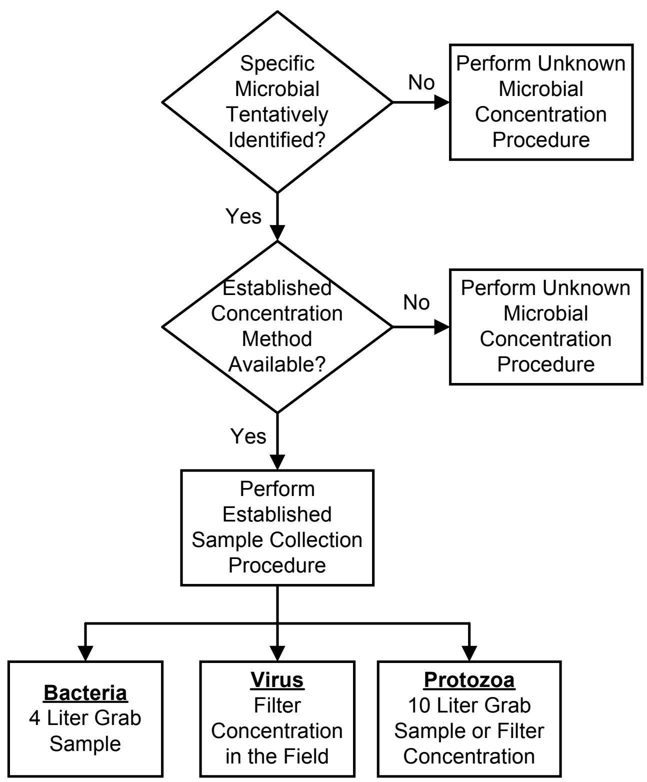

Figure 3-4. Sampling Approach for Microbial Contaminants

If the microbiological contaminant has been tentatively identified **and** has an established analytical technique suitable for water, then samples should be collected in accordance with that technique. However, established and validated sample collection and analytical techniques for microbial contaminants in water are limited to a few pathogenic microorganisms, principally enteric bacteria, viruses and protozoa, and a few other organisms with known waterborne transmission. Module 4, Section 8.2 provides additional information on those pathogens with established analytical techniques. Figure 3-4 indicates the following sampling approach for bacteria, virus, and protozoa:

- **Bacteria**: collect a four-liter grab sample for membrane filtration and culture of several different types of bacteria through use of selective media.
- **Virus**: filter between 100 and 1,200 liters of water through a positively charged filter (ICR Microbial Laboratory Manual, EPA/600/R-95/178, April 1996, http://www.epa.gov/nerlcwww/). The processed filters can be shipped to the laboratory or viruses adsorbed to the filter can be eluted in the field and shipped as a one-liter *retentate* (or concentrate) to a laboratory for further processing by conventional procedures.
- **Protozoa**: collect a 10-liter grab sample for shipment to a laboratory where it is filtered to concentrate the protozoa for subsequent processing and analysis (Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration by IMS/FA, EPA-821-R-99-006, April 1999, http://www.epa.gov/nerlcwww/). Another alternative is to perform the filtration in the field, similar to the approach for virus.

Many microbiological methods also specify the addition of a dechlorinating agent in order to maintain the viability of the organisms so that they can be cultured. The established method for the target microbiological contaminant should be consulted to determine the appropriate dechlorination and preservation techniques.

If the microbial contaminant is unknown, sample collection is performed through the use of ultrafiltration, which is a membrane filtration process that retains particles, including microorganisms, larger than the molecular weight cut-off (MWCO) of the membrane. The solution containing the concentrated particles and pathogens is called the retentate, while the water that passes through the ultrafiltration membrane is called the *filtrate*. Ultrafiltration can concentrate viruses, bacteria, spores, and parasites if the MWCO is sufficiently small. Thus, the method is suitable for sampling water with an unknown microbiological contaminant.

There are several reasons for using the ultrafiltration sampling approach rather than sampling for one or more specific pathogens using existing, standardized methods. First, the sample may contain a mixture of microbial contaminants; thus use of methods for specific pathogens may miss other pathogens that are present. Second, due to the low oral infectious dose of most waterborne pathogens, a sample of 100 liters of finished water may need to be concentrated to obtain a suitable level of sensitivity. Third, sample concentration methods for viruses and protozoa require separate field equipment and procedures and are practical only if the microbial contaminant is suspected or identified as one amenable for concentration by each of these specific technologies. Thus, it may be necessary to utilize a more general sample concentration procedure based on ultrafiltration since it targets a wider range of microorganisms.

In general, the ultrafiltration procedure involves the concentration of a large (100 liters or more) volume of water using an ultrafiltration field concentration apparatus, such as that shown in Figure 3-5. The basic elements of this apparatus include an input reservoir for sample collection, a peristaltic pump, a cross-flow hollow fiber membrane cartridge, a retentate reservoir and a filtrate reservoir. Operating the unit in cross-flow mode is preferable because the high velocity of water scours the membrane surface, preventing excessive deposition of material on the surface. Non-reactive membranes are preferable such as polysulfone or low protein binding membranes.

Sample filtration is conducted by recirculating water (necessary to maintain cross-flow conditions) with a 5-10 psi differential between the feed and filtrate pressure. The pressure differential forces water through the hollow fiber membrane, while particles and microorganisms are concentrated in the retentate. The volume of the retentate is reduced to approximately 250 mL by recirculating the concentrated sample through the smaller retentate loop for capture in the retentate reservoir. The retentate reservoir vessel can be used for sample shipping if necessary. The sample retentate can also be recovered by backflushing (reversing the flow through of the hollow fiber membrane cartridge). Research is currently underway to refine the design of the ultrafiltration apparatus, and future versions of this module will provide more detail on its design and operation.

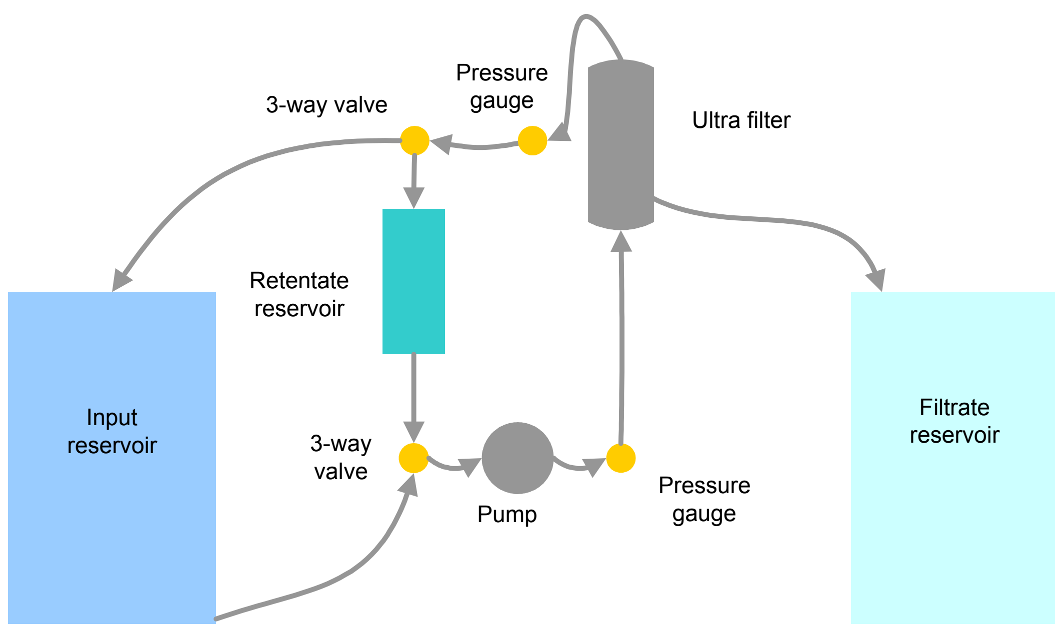

Figure 3-5. Ultrafiltration Field Concentration Apparatus

Some of the general water sampling procedures listed for chemicals also apply to sampling for pathogens, as listed below.

General Water Sampling Procedures for Microbiological Contaminants

1. Avoid splashing or aerosolizing water droplets during sample collection or field concentration.
2. Do not rinse or overfill the sample containers. This is especially important if the sample container contains a preservative or dechlorinating agent.
3. Any sample aliquot collected for culture analysis should be handled in a manner such that viability of the microorganisms is maintained.
4. If necessary, add any preservatives and/or dechlorinating agents. Preservatives and/or dechlorinating agents may be added to the sample containers during sample kit preparation, which can significantly decrease the complexity and time required for sample collection. (See note on preparation of pre-preserved sample containers in Section 3.2.1.)
5. Wipe the outside of the sealed containers with an aseptic wipe or a mild bleach solution.
6. If the sample container is not pre-labeled, place a label on the container and complete the requested information. Transfer the information on the sample label to the sample documentation form (Appendix 8.4).
7. Attach custody seal to the individual sample container, if required by the organization responsible for sample collection and handling. In some cases, it may be sufficient to place the custody seal on the shipping container rather than the individual sample containers themselves. Record the information on chain of custody record (Appendix 8.5).
8. Place the sample container into a sealable plastic bag (bubble wrap baggies can provide protection against breakage of glass sample containers).
9. Additional instructions for packaging samples potentially containing infectious biological contaminants are provided in Section 6.
10. Place the sealed plastic bags containing the samples into an appropriate, rigid shipping container and pack with frozen ice packs (preferred) or sealable freezer bags filled with ice. If ice is used, the bag should be thoroughly sealed to avoid leakage. See Section 6 for more details on sample packaging and shipment.

4.5 Exiting the Site

For a site characterized as a low hazard, it should not be necessary to implement extensive procedures for exiting the site. The following general precautions are recommended when exiting a low hazard site:

- Verify that any hatches, locks, etc., are properly secured before leaving the site.
- Collect all samples, equipment, and materials and move them to the site perimeter. Anything brought onto the site should be removed from the site.
- Make sure that all samples are in the cooler(s) along with ice packs and that the cooler is sealed with chain of custody tape, if applicable.
- Remove all PPE at the site perimeter, and place disposable PPE, along with any other garbage, into the heavy-duty plastic trash bag. Close the bag securely.
- Place all equipment, samples, and the sealed plastic trash bag into the vehicle.
- If the site has perimeter security (e.g., a fence and gate), verify that the perimeter has been properly secured before leaving the site.
- Ensure that all forms have been completely filled out before leaving the site.

If the site was categorized at a higher hazard level and/or if the site is considered a crime scene, then special procedures for exiting the site will likely be required by HazMat officials or law enforcement. For example, personnel and equipment may be required to undergo decontamination prior to exiting the site, and access to the site is likely to be tightly controlled. If the site is considered a crime scene, the site may be secured by law enforcement, and qualified investigators will be responsible for collecting any physical evidence from the site (such as empty containers, dead animals, etc.). A detailed discussion of site exit procedures required under these conditions is beyond the scope of this document, and will likely vary depending on the organization responsible for incident command and site characterization.

5 Site Characterization Report

In order to provide useful information to support the threat evaluation process and the development of an analytical approach, the findings of the site characterization should be summarized in a report. This report is not intended to be a formal document, but simply a concise summary of information from the site activities that can be quickly assembled within an hour or two. The recommended content of the report includes:

- General information about the site.
- Information about potential site hazards.
- Summary of observations from the site evaluation.
- Field safety screening results, including any appropriate caveats on the results.
- Rapid field water testing results, including any appropriate caveats on the results.
- Inventory of samples collected, and the sites from which they were collected.
- Any other pertinent information developed during the site characterization.

The "Site Characterization Report Form" (Appendix 8.2), "Field Testing Results Form" (Appendix 8.3), and "Sample Documentation Form" (Appendix 8.4) are designed to record most of this information during site characterization activities, and these completed forms may serve as the core of the site characterization report. If multiple investigation sites were characterized in response to a particular threat, the results from all site characterization activities should be assembled into a single report.

The information contained in the site characterization report will likely be used to support several follow-on activities:

- Hazard assessment of the site.
- Threat evaluation.
- Implementation of precautionary actions to protect public health.
- Estimate of the spread of the contaminant.
- Analytical plan (including the decision regarding whether or not to analyze samples).

These activities lead into the latter phases of the response to a contamination threat, which are discussed in other modules of the "Response Protocol Toolbox."

The site hazard assessment should be completed at the conclusion of site characterization activities; thus, it may only be necessary to document the conclusions of the assessment in the report. This provides the incident commander with an overall understanding of the site hazard conditions and provides the opportunity to revise the assessment, if necessary.

Following site characterization, a significant amount of new information should be available to support the threat evaluation initiated at the time threat warning is received (see Module 2). Thus, the threat evaluation should be revised following review of the results from the site characterization. In many cases, these results will be critical to the determination regarding whether or not the contamination threat is 'credible.' This determination should be documented in the "Threat Evaluation Worksheet" included in Module 2, Appendix 8.2. This revised worksheet should be included at the front of the site characterization report since it represents the outcome of the site characterization activities.

The revised threat evaluation will dictate the next steps in the response process (sample analysis, public health response, and remediation/recovery). If the threat is determined to be 'not credible' following site characterization, then the investigation may be closed and the system returned to normal operation. On the other hand, if the threat is deemed 'credible' at this stage, it may be necessary to take steps to protect public health as the response progresses. This may require an estimate of the spread of the suspected contaminant through the system, and the site characterization results may support such an analysis (particularly if multiple investigation sites were characterized).

If a decision is made to analyze the samples collected from the site in an attempt to 'confirm' a contamination incident, it will be necessary to develop an analytical approach. The site characterization report can serve as a valuable resource when developing the analytical approach; thus it is critical that the laboratory and other parties involved in designing the analytical plan have immediate access to the report. A briefing among relevant parties is recommended in order to transition from site characterization to laboratory analysis. The development of an analytical approach, and the link between site characterization and sample analysis, is described in Module 4, Section 5.

Finally, it is important to maintain records of all site characterization activities, even for incidents that were ultimately dismissed as 'not credible.' Good records management practices are important since documentation about a particular activity might need to be accessed later, long after the details of the incident have faded from memory. Furthermore, by maintaining documentation about all threat warnings that occur at a utility, a historic record can be established that may help in evaluating future threats. Such a record is considered as a potential information resource in the threat evaluation process (see Module 2, Section 4.1.2).

6 Sample Packaging and Transport

In order to perform analysis of samples beyond rapid field testing, it will be necessary to properly package the samples for transport to the appropriate laboratories as quickly as possible. Prompt and proper packaging and transport of samples will:

- Protect the integrity of samples from changes in composition or concentration caused by bacterial growth or degradation that might occur at increased temperatures.
- Reduce the chance of leaking or breaking of sample containers that would result in loss of sample volume, loss of sample integrity, and potential exposure of personnel to hazardous substances.
- Help ensure compliance with shipping regulations.

Sampling packaging and transport is governed by a number of regulations, as administered by the International Air Transport Association (IATA, http://www.iata.org/) and the U.S. Department of Transportation (DOT, http://www.dot.gov/). In addition, there may be additional requirements specified by states, local authorities, and/or shipping companies. The regulations and requirements that govern the packaging and transport of samples will depend on the nature of the material in the samples. The pertinent regulations are largely based on whether the samples are classified as a hazardous material. Hazardous material is defined as any substance that appears in the 49 CFR Hazardous Materials Table (http://hazmat.dot.gov/rules.htm), subject to certain exemptions based on the quantity and concentration of material.

For the purpose of this module, two general classes of samples are considered: environmental samples and hazardous samples. Environmental samples are those collected from environmental media, such as natural or treated waters, that are not expected to be contaminated with hazardous materials at concentrations that would pose a risk to unprotected personnel. The vast majority of water samples collected are expected to be classified as environmental samples.

Hazardous samples typically consist of concentrated hazardous materials (as defined above), and they are typically collected from drums, tanks, lagoons, pits, waste piles, fresh spills, or areas previously identified as contaminated. Accordingly, they require special handling procedures due to their potential toxicity or hazard. The distinction between environmental samples and hazardous samples becomes blurred when hazardous materials might be present in an environmental sample at unknown concentrations.

The decision regarding the classification of a sample as environmental or hazardous may be based on the hazard classification of the site from which samples were collected. In Section 4.1.3, four broad site hazard categories are defined for the site of a suspected water contamination incident: low, radiological, hazardous chemical, and infectious biological agent.

Samples collected from a low hazard site may be considered environmental samples in most cases. By contrast, samples collected from sites categorized as a radiological, chemical, or biological hazard may be classified as potentially hazardous materials. However, the use of certain sample collection techniques, such as dilution and UV irradiation (as discussed in Section 4.1.4), may reduce the hazard and allow samples to be considered environmental. Following is some general information regarding packaging and transport of low hazard (environmental) and high hazard samples.

6.1 Low Hazard Samples

6.1.1 Packaging

The sampling procedures in Section 4.4 end with the sample being placed into a prepared cooler. Cooler preparation is an important part of packaging, and it is imperative that samples are correctly and carefully packed in shipping containers to prevent the sample containers from breaking or leaking. Following are steps in preparing a cooler:

1. Use a clean cooler to prevent cross contamination. Seal all drain holes of the cooler, both inside and out, to prevent leakage in the event of a compromised sample container.
2. Check all lids/caps to make sure they are tightly sealed and will not leak.
3. Seal samples within a clear plastic bag.
4. If possible, fully chill samples to 4°C or less prior to placement within suitable packing materials.
5. For additional protection in case of breakage, the cooler may be lined with non-combustible, absorbent packing material such as rock wool, ground corncobs, perlite, or clay-based absorbents (e.g., kitty litter or 'oil dry ').
6. After the samples are placed in the cooler, conduct an inventory of the contents of the shipping cooler against the corresponding sample inventory and chain of custody records.
7. Cover samples in double-bagged ice, or frozen ice packs, to prevent water damage to packing materials. **Do not** pour loose ice directly into the sample cooler. The bagged ice will maintain the temperature of the samples within the shipping cooler.
8. A temperature blank may be included within each cooler being shipped. The temperature blank may be a 40 mL vial filled with water and labeled "temperature blank." There are also "memory" thermometers and other data-logging devices available for this purpose.
9. Include necessary paperwork (copies of sample documentation and chain of custody forms) in the cooler. It may be convenient to place all of this in a plastic bag or pouch and affix it to the underside of the lid of the cooler. The original documentation should be maintained by the utility.
10. After the contents of the cooler have been checked for completeness, all openings of the cooler should be sealed with tape. Correct chain of custody seals, if required, should be attached to the cooler in a manner such that it would be apparent if the cooler has been opened prior to laboratory receipt.
11. Prepare the cooler appropriately for shipping depending on the way the container is to be transported.
12. Clearly label the cooler with the address of the laboratory where the samples are to be sent.

6.1.2 Transport

In some cases, it may be desirable to have the site characterization team transport the samples directly to the laboratory. During sample transport, it is important that the team take steps to maintain sample integrity and chain of custody. Maintaining sample integrity may involve delivering the samples to the laboratory as soon as possible, without making any unnecessary stops. Lengthy, unnecessary stops may allow time for the samples to degrade, even when the samples are chilled, reducing the quality of the results. Coolers also have limited insulation value, so if a cooler is left in a warm vehicle while the driver performs errands, the samples could heat up, potentially degrading some sample components. In addition, leaving the sample unattended may violate chain of custody procedures, which must be observed at all times. If it is necessary to hand over control of the cooler to another responsible party, this transfer should be noted on the chain of custody form.

While the site investigation team would typically deliver samples by ground transportation, some transport may be accomplished by air, i.e., airplanes or helicopters. In this case, those responsible for sample transport should consider the effects of their flight patterns on integrity of the samples. For instance, sudden changes in air pressure might cause some previously sealed containers to burst or vent.

In other cases, the only option may be to use an overnight shipping company to deliver the samples to the laboratory. Many shipping companies currently do not have special requirements for shipment of environmental water samples in coolers, other than leak prevention. If overnight shipping is to be used, the site characterization team should have ready access to all pertinent information about the shipping company, including: name, phone number, hours of operation, shipping schedule, any special shipping requirements, and pick-up/drop-off requirements. There is a block for this information in the "Site Characterization Plan Template" in Appendix 8.1. Chain of custody is also important when using an overnight shipping service. Shipping records should be maintained as part of documenting chain of custody. Most major companies are able to maintain chain of custody upon sample receipt, although this should be verified.

6.2 High Hazard Samples

In general, HazMat teams will likely have packaging and shipping procedures for high hazard samples that might contain radiological, chemical, or biological contaminants. It is important to verify that local HazMat teams that might assist in site characterization activities do have the procedures and capabilities in place to transport hazardous samples. A brief overview of considerations for shipment of high hazard samples is provided below.

6.2.1 Packing

Hazardous materials shipments must be packaged in compliance with sections 173.24 and 173.24a of 49 CFR (http://hazmat.dot.gov/rules.htm). Often this is accomplished by the use of United Nations Performance Oriented Package. In 49 CFR, hazardous materials are divided into nine classes, which refer mostly to concentrated materials. Relevant classes for high hazard water samples include Class 2.3 (poisonous gases), Class 6.1 (poisonous materials, inhalation hazard), Class 6.2 (infectious substance), and Class 7 (radioactive substances).

Radiological Hazards. Packaging of radioactive materials is regulated under CFR 49 173.401-173.476 as a Class 7 material. In general, for Class 7 materials the package may consist of one or more receptacles, absorbent materials, spacing structures, thermal insulation, radiation shielding, devices for cooling or absorbing mechanical shocks, and service equipment for filling, emptying, venting and pressure relief. The conveyance, tie-down system, and auxiliary equipment may sometimes be designated as part of the packaging. The type of packaging is dependent on the nature of the radioactive hazard (specific radionuclide and amount of radioactivity). Trained hazardous materials responders should select of the most appropriate packaging for a specific radioactive hazard.

Chemical Hazards. Chemical hazards may be broken down into chemical warfare agents, biotoxins, and conventional toxic chemicals (e.g., cyanide, pesticides, industrial chemicals, etc.). Packaging requirements for chemical hazards are similar to those for low hazard chemicals except that special care is necessary to prevent release of the contaminated water, as might occur through water leaks or volatilization. Preventing such release may involve providing multiple layers of containment, and a regular cooler by itself might not offer appropriate protection. Placing the sample inside an approved shipping container, which in turn is placed inside the cooler, may satisfy the packaging requirement. Some approved shipping containers include a temperature control system (i.e., freezer packs), so the cooler may not be necessary. Approved containers that meet regulatory requirements are readily available since hazardous materials are packaged and shipped routinely in a number of industries. There may be volume or weight limits to the quantity of water that may be packaged in an approved container, largely due to limitations in the structural integrity of the container.

Transport of hazardous materials requires proper labeling and declaration of hazards. This labeling and declaration may be necessary even if a commercial shipper is not used. For instance, if samples are transported to the laboratory by vehicle, it is important that the content, and potential hazards, of the packages by clearly documented to facilitate proper safety and handling precautions during transfer of sample custody.

A special situation exists for chemical weapons. Following collection, the samples must be placed under a tent for a set period of time and the tent monitored for the potential release of chemical weapon vapors using a suitable detector. If chemical weapons are suspected, law enforcement should be contacted as they will have access to expertise and procedures for safely packaging and transporting these types of samples.

Biological Hazards. Packing requirements and procedures for biological samples have been developed by the CDC to facilitate safe shipment of the samples to LRN laboratories, which may be found at http://www.bt.cdc.gov/labissues/PackagingInfo.pdf. In summary, triple packaging (primary receptacle, water tight secondary packaging, and durable outer packaging) is required for infectious biological agents or materials that are known or suspected of containing them.

For biological hazards, the "Infectious Substance" label (shown at the web site listed above) must be placed on the outside of the package. This packaging must be certified to meet rigorous performance tests as outlined in the IATA, DOT, USPS, and PHS regulations. Detailed information about this packaging is found in “Biosafety in Microbiological and Biomedical Laboratories,” United States Department of Health and Human Services, 4th Ed., edited by J.Y.

Richmond and R.W. McKinney, U.S. Government Printing Office, 1999. This document is also available at: http://www.cdc.gov/od/ohs/biosfty/bmbl4/bmbl4s1.htm.

Currently, the largest available container size that meets the CDC shipping requirements is four liters; however, CDC is working on packaging designs to accommodate 10-liter samples. There are also specific requirements and guidance available for certain agents, such as anthrax, http://hazmat.dot.gov/guide_anthrax.htm, although the applicability of this guidance to water samples should be carefully considered.

6.2.2 Transport

Many of the same principles that apply to the transport of low hazard samples also apply to high hazard samples, assuming they are properly packaged and labeled. Depending on the nature of the hazard, law enforcement may be involved in the transport of hazardous samples, especially if the services of a specialty laboratory are required. For instance, if chemical weapons are suspected, a technical escort service from the military may take custody of the samples and transport them to a chemical weapons laboratory. Other technical escort services are available for a variety of samples, but this resource is limited and may be accessed only through specific channels, such as law enforcement.

Many commercial shipping companies (such as FedEx, UPS, USPS, etc) have varying policies regarding labeling and documentation, some based on regulatory requirements, for overnight shipping of hazardous materials.. Some companies offer free advice and training on packaging and shipping such samples. The site characterization team should be familiar with the regulatory requirements, as well as other shipping company policies. In general, commercial shipping companies may transport some many hazardous samples provided that packaging and declaration requirements are fulfilled. However, the shipper may not pick up potentially hazardous samples, but require that they be delivered to the shipping center.

Maintaining and documenting the chain of custody is important when using an overnight shipping service for both high hazard and low hazard samples. Shipping records should be maintained as part of documenting chain of custody, and it should be verified that the company can maintain chain of custody throughout the delivery process.

As part of planning activities, it is recommended that a potential shipping company be contacted with a request for their lists of allowable and prohibited hazardous materials. The prohibited materials often include substances within the following classes: Class 2.3 (poisonous gases), Class 6.1 (poisonous materials, inhalation hazard), Class 6.2 (infectious substances), and Class 7 (radioactive material II and III). Thus, many hazardous substances may be listed as prohibited materials by many commercial shipping company. For example, it is unlikely that a commercial shipper could transport a sample containing chemical warfare agents. However, exemptions to these policies may be available for some hazardous materials. For example, many infectious substances may be acceptable if packaged according to CDC guidelines, which were designed with shipping regulations in mind. Exemptions will vary from company to company.

7 References and Resources

References and information cited or used to develop this module are listed below. The URLs of several sources are cited throughout the text. These URLs were correct at the time of the preparation of this document. If the document is no longer available at the URL provided, please search the sponsoring organization's Web site or the World Wide Web for alternate sources. A copy of referenced documents may also be provided on the CD version of this module, although readers should consult the referenced URL for the latest version.

Chemical Hazards Response Information System (CHRIS). http://www.chrismanual.com

FBI Handbook of Forensic Services
http://www.fbi.gov/hq/lab/handbook/intro.htm

Hazardous Materials Guide for First Responders. http://www.usfa.fema.gov/fire-service/hmgfr3.cfm

Interagency Intelligence Committee on Terrorism (IICT). Chemical/Biological/Radiological Incident Handbook. October 1998. http://fas.org/irp/threat/cbw/CBR_hdbk.htm

National Institute of Justice. U.S. Department of Justice. An Introduction to Biological Agent Detection Equipment for Emergency First Responders, NIJ Guide 101-00. December 2001. http://www.ojp.usdoj.gov/nij/pubs-sum/190747.htm.

National Institute of Justice. U.S. Department of Justice. Guide for the Selection of Chemical Agent and Toxic Industrial Material Detection Equipment for Emergency First Responders, NIJ Guide 100-00. June 2000. http://www.ojp.usdoj.gov/nij/pubs-sum/184449.htm.

NIOSH Emergency Response Resources. http://www.cdc.gov/niosh/topics/emres/

OSHA, 2002, "Safety and Health Topics Personal Protective Equipment"
http://www.osha.gov/SLTC/personalprotectiveequipment/index.html

OSHA, 2003a, "OSHA e-HASP Software –Version 1.0, September 2003"
http://www.osha.gov/dts/osta/oshasoft/ehasp/

OSHA, 2003b, "Occupational Safety and Health Administration Homepage"
http://www.osha.gov

U.S. Army Soldier and Biological Chemical Command. Law Enforcement Officers Guide for Responding to Chemical Terrorist Incidents. January 2003.

Standard Emergency Management System (SEMS) Guidelines
http://www.oes.ca.gov/Operational/OESHome.nsf/Content/B49435352108954488256C2A0071E038?OpenDocument

U.S. Environmental Protection Agency. On Scene Coordinator homepage
http://www.epaosc.org

U.S. Environmental Protection Agency. On Scene Coordinator Training http://www.epaosc.org/training.htm.

U.S. Environmental Protection Agency. Chain of Custody guidelines http://www.epa.gov/safewater/certlab/laba.html

U.S. Environmental Protection Agency. Environmental Technology Verification program for field detection technologies. http://www.epa.gov/etv/

U.S. Environmental Protection Agency. Environmental Response Team. Standard Operating Procedures. http://www.ertresponse.org/Response_Resrcs/index.htm.

U.S. Environmental Protection Agency. Environmental Response Team. Health and Safety. http://www.ertresponse.com/health_safety/index.htm

U.S. Environmental Protection Agency. Environmental Response Team. General Field Sampling Guidelines Standard Operating Procedure (#2001). August 11, 1994. http://www.ertresponse.com/sops/2001.pdf.

U.S. Environmental Protection Agency. Environmental Response Team. Surface Water Sampling Standard Operating Procedures (#2013). January 17, 2002. http://www.ertresponse.com/sops/2013-r10.pdf

U.S. Environmental Protection Agency. ICR Microbial Laboratory Manual, EPA/600/R-95/178, April 1996, http://www.epa.gov/nerlcwww/

U.S. Environmental Protection Agency. Method 1623: *Cryptosporidium* and *Giardia* in Water by Filtration by IMS/FA, EPA-821-R-99-006, April 1999, http://www.epa.gov/nerlcwww/

U.S. Geological Survey. Field Procedures for Water Sampling http://water.usgs.gov/owq/Fieldprocedures.html.

8 Appendices

8.1 Site Characterization Plan Template

INSTRUCTIONS

This form is intended to support in the development of a customized site characterization plan developed in response to a specific water contamination threat. The incident commander and site characterization team leader should develop this plan jointly if possible. The completed form will be used to guide site characterization activities in the field; however, it may be necessary to revise the initial plan based on initial observations at the site. A form should be completed for each investigation site that will be characterized.

THREAT WARNING INFORMATION

Consult Module 2, Appendix 8.2 "Threat Evaluation Worksheet" for details about the threat.

INVESTIGATION SITE

Site Name: ______________________________

Type of facility:

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

Address: ______________________________

____

Additional Site Information: ______________________________

____

INITIAL HAZARD ASSESSMENT

Are there any indicators of an explosive hazard? ☐ Yes ☐ No

If "Yes," notify law enforcement and do not send a team to the site.

Initial hazard categorization

☐ Low hazard	☐ Chemical hazard
☐ Radiological hazard	☐ Biological hazard

If the initial hazard assessment indicates a chemical, radiological, or biological hazard (as described in Module 3, Section 4.1.3), then only teams trained to deal with such hazards should be sent to the site.

SITE CHARACTERIZATION TEAM

Name & Affiliation of Site Characterization Team Leader:

____

Drinking water utility staff:

- ☐ Water quality specialist Name: ________________
- ☐ Security specialist Name: ________________
- ☐ Operations specialist Name: ________________
- ☐ Other ____________ Name: ________________

Representatives from other agencies:

- ☐ Local law enforcement
- ☐ Fire department
- ☐ HazMat
- ☐ US EPA
- ☐ FBI
- ☐ Other

COMMUNICATION PROCEDURES

Mode of communication:

- ☐ Phone
- ☐ 2-way radio
- ☐ Digital
- ☐ Facsimile
- ☐ Other ________________

Reporting events:

- ☐ Upon arrival at site
- ☐ During approach
- ☐ Site entry
- ☐ After site evaluation
- ☐ After field testing
- ☐ Site exit
- ☐ Other ________________

FIELD SCREENING CHECKLIST

✔	Parameter[1]	Screen[2]	Meter/Kit ID[3]	Check Date[4]	Reference Value[5]
	Radiation	Both			
	Chlorine residual	Water			
	pH / conductivity	Water			
	Cyanide	Water			
	Volatile chemicals	Safety			
	Chemical weapons	Both			
	Biotoxins	Water			
	Pathogens	Water			

1. List the parameters that will be evaluated as part of field screening (examples are listed).
2. Screening may be conducted for safety, rapid water testing, or both.
3. Report the unique identifier for the meter or kit used during screening.
4. Report date of last calibration, expiration date, or date of last equipment check as appropriate.

5. List any reference value that would trigger a particular action, such as exiting the site.

SAMPLING CHECKLIST

✔	Analyte[1]	No. Samples	Sample Preservation[2]
	Standard VOCs		
	Semi-volatiles		
	Quartenary nitrogen compounds		
	Cyanide		
	Carbamate pesticides		
	Metals/elements		
	Organometallic compounds		
	Cyanide		
	Radionuclides		
	Non-target VOCs		
	Non-target organic compounds		
	Non-target inorganic compounds		
	Immunoassays		
	Pathogens – culture		
	Pathogens – PCR		
	Water quality – bacteria		
	Water quality – chemistry		

1. List the parameters that will be sampled during site characterization (examples are listed).
2. List preservatives and dechlorinating agents and indicate if they are to be added in the field.

EQUIPMENT CHECKLIST

- ☐ Completed Site Characterization Plan
- ☐ Emergency Water Sampling Kit (Table 3-1)
- ☐ Reagents (if stored separately)
- ☐ Laboratory grade water (5 gal)
- ☐ Special equipment for the specific site
- ☐ Additional documentation
- ☐ Field Testing Kit (Table 3-3)
- ☐ Bags of ice or freezer packs
- ☐ Rinse water (20 liters)
- ☐ Disposable camera
- ☐ Other ____

SAMPLE HANDLING INSTRUCTIONS

Sample delivery:

- ☐ Return samples to water utility
- ☐ Ship samples to specified location
- ☐ Deliver samples to specified recipient (e.g., laboratory, law enforcement, shipping co., etc.)

Name of recipient: ____________________

Phone No.: ____________________ Fax No.: ____________________

Delivery address: ____________________

____

Sample storage and security:

Describe any special precautions or instructions related to sample storage and security:

____

____

____

SIGNOFF

Incident Commander (or designee responsible for developing Site Characterization Plan):

Print name ____________________

Signature ____________________ Date/Time: __________

Site Characterization Team Leader:

Print name ____________________

Signature ____________________ Date/Time: __________

8.2 Site Characterization Report Form

INSTRUCTIONS
Members of the site characterization team can use this form to record their observations at the investigation site. It also serves as a checklist for notifying incident command at key points during the characterization. Additional checklists are included in this form for sample collection and exiting the site. The completed form can also be used as a component of the site characterization report. A form should be completed for each investigation site that is characterized

GENERAL INFORMATION

Date: _______________ **Time arrived investigation at site:** ___________

Name of Site Characterization Team Leader: ____________________________________

Phone No.: ______________________ **Fax No.:** ______________________

LOCATION OF INVESTIGATION SITE

Site Name: ____

Type of facility:

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

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"):

☐ None	☐ Radiation	☐ Volatile chemicals
☐ HAZCAT	☐ Chemical weapons	☐ Biological agents
☐ Other ______________________________________		

Report results of field safety screening in Appendix 8.3 "Field Testing Results 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

☐ None	☐ Radiation	☐ Volatile chemicals
☐ HAZCAT	☐ Chemical weapons	☐ Biological agents
☐ Other ______________________________________		

Report results of field safety screening in Appendix 8.3 "Field Testing Results 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 or stressed vegetation
☐ Unexplained liquids
☐ Unexplained dead animals
☐ Unexplained clouds or vapors
☐ Other ____________________

Describe signs of hazard: ____
____
____
____

Unexplained or Unusual Odors:

☐ None
☐ Sulfur
☐ Sweet/Fruity
☐ Pungent
☐ Skunky
☐ New mown hay
☐ Irritating
☐ Bitter almond
☐ Other ____________

Describe unusual odor: ____
____
____

Unusual Vehicles Found at the Site:

☐ Car/sedan
☐ Flatbed truck
☐ SUV
☐ Construction vehicle
☐ Pickup truck
☐ None
☐ Other ____

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

Signs of Tampering:

☐ None
☐ Open/damaged gates, doors, or windows
☐ Missing/damaged equipment
☐ Cut locks/fences
☐ Open/damaged access hatches
☐ Facility in disarray
☐ Other ____

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

☐ Yes
☐ No

Describe signs of tampering: ____
____
____
____

Unusual Equipment:

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

Describe equipment: ______________________________

____

____

____

Unusual Containers:

Type of container:

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

Condition of container:

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

Size of container: ______________________________

Describe labeling on container: ______________________________

____

Describe visible contents of container: ______________________________

____

Rapid Field Testing of the Water

- ☐ None
- ☐ Cyanide
- ☐ Pesticides
- ☐ Residual disinfectant
- ☐ Radiation
- ☐ Biotoxins
- ☐ pH / conductivity
- ☐ VOCs and SVOCs
- ☐ General toxicity
- ☐ Other ______________________________

Report results of rapid field testing of the water in Appendix 8.3 "Field Testing Results 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:

- ☐ Low hazard
- ☐ Chemical hazard
- ☐ Radiological hazard
- ☐ Biological hazard

If the site is characterized as a chemical, radiological, or biological hazard (as described in Module 3, Section 4.1.3), 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 dechlorinating agents as specified.
- ☐ Carefully close sample containers and verify that they don't 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 "Sample Documentation Form" (Appendix 8.4).
- ☐ Complete "Chain of Custody Form" (Appendix 8.5).
- ☐ 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: ____________

8.3 Field Testing Results Form

Date of Field Testing:			**Site Name:**		**Field Tester:**	**Phone No.**	
Parameter	**Units**	**Screen**[1]	**Meter/Kit ID**[2]	**Testing Location**[3]	**Testing Time**[4]	**Results**[5]	**Ref. Value**[6]

1: Screening may be conducted for safety, rapid water testing, or both.
2: Report the unique identifier for the meter or kit used during screening.
3: Report the specific location where the field testing was conducted.
4: Report the specific time at which the test was performed.
5: Results of field testing should include replicate analysis where appropriate.
6. Results should be compared with a reference value, if available, to determine whether or not the levels detected pose a hazard.

8.4 Sample Documentation Form

Collection Date:		**Site Name:**		**Sampler:**	**Phone No.**	
Sample ID	**No. Bottles**	**Sampling Time**	**Sampling Location**	**Sample Description**	**Analysis**	**Sample Additives**[1]

1: Report preservatives, dechlorinating agents, acid/base for pH adjustment, and any other sample additives.

8.5 Chain of Custody Form

Site Name:		**Sampler:**	
Sampler Phone No.:		**Signature:**	
Sample ID	**Collection Date**	**No. Bottles**	**Analysis**

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 for Laboratory by:**	**Date/time:**

Method of Sample Transport:		
Shipper:	**Phone No.:**	**Tracking No.:**

Office of Ground Water and Drinking Water
Water Security Division
EPA 817-D-03-003
www.epa.gov/safewater/security
December 2003

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