United States
Environmental Protection
Agency

Sampling and Analysis Primer

For Water Quality Surveillance and Response Systems

Office of Water (MC 140) EPA 817-B-15-002F May 2015

Introduction

A Water Quality Surveillance and Response System (SRS) provides a systematic framework for enhancing distribution system monitoring activities to detect emerging water quality issues and respond before they become problems. An SRS consists of six components grouped into two operational phases, surveillance and response. The surveillance components are designed to provide timely detection of water quality incidents in drinking water distribution systems and include: Online Water Quality Monitoring, Enhanced Security Monitoring, Customer Complaint Surveillance and Public Health Surveillance. The response components include Consequence Management and Sampling & Analysis, which support timely response actions that minimize the consequences of a contamination incident. The *Water Quality Surveillance and Response System Primer* provides a brief overview of the entire system (USEPA, 2015).

This document provides an overview of Sampling and Analysis (S&A), a response component of an SRS. It presents basic information about the goals and objectives of S&A in the context of an SRS. This primer covers the following four topics:

- **Topic 1**: What is S&A?
- **Topic 2**: What are the major design elements of S&A?
- **Topic 3**: What are common design goals and performance objectives for S&A?
- **Topic 4**: What are cost-effective approaches for S&A?

Topic 1: What is Sampling and Analysis?

S&A involves the collection and analysis of water samples to confirm or rule-out contamination. It involves water quality parameter testing for indicators of contamination, rapid field testing for specific contaminants and contaminant classes, and laboratory screening and confirmatory analyses. Additional S&A activities include site safety screening and working with emergency response partners and laboratories.

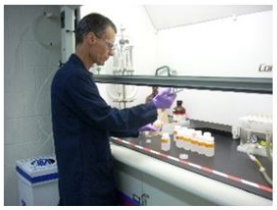
Water system contamination can occur as a result of natural, accidental or intentional threats. S&A is one of the earliest response actions initiated by the utility when water contamination is suspected. In an SRS, S&A is initiated in response to surveillance component alerts after the investigation has led to the conclusion that contamination is possible. S&A continues to play an important support function throughout the credibility determination process and during remediation and recovery activities of consequence management.

Topic 2: What are the major design elements of S&A?

A design element is a useful means to group planning or implementation activities the utility must engage in to build an S&A response component. Major S&A design elements are depicted in **Figure 1** and described in more detail below.

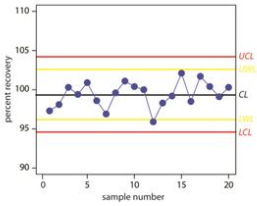
Field Capabilities

Collect and analyze samples in the field



Laboratory Capabilities

Perform laboratory screening and confirmatory analyses



Routine S&A

Establish baseline contaminant occurrence and method performance

Response Procedures

Identify, develop, test and refine response procedures for all response S&A activities

Figure 1. Major S&A Design Elements

Field Capabilities

The Field Capabilities design element includes planning for equipment, supplies, quality assurance and staffing needs for all activities that would be performed in the field in response to possible, credible or confirmed water contamination incidents. It also involves planning with emergency response partners for contaminants or contamination scenarios that may require their support. The field capabilities design element includes the following sub-elements:

- **Water Quality Parameter Testing**: Basic water quality parameter tests can indicate changes in water quality due to contamination. Testing can include pH, disinfectant residual, conductivity, temperature, and turbidity as well as additional water quality tests for total organic carbon, dissolved oxygen, color and other tests that may reveal water quality anomalies when compared to baseline data.
- **Site Safety Screening**: Visual hazard assessment is always performed during investigation of possible water contamination incidents and relies on the ability of field personnel to recognize hazardous materials or situations. Additionally, instrumentation to detect site hazards, such as radiation, volatile gases and combustible gases, can help ensure the safety of workers and characterize a site of suspected contamination.
- **Rapid Field Testing**: Rapid water testing for specific contaminants or contaminant classes can help to prioritize laboratory analyses. Examples of rapid field tests are free cyanide, chemical warfare agents, arsenic, volatiles and radiation screening.
- **Quality Assurance**: To ensure that high quality data is generated during response S&A, a demonstration of capability should be performed and quality assurance/quality control implemented for all pre-established field methods. All field response methods should be incorporated into the utility's quality assurance program.
- **Sample Collection**: Planning for sample collection involves advanced preparation of sampling supplies for contaminants or contaminant classes that the utility or laboratory partners would analyze for in response to possible water contamination incidents.
- **Field Staffing**: Planning for staffing needs involves identifying and training staff, cross-training and developing contingency plans in the event that there are contamination scenarios for which the utility would require the support of emergency response partners such as HazMat or similarly qualified emergency response partners.

- **Field Safety**: Planning for the health and safety of employees who may be called on to respond to water contamination incidents involves review of existing Health and Safety Plans. This is to ensure that they cover non-routine activities or locations of response S&A and address any modified or additional safety precautions the utility would implement when responding to possible contamination incidents involving an unknown contaminant.

Laboratory Capabilities

The Laboratory Capabilities design element encompasses planning for equipment, analytical methods, supplies, quality assurance and staffing needs for all activities that would be necessary to perform laboratory analyses in response to possible, credible or confirmed water contamination incidents. It also involves planning with emergency response partners and laboratories for contaminants or contamination scenarios that may require their support. Resources of the Water Laboratory Alliance can be used to help build laboratory capabilities. The laboratory capabilities design element includes the following sub-elements:

- **Contaminant Coverage**: By evaluating potential contamination threats the utility can identify contaminants or contaminant classes and laboratory methods that could be used in the early phases of investigation into possible contamination incidents. By identifying in advance the methods necessary for broad contaminant coverage, the utility can build in-house capabilities or identify partner laboratories. For more information regarding how to build laboratory capabilities for contaminant classes of concern from intentional threats, refer to *Water Security Initiative: Guidance for Building Laboratory Capabilities to Respond to Drinking Water Contamination* (USEPA, 2013).
- **Quality Assurance**: To ensure that high quality data is generated during response S&A, a demonstration of capability should be performed and quality assurance/quality control established for all pre-established laboratory methods. All laboratory response methods should be incorporated into the utility's quality assurance program. Partner laboratories should be selected based on their demonstrated capabilities and quality assurance program.
- **Laboratory Staffing**: Planning for staffing involves identifying and training staff in the use of laboratory methods and procedures, cross-training and developing contingency plans in the event that there are contamination scenarios for which the utility would require the support of partner laboratories.
- **Laboratory Safety**: Planning for the health and safety of employees who may be called on to respond to water contamination incidents involves review of existing Health and Safety Plans to ensure they address any modified or additional safety precautions the utility may implement when responding to incidents in which the contaminant has not yet been identified.
- **Mutual Aid Laboratory Networks**: Mutual aid laboratory networks are formal alliances whereby laboratories share resources in an emergency. Establishing these relationships in advance can ensure that the utility has access to the resources they need during response S&A. A Water/Wastewater Agency Response Network (WARN) is an intrastate mutual aid and assistance agreement commonly established between public and private water and wastewater utilities to provide emergency assistance through sharing of equipment, personnel and other resources. WARNs, or other similar mutual aid agreements that include the utility's emergency response analytical needs, can reduce the typical response gap between local and statewide agreements as they do not require emergency declaration prior to activation.

Routine S&A

The Routine S&A design element involves establishing baseline contaminant occurrence and method performance data for all pre-established methods that could be used during response to possible water contamination. The purpose of routine sampling and analysis is to ensure that baseline contaminant occurrence and method performance are established in advance of response S&A and that methods are used at a frequency to maintain baseline data, analyst proficiency and instrumentation readiness. The Routine S&A design element includes the following sub-elements:

- **Establishing Baseline Data**: Baseline data can be established by mining routine historical data, by using data collected from previous incidents, through one-time special utility projects, drills and exercises, or by performing new baseline monitoring.
- **Maintenance Monitoring**: After baseline data and method performance have been established for all pre-established methods the utility would use during response S&A, the utility can determine a schedule for routine S&A to maintain baseline data, analyst proficiency and instrumentation readiness.

Response Procedures

S&A requires response procedures for all field and laboratory methods and activities as well as procedures for internal and external notifications and communications. Response procedures are often different from routine procedures with respect to workflow, responsibilities, safety precautions, personal protective equipment, modes of communication and data reporting such that existing procedures may need to be modified. **Figure 2** illustrates the sequential activities typically involved in response S&A when the utility has activated incident command. Each block of activities in the figure involves multiple steps, staff and procedures. These activities are typically implemented upon activation of the utility's consequence management plan.

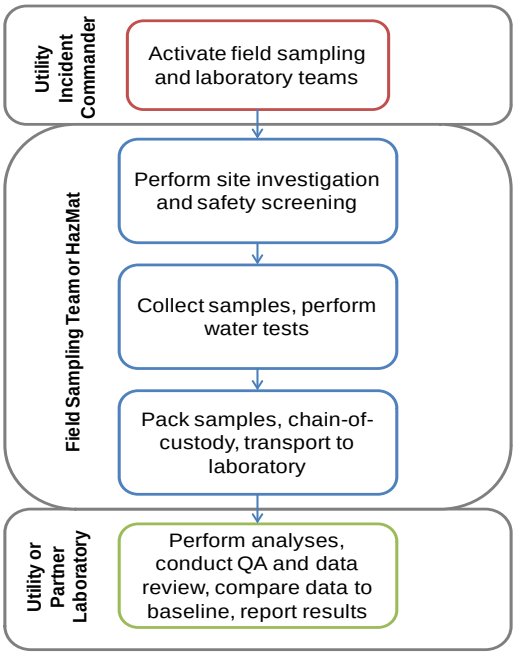


Figure 2. Response Sampling and Analysis

The identification, development and practice of S&A procedures for each activity are critical for timely and effective response. Because response procedures may be infrequently used it is important to test and refine them periodically. The Response Procedures design element includes the following sub-elements:

- **Identification and Development of Response Procedures**: The utility will have pre-established capabilities for contaminants, methods and laboratories under the previous design elements. In this sub-element the utility identifies all S&A activities that could be performed by the utility in response to possible, credible or confirmed water contamination incidents. Routine procedures may need to be modified or new procedures developed to document the utility's planned response activities, internal and external contacts, notifications and communications. Response procedures are developed to consider chain of command and roles and responsibilities and should be aligned with the utility's Incident Command System and local Emergency Operations Center.
- **Testing and Refinement of Procedures**: In this sub-element response procedures are regularly practiced by S&A component staff and tested and refined through drills and exercises with other utility SRS surveillance component staff and with the utility's S&A emergency response partners and laboratories.

Topic 3: What are common design goals and performance objectives for S&A?

The design goals and performance objectives established for S&A by the utility provide the basis for the design of an effective component.

S&A Design Goals

Design goals are the specific benefits that utilities expect to achieve by implementing S&A. The overarching goal of a well-designed S&A component is to be able to confirm or rule-out a wide variety of contaminants representative of natural, accidental and intentional water contamination threats. All subsequent design goals listed in **Table 1** are a result of building an S&A component capable of achieving this overarching goal.

Table 1. Examples of Common S&A Design Goals

Design Goal	Description
Ability to respond to a wide range of contamination incidents	Planning for a wide range of contaminants and contaminant classes requires identifying methods, identifying field and laboratory response partners and developing procedures for all S&A activities the utility would be involved in during response to a water contamination incident.
Improved characterization of the distribution system	Routine use of pre-established field and laboratory methods can provide additional information about water quality and contaminant occurrence in the distribution system. This can include a better understanding of the occurrence of contaminants that were not previously monitored in the distribution system and of possible spatial and temporal water quality trends in the distribution system.
Improved field and laboratory and emergency response partnerships	Planning for response S&A requires that the utility form new, or improve existing, relationships with emergency response partners, establish communication channels and develop response procedures.
Improved cooperation across utility divisions during emergency response	Responding to possible, credible or confirmed water contamination incidents requires that utility staff have an understanding of the roles and responsibilities of multiple utility divisions that would be involved during response to the incident, such as water quality and treatment personnel, field sampling teams and laboratory personnel.

Performance Objectives

Performance objectives are measurable indicators of how well the SRS or its components meet the design goals established by the utility. Throughout design, implementation and operation of the SRS or its components, the utility can use performance objectives to evaluate the added value of each capability, procedure or partnership. While specific performance objectives should be developed by each utility in the context of its unique design goals, general performance objectives for an SRS were identified in *Water Quality Surveillance and Response System Primer* (USEPA, 2015) and are further described in the context of S&A as follows:

- **Incident coverage**: Detect and respond to a broad spectrum of potential water contamination incidents whether natural, accidental or intentional. An S&A component ensures that the utility can effectively respond by establishing capabilities in advance for site investigation, distribution system sampling and field and laboratory analyses.
- **Spatial coverage**: Achieve spatial coverage of the entire distribution system. S&A should be able to provide field and laboratory support to any part of the distribution system during investigation of possible, credible or confirmed contamination incidents.
- **Timeliness of response**: Provide timely response to possible, credible or confirmed water contamination incidents as detected by one or more of the SRS surveillance components. S&A response procedures and training ensures that field and laboratory analyses are timely and effective in all phases of consequence management. Periodic drills and exercises also improve timeliness of response by providing practice to utility personnel and response partners.
- **Operational reliability**: Minimize downtime for equipment and instrumentation. Utility field and laboratory instrumentation should be reliable, durable and regularly maintained. Utility and partner methods and staff should be available at all times and capable of producing quality data.
- **Sustainability**: All pre-planned S&A capabilities the utility would utilize during response to possible water contamination should be sustainable. Any additional costs for field equipment, laboratory instrumentation, supplies, consumables and staffing should be justified by the benefits derived from the investment. For example, new investments may save time and money in the long run or have benefits unrelated to water contamination response.

Topic 4: What are cost-effective approaches for S&A?

Utilities can take the following simple steps to develop the foundation for S&A:

- Determine if the utility's current field and laboratory capabilities are sufficient for responding to intentional, accidental and natural contamination threats and establish emergency response and laboratory partnerships to fill gaps.
- Establish capabilities to collect samples for laboratory-based analyses for a wide range of contaminant classes and be able to perform water quality parameter testing in the field. This may involve preparing testing and sampling supplies in advance for rapid deployment in an emergency.
- Develop emergency response procedures for all S&A activities the utility would perform in response to possible, credible and confirmed water contamination. Establish points of contact and notification procedures for pre-established emergency response and laboratory support partners.

Next Steps

Visit the Water Quality Surveillance and Response Website at http://water.epa.gov/infrastructure/watersecurity/lawsregs/initiative.cfm for more information about SRS practices. The Website contains guidance and tools that will help a utility to enhance surveillance and response capabilities, as well as case studies that share utility experiences with SRS implementation and operation.

References

USEPA. (2013). *Water Security Initiative: Guidance for Building Laboratory Capabilities to Respond to Drinking Water Contamination*, 817-R-13-001.

USEPA. (2015). *Water Quality Surveillance and Response System Primer*, 817-B-15-002.