



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

Interim Final - April 2004

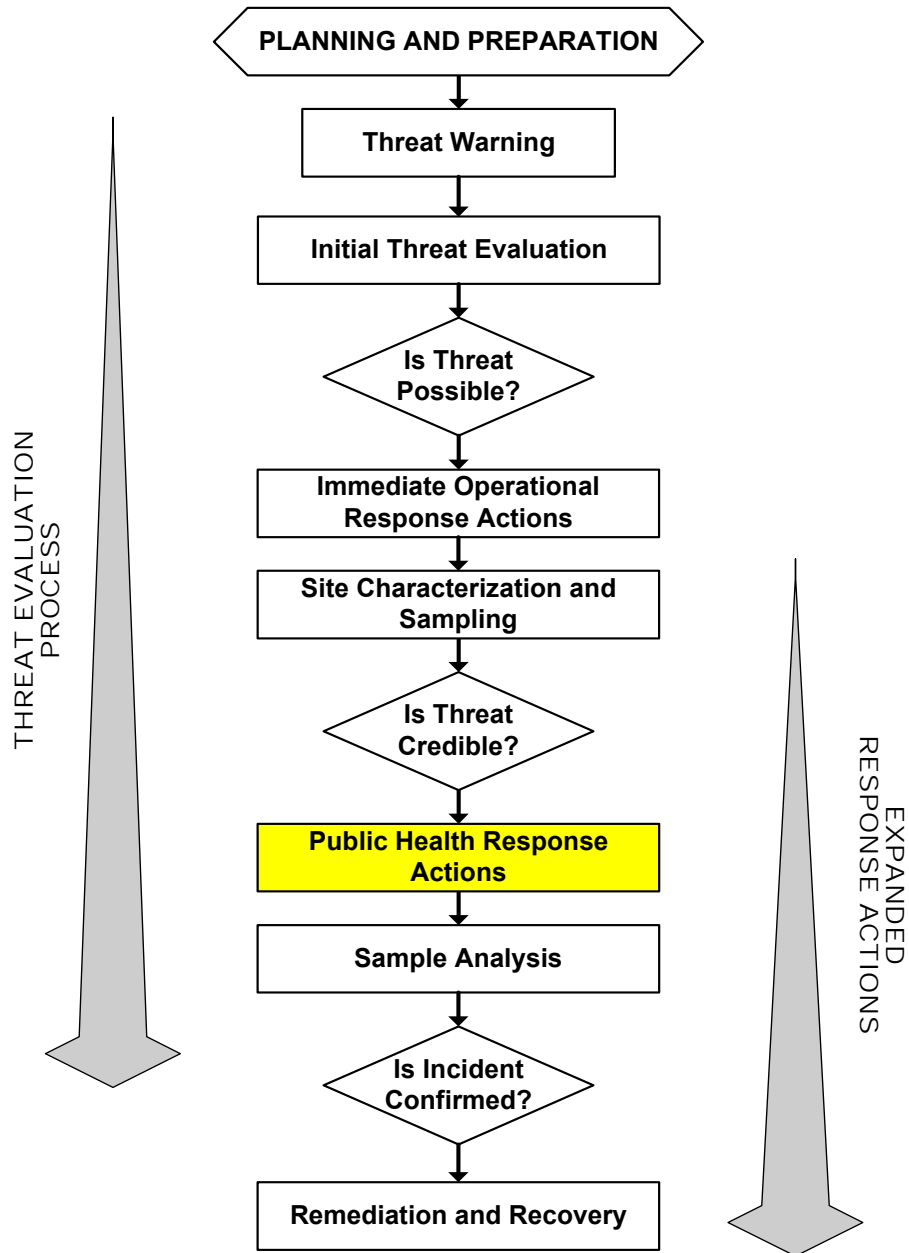
Module 5: Public Health Response Guide



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

Module 5: Public Health Response Guide

Interim Final – April 2004



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 *(April 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 *(April 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.

ACKNOWLEDGEMENTS

This document was prepared by the United States Environmental Protection Agency, Office of Ground Water and Drinking Water, Water Security Division through a contract with SAIC. The EPA Work Assignment Manager was Brain Frazer, and the SAIC Work Assignment Manager was Mary Wolfe. The primary contributors to the document included:

- Steven C. Allgeier (US EPA, OGWDW)
- Mark J. Klingenstein (SAIC)
- Jennifer L. Larkin (SAIC)
- Carol A. Winston (SAIC)

Other contributors included Susan Dolgin, Grace Robiou, and Veronika Pesinova of the US EPA, OGWDW.

Additional support for this work was provided by a panel of peer reviewers, including: Cliff Bowen (California DHS), Keith Burkhart (ATSDR), Lisa Christ (US EPA, OGWDW), Steve Clark (US EPA, OGWDW), Steve Dennis (Alameda County Water District), Lauren DiSano (US EPA, ORD), Ron Hunsinger (EBMUD), Kim Fox (US EPA, ORD), Audrey Galizia (USEPA, ORD), David Hartman (Cincinnati Water Works), Vincent Hill (CDC), Craig D. Jackson (NYSDOH Bureau of Water Supply Protection), Dennis Juranek (CDC), Bart Koch (MWD So. Cal.), Janice Lee (Wisconsin DPH), Carrie Lewis (Milwaukee Water Works), Matthew Magnuson (USEPA, ORD), Maureen McClelland (US EPA, Region 1), Janet Pawlukiewicz (US EPA, OGWDW), Alan Roberson (AWWA), Eletha Brady-Roberts (USEPA, ORD), Stanley States (Pittsburgh Water and Sewer Authority), Gene Taylor (US EPA, Region 10), Gregory Welter (O'Brien & Gere Engineers), James Wheeler (US EPA, OWM), Caroline Wehling (US EPA, OGC), and Kelvin Yamada (California DHS).

TABLE OF CONTENTS

1 INTRODUCTION: OBJECTIVES AND ORGANIZATION OF THE MODULE.....14

2 OVERVIEW OF PUBLIC HEALTH RESPONSE.....16

2.1 PUBLIC HEALTH RESPONSE PLANNING18

2.1.1 *Integrating Public Health Response Planning into ERPs.....18*

2.1.2 *Identification of Agencies Involved in Public Health Response.....20*

2.1.3 *Development of Communications Strategy.....23*

2.1.3 *Development of Operational and Public Health Response Actions.....26*

3 PUBLIC HEALTH CONSEQUENCES DUE TO WATER CONTAMINATION28

3.1 CONTAMINANT PROPERTIES28

3.2 ASSESSING THE SPREAD OF CONTAMINANT IN THE SYSTEM32

3.2.1 *Manual Assessment Methods33*

3.2.2 *Water Distribution Models35*

4 OPERATIONAL RESPONSE OPTIONS38

4.1 CONTAINMENT OF SUSPECT/CONTAMINATED WATER38

4.2 NOVEL OPERATIONAL RESPONSES TO CONTAMINATION.....42

5 PUBLIC NOTIFICATION STRATEGY.....43

5.1 HOW TO DECIDE WHAT TYPE OF PUBLIC NOTIFICATION IS APPROPRIATE43

5.2 TARGET AUDIENCE46

5.3 CONTENT AND FORMAT OF THE PUBLIC NOTIFICATION46

5.3.1 *Content.....47*

5.3.2 *Format48*

5.3.3 *Notifications for Special Populations49*

5.3.4 *Data Visualization and Interpretation Tools50*

5.4 METHODS TO DELIVER THE PUBLIC NOTIFICATION.....50

6 SHORT-TERM ALTERNATE DOMESTIC WATER SUPPLY.....53

6.1 ALTERNATE SUPPLY FOR CONSUMER USE53

6.1.1 *Who Provides the Alternate Water54*

6.1.2 *Potential Household Sources of Emergency Water Supply55*

6.2 ALTERNATE SUPPLY FOR FIREFIGHTING NEEDS57

7 RETURNING TO NORMAL OPERATION AND USE59

8 REFERENCES AND RESOURCES60

9 APPENDICES62

9.1 CONTAMINANT CHARACTERIZATION AND TRANSPORT WORKSHEET62

9.2 PUBLIC HEALTH RESPONSE ACTION WORKSHEET68

9.3 EXAMPLE NOTIFICATIONS72

9.3.1 *Example Boil Water Notice.....73*

9.3.2 *Example Do Not Drink Notice74*

9.3.3 *Example Do Not Use Notice75*

9.3.4 *Example Notice for an Unknown Contaminant76*

9.4 DESCRIPTION OF THE PIPELINE^{NET} DISTRIBUTION SYSTEM MODEL77

LIST OF TABLES

TABLE 5-1. PUBLIC HEALTH RESPONSE - ENTITIES THAT SHOULD BE NOTIFIED25
TABLE 5-2. OPTIONS FOR SHORT-TERM ALTERNATE SUPPLIES OF DRINKING WATER27
TABLE 5-3. PROPERTIES APPLICABLE TO BOTH BIOLOGICAL AND CHEMICAL CONTAMINANTS28
TABLE 5-4. PROPERTIES APPLICABLE TO CHEMICAL CONTAMINANTS.....29
TABLE 5-5. PROPERTIES APPLICABLE TO BIOLOGICAL CONTAMINANTS31
TABLE 5-6. OPTIONS FOR SHORT-TERM ALTERNATE SUPPLIES OF DRINKING WATER54
TABLE 5-7. ALTERNATE WATER SOURCES IN THE HOME55
TABLE 5-8. PUBLIC GUIDANCE ON WATER PURIFICATION.....56

LIST OF FIGURES

FIGURE 5-1. RELATIONSHIPS AMONG COMPONENTS OF PUBLIC HEALTH RESPONSE17
FIGURE 5-2. DECISION PROCESS FOR CONTAINMENT AS A PUBLIC HEALTH RESPONSE39
FIGURE 5-3. COMPARISON OF CONTAMINANT SPREAD WITH AND WITHOUT VALVE CLOSURE.....41
FIGURE 5-4. EXAMPLE DECISION PROCESS FOR PUBLIC NOTIFICATION44
FIGURE 5-5. OUTPUT OF SELECTION PROCESS SHOWING POTENTIAL MONITORING LOCATIONS. ..79
FIGURE 5-6. WATER QUALITY SIMULATION.....81
FIGURE 5-7. CONSEQUENCE ASSESSMENT TOOL.82
FIGURE 5-8. ISOLATION TOOL INTERFACE.....83

DISCLAIMER

The mention of trade names or commercial products does not constitute endorsement or recommendation for use.

DISCLAIMER

This module summarizes and contains references to specific sections of the Code of Federal Regulations (CFR) and to specific Statutes that codify the Nation's environmental laws (e.g., the Public Notification Rule). The summaries contained herein do not substitute for these requirements. Interested persons should become familiar with the actual federal regulations and Statutes themselves, or the corresponding regulation adopted by the primacy agency.

ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
AWWA	American Water Works Association
AWWARF	American Water Works Association Research Foundation
CCR	Consumer Confidence Report
CDC	Centers for Disease Control and Prevention
CFR	Code of Federal Regulations
DHHS	Department of Health and Human Services
DHS	Department of Homeland Security
EMPACT	Environmental Monitoring for Public Access and Community Tracking
EMS	Emergency medical services
EPS	Extended period simulations
ERP	Emergency response plan
ESF	Emergency support function
ESRI	Environmental Systems Research Institute
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
GIS	Geographic information system
HSPD	Homeland Security Presidential Directive
ICS	Incident Command System
JIC	Joint information center
LRN	Laboratory Response Network
NACCHO	National Association of City and County Health Officials
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEDSS	National Electronic Disease Surveillance System
NIOSH	National Institute for Occupational Safety and Health
NRP	National Response Plan
OSWER	Office of Solid Waste and Emergency Response
PAO	Public Affairs Officer
PN	Public notification
PPE	Personal protective equipment
RAIS	Risk Assessment Information System
RR-MO	FEMA's Response and Recovery Directorate's Mobile Operations Division
RTECS	Registry of Toxic Effects of Chemical Substances
SDWA	Safe Drinking Water Act
UKWIR	United Kingdom Water Industry Research
USACE	United States Army Corps of Engineers
USAMRIID	United States Army Medical Research Institute of Infectious Diseases
US DOE	United States Department of Energy
US EPA	United States Environmental Protection Agency
UV	Ultraviolet
WaterISAC	Water Information Sharing and Analysis Center
WCIT	Water contaminant information tool
WHO	World Health Organization
WUERM	Water Utility Emergency Response Managers

GLOSSARY

Definitions in this glossary are specific to the Response Protocol Toolbox but have been conformed to common usage as much as possible.

Agency – a division of government with a specific function, or a non-governmental organization (e.g., private contractor, business, etc.) that offers a particular kind of assistance. In the Incident Command System, agencies are defined as jurisdictional (having statutory responsibility for incident mitigation) or assisting and/or cooperating (providing resources and/or assistance).

‘Confirmatory’ Stage – the third stage of the *threat management* process from the point at which the threat is deemed ‘credible’, through the determination that a contamination incident either has or has not occurred.

‘Confirmed’ – in the context of the *threat evaluation* process, a water contamination incident is ‘confirmed’ if the information collected during the threat evaluation process provides definitive evidence that the water has been contaminated.

Consequence – the adverse outcome resulting from a drinking water contamination incident. In the context of the *threat management* process, the consequence considers both the number of individuals potentially affected as well as the severity of the health effect experienced upon exposure.

Consequence Management – DHS defines consequence management as measures to protect public health and safety, restore essential government services, and provide emergency relief to governments, businesses, and individuals affected by the consequences of terrorism.

Contaminant – any chemical, biological, or radiological substance that has an adverse effect on public health or the environment.

Contamination Site – the location where a contaminant is known or suspected to have been introduced. 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*.

‘Credible’ – in the context of the *threat evaluation* process, a water contamination threat is ‘credible’ if information collected during the threat evaluation process corroborates information from the *threat warning*.

‘Credible’ Stage – the second stage of the *threat management* process from the point at which the threat is deemed ‘possible’, through the determination as to whether or not the threat is ‘credible’.

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 or tribe may reside in one of a variety of agencies, such as health departments, environmental quality departments, etc. or may be US EPA. 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 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.

Field Safety Screening – screening performed to detect environmental hazards (i.e., in the air and 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.

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

Impact – the consequence or effect on drinking water consumers, or the utility itself, that results from the implementation of response actions. An impact could also be considered as the cost of implementing a response action.

Incident – a confirmed occurrence that requires response actions to prevent or minimize loss of life or damage to property and/or natural resources. A drinking water contamination incident occurs when the presence of a harmful contaminant has been confirmed.

Incident Command System – a standardized on-scene emergency management concept specifically designed to allow its user(s) to adopt an integrated organizational structure equal to the complexity and demands of single or multiple incidents, without being hindered by jurisdictional boundaries.

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

Information Officer – the individual responsible for interfacing with the public and media or with other agencies requiring information directly from the incident. Under the Incident Command System, there is only **one** Information Officer per incident.

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.

Joint Information Center – a center established to coordinate the Federal public information activities on-scene. It is the central point of contact for all news media at the scene of the incident. Public information officials from all participating Federal agencies should co-locate at the JIC. Public information officials from participating State and local agencies also may co-locate at the JIC.

Lead Agency – as defined in Homeland Security Presidential Directive-7 (HSPD-7), the Federal department or agency assigned lead responsibility to manage and coordinate a specific function — either crisis management or consequence management. Lead agencies are designated on the basis that they have the most authorities, resources, capabilities, or expertise relative to accomplishment of the specific function.

Mutual Aid Agreement – written agreement between agencies and/or jurisdictions in which they agree to assist one another upon request by furnishing personnel, equipment, or water.

‘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.

‘Possible’ Stage – the first stage of the *threat management* process from the point at which the *threat warning* is received through the determination as to whether or not the threat is ‘possible’.

Public Health – the health and well being of an entire population or community. Public health is not limited to the health of individuals.

Public Health Response Plan – a document that describes public health response actions taken in response to various emergencies, disasters, and other unexpected incidents. The Public Health Response Plan is typically developed by the State Health Department.

Public Notification – under the Safe Drinking Water Act, public water systems are required to notify their customers when they violate US EPA or State drinking water standards (including monitoring requirements) or otherwise provide drinking water that may pose a risk to consumers' health.

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 Decisions – part of the *threat management* process in which decisions are made regarding appropriate response actions that consider 1) the conclusions of the *threat evaluation*, 2) the consequences of the suspected contamination incident, and 3) the impacts of the response actions on drinking water customers and the utility.

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.

“Reverse 911” Messaging – a communications product that establishes a virtual calling network. This system enables public safety agencies to telephone community residents with recorded messages informing them of emergencies, hazards, major road closures, or other important matters relevant to public health and public safety. The system is built on a database of local resident and business phone numbers.

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 is discussed in Module 3.

System Characterization – a detailed assessment of the nature and extent of contamination in a drinking *water system* for the purpose of planning remediation of the contaminated *water system*. The system characterization process is modeled, in part, on the concept of a *remedial investigation* under EPA’s Superfund program and, similarly, would be done with the *feasibility study*.

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.

Terrorist Incident – the FBI defines a terrorist incident as a violent act, or an act dangerous to human life, in violation of the criminal laws of the United States or of any State, to intimidate or coerce a government, the civilian population, or any segment thereof in furtherance of political or social objectives.

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.

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 threatening a water system may be a crime under the Safe Drinking Water Act as amended by the Public Health Security and Bioterrorism Preparedness and Response Act of 2002.

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: Objectives and Organization of the Module

The primary intended users of this module include water utility staff and agencies, *drinking water primacy agencies*, and *technical assistance providers* that will assist water utilities during the response to a *water contamination threat* or *incident*. In addition, public health *agencies* (e.g., US Environmental Protection Agency, State and local health departments, Centers for Disease Control and Prevention) are encouraged to read this module because they will typically be involved in choosing and implementing the public health response actions taken during a water contamination threat. The objective of Module 5 is to help the user understand the issues and activities involved in public health response to a contamination incident or threat, including:

- Identification of the organizations and officials responsible for making and implementing public health *response decisions* for drinking water.
- Understanding the role of the drinking water utility during public health response to a water contamination threat.
- Evaluation of the public health consequences due to water contamination, and identification of resources and techniques to aid in consequence evaluation.
- Evaluation of response options to limit exposure to the public, by containing the suspect water and/or notifying the public to limit their use of the water.
- Development of communication procedures and structures both within the responding organizations and also for communication with the public and the media.
- Identification of potential short-term alternate water supplies.

This module is organized into eight sections as described below. Water utility and public health officials are encouraged to review this module in its entirety, as well as the other modules in the “Response Protocol Toolbox,” to obtain a comprehensive understanding of public health response for water contamination threats and incidents.

- Section 1: Introduction: describes the overall organization and objectives of this module.
- Section 2: Overview of Public Health Response: describes the organizations that may be involved in public health response decisions, response options, *impacts* of particular response actions, and communications.
- Section 3: Public Health Consequences due to Water Contamination: includes general procedures for evaluating contaminant characteristics such as acute and chronic effects of exposure, exposure routes, and stability of the contaminant in water, and methods of estimating the spread of contaminated water.
- Section 4: Operational Response Options: describes containment options and other novel operational responses.
- Section 5: Public Notification Strategy: discusses public notification as a means of reducing or mitigating exposure and avoiding panic.

- Section 6: Short-term Alternate Domestic Water Supply: discusses issues to be considered in planning for an alternate water supply to meet the needs of domestic consumption and sanitation, firefighting activities, and customers with special requirements. (This section will consider the need for an alternate water supply over a short duration. Long-term alternate water supply needs will be addressed in Module 6.)
- Section 7: Returning to Normal Operations and Use: describes the actions to be taken and presents examples of returning to normal operations.
- Section 8: References and Resources: includes literature citations, sources of internet information, and other publications of relevance to public health response.
- Section 9: Appendices: includes forms and tools that support this module and that may aid in preparing for public health response to a contamination threat.

2 Overview of Public Health Response

In the context of this module, public health response can be defined as the actions taken to mitigate consequences resulting from threats or incidents involving biological, chemical, or radiological contaminants. Public health response is one component of the *threat management* process, which is described in detail in Module 2. Figure 5-1 provides an overview of the public health response process, which is considered in the following five major components:

1. Conduct planning – During the planning phase, the roles and responsibilities of the agencies involved in public health response are identified; the communication strategy is developed; and the feasibility of potential operational response actions is evaluated. A water utility may choose to address its role during a public health response as part of the development or revision of its emergency response plan (ERP). As part of planning, identified gaps in operating procedures, technical capabilities, and communication should be addressed. As with all response plans, regular exercising of the plan is critical to effective implementation. The planning component is discussed in Section 2.1 of this module.
2. Determine public health consequences due to water contamination – This is the process of assessing the properties and health effects of contaminants, as well as the potential spread of the contaminated water, which will support appropriate public health response decisions. However, the detailed information necessary to assess potential health consequences will be unknown or poorly characterized in the time frame in which public health decisions need to be made in many cases. The utility and public health agencies should be prepared to respond given these uncertainties, as discussed in Section 3 of this module.
3. Implement operational responses – Certain operational responses identified during the planning process may be implemented in response to a ‘*possible*’ or ‘*credible*’ contamination threat if they are deemed feasible and effective. These operational response actions are generally limited to containment of suspect water in a distribution system, but other novel operational responses may be considered, as discussed in Section 4 of this module.
4. Implement public notification strategy – The public notification strategy will aid in the development and distribution of appropriate notifications and instruction to the public. These notifications will be a key component of an effective response to a ‘*credible*’ threat or ‘*confirmed*’ incident. Section 5 provides guidance regarding the development of appropriate and effective public notification.
5. Implement alternate water supply - If restrictions are placed on water consumption or use due to a public health response action, it may be necessary to provide an alternate supply of domestic water. Section 6 discusses various options for short-term alternate drinking water supplies and their implementation by the appropriate organization.

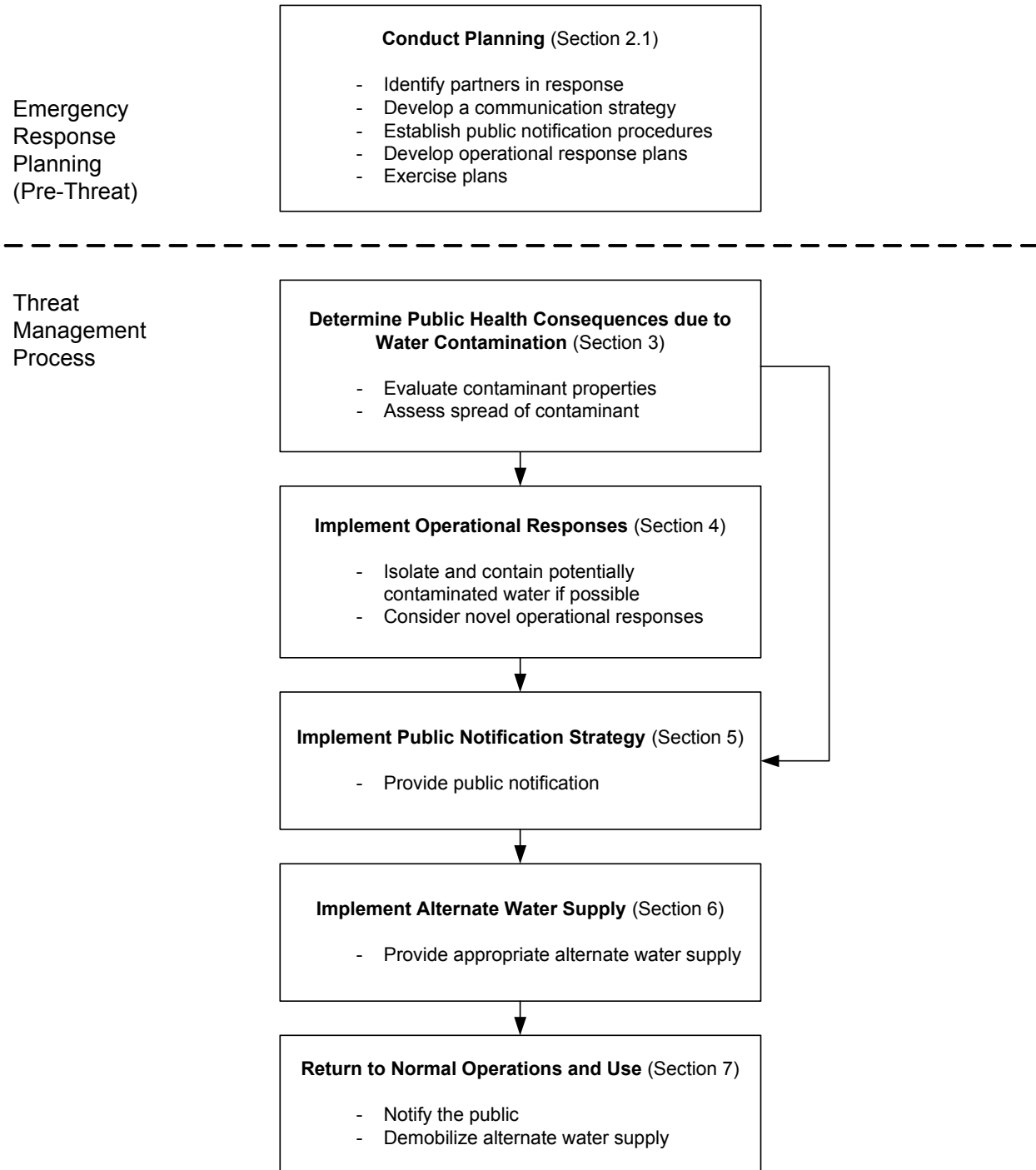


Figure 5-1. Relationships among Components of Public Health Response

While Figure 5-1 is shown as a sequential process, the implementation steps are not necessarily implemented sequentially, but rather may be implemented individually or in combination at any point throughout the threat management process. For example, it is highly possible that the water utility could be evaluating the contaminant’s properties, implementing containment, and providing public notification simultaneously during one or more stages of the threat management

process. The consideration of each public health response action at the ‘possible’, ‘credible’, and ‘confirmatory’ stages of the threat management process is described in detail in Sections 3.1.8, 4.2.3, and 5.2 of Module 2, respectively.

2.1 Public Health Response Planning

This section describes four key components of public health response planning: integrating public health response planning into ERPs, identifying agencies involved in public health response, developing a communications strategy, and developing operational and public health response actions. These components are described in Sections 2.1.1, 2.1.2, 2.1.3 and 2.1.4, respectively.

In addition to these four key components, training is critical to ensuring smooth implementation of public health response. Training should be conducted for all parties with responsibilities under the Public Health Response Plan to ensure that all parties understand their role and can implement the plan properly. The utility also should conduct training on implementation of its ERP, including public communication and short-term alternate water supplies. Additionally, integrated public health response should be tested as part of a table-top or actual field exercise involving all parties with a role, such as public health agencies, the medical community, the utility, laboratories, and others. The National Association of City and County Health Officials (NACCHO) developed a table-top exercise template tool that parties may use to exercise their plans.

2.1.1 Integrating Public Health Response Planning into ERPs

Public health response planning should be integrated into planning at both the State and local levels. Before initiating public health response planning, a water utility should identify and evaluate any existing emergency response or public health response plans at the State or local level. Examples of such plans are described below.

State ERPs - States typically have ERPs that are wide-ranging and designed to address the range of emergencies the State may face. Among other objectives, these plans may address the protection of critical infrastructure, such as water, approaches to public health protection (described more fully in the State’s Public Health Response Plan), and communications strategies at the State level. The State drinking water primacy agency may also have plans in place to address emergencies.

State or Local Health Department Public Health Response Plans - The State or local health department typically develops a Public Health Response Plan, which covers responses to a variety of public health emergencies, potentially including *water contamination incidents*. Such a plan may cover public health surveillance and epidemiological investigations conducted by the medical community, laboratory diagnosis, laboratory capacity planning, medical management, reconstruction of the patients’ recent whereabouts to determine potential sources of exposure, and *consequence management*. To assist in the development of a Public Health Response Plan, the Centers for Disease Control and Prevention (CDC) published a planning guidance document entitled "The Public Health Response to Biological and Chemical Terrorism: Interim Planning Guidance for State Public Health Officials" (CDC, 2001a).

City or Regional ERPs - Cities or Regional governmental agencies often develop ERPs that establish a plan of action and organizational structure to efficiently respond to a variety of emergencies such as fires, floods, tornadoes, terrorism, chemical and biological weapons threats, workplace violence, major utility disruptions, etc. The plan may delineate the roles and responsibilities of each agency involved (municipal, State, Federal, and the private sector) in emergency response; define what constitutes and who declares an emergency; provide guidelines for implementation of the ERP components; and address communication procedures (e.g., creating a list of key public- and private-sector personnel who would respond to an emergency).

Utility ERPs - Finally, local drinking water utilities have ERPs that consider vulnerabilities identified during a vulnerability assessment and outline response plans for a variety of emergencies. The utility's ERP should identify Federal, State, and local agencies that need to be involved in response actions and address the roles and responsibilities of the utility and these agencies during public health response. These include a public notification strategy in the event of loss of potable water due to any cause, including contamination, and a plan for obtaining alternate water supplies should they be needed. The ERP should include procedures for rapidly initiating strategies to contain water suspected of being contaminated. To assist in the development of utility ERPs, US EPA published the following two documents: "Large Water System Emergency Response Plan Outline: Guidance to Assist Community Water Systems in Complying with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002" (US EPA, 2003) and "Small and Medium Water System Emergency Response Plan Guidance to Assist Community Water Systems in Complying with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002" (US EPA, 2004a).

Local and State health departments and utilities should work together to fine-tune their public health response plans for water contamination incidents. The utility should understand how the public health response plans of local and State health departments would address a water contamination incident and should integrate appropriate portions of these plans into the utility ERP. In some cases, the local and State health department's plan may need to be modified to address a water contamination incident. The utilities and public health departments should establish specific agreements on standardized communications protocols, triggers for initiating notifications between the health department and water utility, and analytical support from public health labs.

In addition, there may be potential challenges in sharing data between the public health agency and the utility (e.g., the public health agency may not be able to share addresses based on patient privacy constraints). The utility and public health agency should review any requirements for special clearances necessary to share public health and utility data as part of planning for a public health response.

The level at which public health response to a water contamination threat or incident starts and which ERP takes precedence will depend on the nature of the incident. Some of the factors that may determine which ERP takes precedence include who discovers the incident, whether Federal agencies are involved, and whether the public is already experiencing illnesses. Furthermore, the lead agency and the role of supporting agencies may change during an incident, as discussed in

Module 1. To facilitate these transitions, utilities and other agencies should incorporate the Incident Command System (ICS) in their ERPs, which is discussed in Module 1, Section 4.4.

2.1.2 Identification of Agencies Involved in Public Health Response

In preparing a Public Health Response Plan, the State health department will most likely identify the agencies (at the Federal, State, and local levels) to be involved in response during any type of public health emergency, which would include water contamination incidents. Examples include local (often county or city-level) public health agencies, medical centers and hospitals, regional poison control centers, State health departments and laboratories, and Federal agencies such as the Department of Health and Human Services (DHHS) [including CDC and the Agency for Toxic Substances and Disease Registry (ATSDR)] and the United States Environmental Protection Agency (US EPA). The roles and responsibilities of each of the identified agencies involved in public health response should be defined in the Public Health Response Plan.

Significant roles and areas of responsibility for selected agencies and groups in support of public health response are described below. In addition, the roles and responsibilities of the water utility, which plays an important role in public health response to water contamination incidents, are described in detail at the end of this section. These agencies and groups are subject to various regulatory requirements, so their roles and responsibilities are subject to applicable regulations and hence may be dependent on the nature of the contamination threat or incident. The roles and responsibilities for other Federal agencies are discussed throughout the remainder of this module where appropriate (also in Module 1, Appendix 6.2 and Module 6, Section 2.2).

Water Utility – The water utility will possess the most detailed first-hand knowledge and technical expertise regarding the configuration and operation of the water source, storage, treatment, and distribution systems. Accordingly, water utility personnel will support immediate operational responses (e.g., evaluation and implementation of containment options). The water utility personnel will also be experts in interpreting and explaining their operational and water quality data, and can provide an historic perspective to the interpretation of this data. In addition, the water utility will support, or potentially be the lead agency for public notification, depending on arrangements made with the State/local health department or drinking water primacy agency. The water utility may also provide accurate and up-to-date information on the water system to the designated information officer or media point of contact. It is especially important that during public health response planning, local health departments and utilities hold joint discussions and develop an integrated response plan for water-related events that clearly defines each organization's respective roles and responsibilities to ensure that their plans are consistent with existing State and local emergency response plans. The utility should participate in drills designed to exercise communication networks, with the understanding that the utility may not be the lead agency for public notification when dealing with intentional contamination.

Drinking water primacy agency – The drinking water primacy agency is the agency that has primary enforcement responsibility for national drinking water regulations, namely, the Safe Drinking Water Act as amended. The drinking water primacy agency is typically the State public health department or the State environmental agency; however, US EPA is the drinking water primacy agency for Wyoming, the District of Columbia, and most of Indian country. The drinking water primacy agency will provide guidance and oversight of public notifications. The drinking water primacy agency should work with the State to ensure that the State's ERP

addresses water emergencies and with the water utility to ensure that its ERP is consistent with the State's ERP. Additional roles and responsibilities of the State public health department and US EPA in support of public health response are described below.

State public health department – The State public health department is responsible for developing a Public Health Response Plan that includes an effective communications strategy and identifies specific actions to take in response to all types of public health emergencies, including terrorist incidents. The health department may also coordinate the investigation and control of disease, including coordinating the allocation of medications essential to the public and implementing appropriate public health response actions (e.g., issue health advisories and protective action guides to the public). The State public health department also typically has a clinical laboratory that is part of the LRN and which may provide analytical support, particularly for biological contaminants, in the case of a suspected contamination incident. The State health department also provides support to local emergency operations and serves as liaison to Federal and emergency health and medical programs and services.

Local public health department – The local public health departments may assist in diagnosing and investigating disease outbreaks and may have their own disease surveillance system in place. They may coordinate the care to be provided by local health care entities and provide mass prophylaxis to prevent epidemics. Local public health departments may have authority and responsibility to issue public notification to protect public health. In addition, the local public health department may concur with the water utility regarding public notification required under the Safe Drinking Water Act (SDWA).

Hospital staff, clinics, physicians, and poison control centers – In accordance with individual State laws, health care personnel report to the appropriate designated agency information on respiratory infections, skin rashes, diarrhea, and other syndromes that may provide an early warning of an outbreak of diseases such as anthrax, plague, and smallpox, as well as the intentional release of more common infectious agents. The ongoing reporting, compilation, and analysis of this data can lead to the early detection of *terrorist incidents* as well as other potential public health emergencies. Health care personnel are also responsible for proper care and treatment of the impacted public and containment of infectious diseases to the maximum degree possible. Regional poison control centers have expertise in the diagnosis and management of poisoning, including those involving hazardous substances. In addition, they are actively involved in surveillance, including collaboration with the CDC and ATSDR. The closest poison control center can be reached by the national toll free number, 1-800-222-1222.

State office of emergency services – Most State offices of emergency services coordinate overall State agency response to major disasters in support of local government. The office is usually responsible for assuring the State's readiness to respond to, and recover from, natural, man-made, or war-caused emergencies and assisting local governments with emergency response and recovery efforts. It is important for water utilities and public health agencies to involve their State office of emergency services in the planning process to investigate the types of resources this office can provide in a crisis.

Local office of emergency services – Most city or county offices of emergency services are mandated to coordinate disaster activities, before, during, and following catastrophic emergencies impacting the citizens of their particular jurisdiction. Local emergency service

offices usually provide planning, training, and coordination to county or city departments and other agencies within their jurisdiction. In most States, these local offices can provide a link to State and Federal resources during a disaster.

US Environmental Protection Agency (US EPA) – US EPA will typically activate technical capabilities to support the Federal response to terrorist incidents. US EPA may coordinate with individual agencies identified in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) to use the structure, relationships and capabilities of the National Response System as described in the NCP [40 Code of Federal Regulations (CFR) Part 300 subpart B] to support the response operations. US EPA will also provide resources to help the water utility assess the public health consequences due to a particular water contaminant and the appropriate operational response actions to take.

Centers for Disease Control and Prevention (CDC) – An operating division of DHHS, CDC develops resources to assist hospital staff, clinics, and physicians in diagnosing diseases related to terrorism, reporting incidences of disease, and controlling the spread of infection. Working with States and other partners, CDC provides a system of health surveillance to monitor disease and minimize the spread of outbreaks, implement disease prevention strategies, and maintain national health statistics. CDC provides expertise for investigating unusual public health episodes, environmental contamination, and unexplained illnesses. In 1999, CDC established the Laboratory Response Network (LRN), which is a national network of approximately 120 clinical laboratories that can respond to biological and chemical terrorism. LRN's resources may be activated when the FBI designates that there is a credible threat to water.

Agency for Toxic Substances and Disease Registry (ATSDR) - An operating division of DHHS, ATSDR performs specific functions concerning the public health effects of hazardous substances in the environment. Some of these functions include health surveillance and registries, response to emergency releases of hazardous substances, applied research in support of public health assessments, and information development and dissemination.

Federal Emergency Management Agency (FEMA) – FEMA, which is part of the Department of Homeland Security (DHS), is the lead Federal agency for supporting State and local response to the consequences of public health emergencies, including natural disasters and terrorist attacks. In response to requests from State or local agencies, FEMA provides support through the Response and Recovery Directorate's Mobile Operations Division, which can provide mobile telecommunications, operational support, life support, and power generation (FEMA, 2003d). FEMA may also train emergency personnel in preparation for emergency situations (FEMA, 2003a).

US Army Corps of Engineers (USACE) – Under National Response Plan (NRP) Emergency Support Function (ESF) #3, Infrastructure Annex, USACE, along with FEMA, serves as one of the primary agencies responsible, in part, for emergency restoration of critical public facilities (e.g., temporary restoration of water supplies and emergency contracting to support public health and safety).

Coordination among public health response agencies at all levels is critical to the successful implementation of public health response actions. The mechanisms for this coordination may be via phone, pagers, or any other means of rapid and reliable communication. Another valuable

tool for rapid information exchange is the Water Information Sharing and Analysis Center (WaterISAC). WaterISAC (www.waterisac.org) is a highly secure, Web-based information service available only to subscribers. It provides drinking water and wastewater utility managers with fast access to sensitive information about physical, contamination, and cyber threats. Established by the Association of Metropolitan Water Agencies, with support from US EPA, WaterISAC gathers, analyzes, and disseminates information on threats and incidents that is specific to the water sector. It serves as an important link between the water sector and Federal environmental, homeland security, law enforcement, intelligence, and public health agencies. In addition to providing a forum for sensitive water security discussions, WaterISAC provides information resources for improvements to water system security and emergency response plans.

2.1.2 Development of Communications Strategy

Reliable and rapid communications are crucial to ensure a prompt and coordinated public health response to a water contamination threat or incident. The first step for a successful response is information sharing and communication among water utilities, public health response agencies, emergency response agencies, and any other agencies with identified roles during a public health response. Ongoing communication of accurate and up-to-date information can facilitate public health response by the responsible agencies, help to minimize public health consequences, and aid in calming public fears.

Especially important is communication with public health agencies. Two-way communication between water utilities and public health agencies is critical and should be routinely tested in advance of a water contamination threat or incident. The *Incident Commander* (see Module 1, Section 4.4) of the investigation, who may or may not be from the utility, should report a ‘*credible*’ *contamination threat* to public health agencies so physicians, hospital staff, and clinical laboratories can be alerted regarding potential signs and symptoms that should be reported to the public health department. In some cases, the contamination threat may be identified by public health agencies, and arrangements should be made for public health agencies to communicate with water utilities regarding unusual symptoms that may have a connection to drinking water.

The drinking water utility and public health officials should develop criteria regarding when these notifications should occur and identify the key contacts within each agency to ensure that effective communications occur as a potential water-related public health incident unfolds. Public health agencies should implement public health surveillance procedures to determine if an increase in the occurrence of unusual symptoms, or an increase in sales of over-the-counter pharmaceutical products, warrants an investigation. The public health agencies’ notification procedures should include notification to the drinking water utility if it is determined that the drinking water is a potential cause of the increased death/disease. Coordination of notification procedures between the Public Health Response Plan and the utility’s ERP will be critical to seamless notification protocols. Where available, electronic means of information exchange/communication can greatly enhance communications and the speed of response. One such example is the National Electronic Disease Surveillance System (NEDSS) being developed by CDC for automated, timely electronic capture of data from the healthcare system.

Some critical features of effective communications are as follows:

- A comprehensive communications and public notification strategy addresses the “why, who, when, what, and how” of relaying information to agencies involved in public health response, as well as to the media and public when necessary. It should identify the information to be communicated, target audience, potential dissemination vehicles, resources required, and feedback mechanisms.
- The strategy should include a list of entities to be contacted and a notification roster that contains the appropriate contact names, titles, addresses, and all applicable landline, cellular phone, and pager numbers. The list should also identify the secondary contact if the primary contact in an organization cannot be reached in a reasonable amount of time. This list should be maintained and updated on a periodic basis. In addition, the communications protocol should define the reasonable amount of time and effort that should be expended before emergency response actions are taken without consulting the organizations that could not be reached. Whenever practical, the communications list should be standardized in format among agencies to allow ease and consistency in updating.
- In extreme emergencies (e.g., the terrorist incident involves more than contamination of the water system), it may not be possible to use normal channels of communication such as phones. Provisions should be made for an efficient and reliable form of backup communication to be available during emergency conditions when the use of normal facilities may be denied by the crisis. The utility, public health departments, and local or State emergency operations center may have already established backup forms of emergency communication.
- Communications protocols should be endorsed by all involved agencies, tested prior to finalization, and exercised periodically.

As presented in Module 1, the Incident Commander will decide on the appropriate communication to be implemented. The water utility should have its own strategy in the event that (1) they are responsible for incident command (potentially during the ‘possible’ and ‘credible’ stages of the threat management process) or (2) they are delegated responsibility for communication by the Incident Commander.

Table 5-1 consists of a list of potential entities to be notified as part of public health response, as well as the purpose of the notification for each entity notified. Each utility should identify in its ERP the appropriate entities to be notified. It is important to note that under 40 CFR Part 141, Subpart Q [the Federal Public Notification (PN) Rule], utilities must provide public notice to persons served by the water system in situations with significant potential to have serious adverse effects on human health as a result of short-term exposure. Such a situation requires a Tier 1 notice under the Federal Rule. Persons served by the water system include renters and transient populations in addition to billed customers.

The utility must also provide a copy of the public notice to the primacy agency. In addition, utilities that sell or otherwise provide drinking water to other public systems (i.e., consecutive systems) are required to give notice to the owner or operator of the system; the consecutive system is responsible for providing notice to the persons it serves. The PN Rule is described more fully in Section 5.

Table 5-1. Public Health Response - Entities That Should Be Notified

Entity		Purpose of the Notification
Public Health Agencies	State/local health and/or environmental department	To work with these officials in making the decision on the distribution of “boil water,” “do not drink,” or “do not use” notices. These officials may be involved with public health decisions related to the proper use of the water supply, status of the water distribution system, selection of a short-term alternate water supply, and communicating the necessary public health information.
	Other associated system authorities (wastewater, water)	
	Poison Control Centers	
Emergency Responders	Emergency Medical Services (EMS)	To notify the organization of the need for assistance with the distribution of an alternate water supply (e.g., bottled water) and whether or not the contamination impacts the availability of water for firefighting. Also, these agencies should be provided with all information related to public health including: information on water notices, alternate water supplies, critical care facilities, and public health notifications.
	Fire Department	
	State and/or Local Office of Emergency Services	
Law	Federal, State, and local law enforcement	Local law enforcement should be notified immediately if a malevolent act is suspected. Law enforcement agencies should also be notified of the need for assistance with getting important information out to the public and the distribution of water from the short-term alternate water supply (i.e., distribution of bottled water, etc.). Law enforcement agencies should also be contacted because the public may be contacting them through 911 regarding the incident.
Consecutive Systems (i.e., public water systems that receive water from the water utility where the water contamination threat or incident occurred)		To provide information related to restrictions on the use of the drinking water supply, as well as instructions on obtaining alternate sources of drinking water, through the duration of the incident. Also, information should be provided on the status of the water supply, the potential problem, and what is being done to manage the incident.
Customers/Public		To provide information related to restrictions on the use of the drinking water supply, as well as instructions on obtaining alternate sources of drinking water, through the duration of the incident. Also, information may be provided on the status of the water supply, the potential problem, and what is being done to manage the incident. Section 5 provides more detailed guidance regarding public notification.
Customers with special needs	Critical care facilities (e.g., hospitals, clinics, nursing homes, dialysis centers)	These facilities should be some of the first to be notified. Information should be provided regarding the proper use of the water supply for public health purposes as well as the identity of the contaminant so these facilities can identify the symptoms of exposure as well as potential medical treatment. They may be given information on how water will be provided or how they need to obtain short-term alternate water supplies. Critical care facilities may also need to be notified of any changes in the type of chemical disinfection being used or the concentration of these chemicals in the water as this may affect some of their medical procedures.

Table 5-1. Public Health Response - Entities That Should Be Notified

Entity		Purpose of the Notification
	Schools	To provide information regarding restrictions on water use, alternate water supplies, and other public health information.
	Day Care Facilities	To provide information regarding restrictions on water use, alternate water supplies, and other public health information.
	Businesses (e.g., food and beverage manufacturers, commercial ice manufacturers, restaurants, agricultural operations, power generation facilities, any other businesses identified by the utility)	To provide information regarding restrictions on water use, alternate water supplies, and other public health information. These customers may also need information regarding whether heating or superheating the water may pose a hazard.
Other	Elected officials	To provide all information related to public health, including: the status of the <i>threat evaluation</i> , information on “boil water,” “do not drink,” or “do not use” notices, alternate water supplies, customers with special needs, and public health notifications.

2.1.3 Development of Operational and Public Health Response Actions

Module 2 presented a threat management process under which responses occur during the ‘possible’, ‘credible’, and ‘confirmatory’ stages. Public health response decisions, which may include containment of the suspect water and/or public notification regarding restrictions on water use, may need to be considered at each stage as a means of minimizing and/or preventing exposure to the suspect water. However, it is also necessary to consider the potential impacts of response actions on the public (e.g., the lack of a supply of water for drinking and sanitation). In many cases, the responsibility will fall on the water utility to determine the proper approach and methods to address water supply related impacts of various response actions.

Potential operational and public health response actions should be defined during the planning process. The plan should identify the agency or organization that is responsible for carrying out the action(s) as well as the circumstances under which the actions are to be taken (the “Threat Management Matrices” presented in Module 2 may be useful for this purpose). Operational responses to a ‘possible’ water contamination threat include isolating and containing the affected portion of the system and other novel operational responses. A detailed discussion of implementing operational responses can be found in Section 4 of this module.

Potential restrictions on water use that might be achieved through public notification include issuing a “boil water” notice, “do not drink” notice (no consumption), and “do not use” notice. A detailed discussion of implementing public notification can be found in Section 5 of this module.

An extremely important element of public health response is the identification of options and plans for a short-term alternate supply of drinking water if the public is notified not to drink or use the water. These options should be identified in the drinking water utility’s ERP. Table 5-2

provides a list of potential options for short-term supplies. A detailed discussion of potential alternate water supplies can be found in Section 6 of this module.

Table 5-2. Options for Short-term Alternate Supplies of Drinking Water

Type	Source
Bottled water	Local government agencies
	Local retailers
Bulk water	Certified water haulers
	Military assets (i.e., National Guard)
	Neighboring water utilities
Utility treated	Uncontaminated source water treated by the utility
	Uncontaminated water stored in the distribution system

3 Public Health Consequences due to Water Contamination

Potential consequences of a contamination threat or incident should be considered to the extent possible when making public health response decisions. Two factors that influence the potential consequences include the contaminant properties and the spread of a contaminant through the water system. Once the contaminant has been identified, the water utility, working with other public health or law enforcement agencies, as appropriate, may need to access information on the public health consequences of that contaminant. The information, data, and methods needed to assess public health consequences of contaminants are presented in this section. In addition, this section examines various methods to assess the spread of a contaminant.

3.1 Contaminant Properties

Within this section, Tables 5-3, 5-4, and 5-5 contain an overview of properties important in evaluating the threat that a contaminant poses to public health, as well as a brief discussion of their relevancy in determining public health consequences. These properties should be considered collectively in determining the public health consequences of a particular contaminant. Sources that provide this type of information for specific contaminants are presented following these tables.

Table 5-3. Properties Applicable to both Biological and Chemical Contaminants

Property	Discussion
Acute Health Effects	Acute health effects occur immediately (i.e., within minutes to days) following short-term exposure (i.e., up to 30 days) to certain contaminants such as pathogens or chemicals that may be in drinking water and depend on the route of exposure. For example, the acute health effects following ingestion of ethylene glycol can lead to myocardial failure, renal failure, metabolic acidosis, tachycardia, upper gastrointestinal bleeding, tremors, agitation, ataxia, stupor, seizure, loss of consciousness, coma, and death (CDC, 2004). Since the acute health effects of many biological contaminants are flu-like, many health care providers may not make the connection between increases in flu-like symptoms in the community and a potential water contamination incident.
Chronic Health Effects	Chronic health effects can result from short-term exposure or prolonged exposure, presumably in low doses, to a contaminant. Contaminants causing long-term health effects are mostly chemical contaminants and include, among others, byproducts of solvents used by commercial and industrial facilities, disinfectants, pesticides, and metals such as lead and mercury. For example, chronic ingestion of small amounts of cyanide may lead to weakness of the fingers and toes, difficulty walking, dimness of vision, deafness, and decreased thyroid gland production (ATSDR, 1997a). Cyanide is regulated at 0.2 mg/L on the basis of these chronic health effects. Although less common, chronic effects can also result from exposure to biological agents. For example, chronic arthritis can result from acute exposure to Salmonella bacteria if Reiter's syndrome develops. Chronic health effects from prolonged exposure may determine the remedial goal for a contaminated water system, particularly if the contaminant is persistent in the system. Drinking water regulations prescribe maximum concentrations of several contaminants on the basis of chronic effects.

Table 5-3. Properties Applicable to both Biological and Chemical Contaminants

Property	Discussion
Taste/Odor/ Color	Although many contaminants will not be easily detectable via the five senses, those that produce a noticeable taste, odor, or color in water may pose less of a public health threat. These properties may alert consumers that the water may be unsafe, thus minimizing the use of contaminated water. For example, if a contaminant caused the water to have a strong, unpleasant odor (e.g., rotten eggs), it seems likely that many individuals would be deterred from consuming a sufficient quantity to cause serious health effects. However, these properties should not be relied on to eliminate exposure because some subpopulations (e.g., blind, elderly) may not be able to detect these changes. In addition, contaminants that adversely impact the aesthetic qualities of water, even if they have low health impacts, still present a problem because the public may refuse to use the water until the system is remediated.
Aerosolization	Aerosolization is the process of making particles of solid or liquid matter such that they can remain suspended in air for a few minutes to many months. The particle size and weight of contaminants will determine whether aerosolization is a concern and should be considered during the assessment of potential public health consequences. Specifically, chemical and biological contaminants likely to become suspended in air are more likely to pose a threat to public health through inhalation pathways (e.g., while showering).

Table 5-4. Properties Applicable to Chemical Contaminants

Property	Discussion
Toxicity Values (e.g., LD ₅₀ , LC ₅₀ , TD _{L0} , TC _{L0})	Toxicity values can be used to estimate the contaminant concentrations at which acute health effects will be realized in large portions of the population. Some examples of toxicity values include the lethal dose for 50 percent of the population (LD ₅₀); lethal concentration for 50 percent of the population (LC ₅₀); lowest dose at which toxic effects are observed in an individual (TD _{L0}); and lowest concentration at which toxic effects are observed in an individual (TC _{L0}). Typically, these doses are designated as being administered via the oral, inhalation, dermal, or ocular routes and are expressed as a mass of contaminant per mass of body weight. The toxicity of a chemical, as well as the resulting adverse health effects, depends on the route of exposure. The toxicity values may also be time dependent (i.e., the lethal dose or concentration will change depending on the time period over which exposure occurred). When human estimates for these parameters are available, they should be used, but in most cases it will be necessary to use data from animal studies. When data from animal studies are used, the type of animal used should be considered when estimating the concentrations that will cause health effects in humans. In addition, several methods are used to extrapolate the data to humans, including multiplying values by safety factors to account for genetic and physiological differences and susceptible populations. Furthermore, it is important to consider that sensitive populations may experience adverse health effects at levels significantly below the reported toxicity values.

Table 5-4. Properties Applicable to Chemical Contaminants

Property	Discussion
Hydrolysis	Hydrolysis is the reaction that occurs between a chemical and the ions in water (H ⁺ and OH ⁻), which may produce byproducts that are less toxic than the parent chemical. However, it is important to consider the toxicity of the hydrolysis products, as some can be highly toxic themselves. The hydrolysis half-life of a chemical is the time required for the concentration to be reduced to ½ the initial concentration as a result of hydrolysis reactions. Contaminants that are resistant to hydrolysis have longer half-lives in water, and thus may be of greater concern due to their persistence. For example, if a contaminant has a half-life in water of 8.5 hours, it would have less long-term contamination impact than a contaminant with a half-life of 8.5 weeks.
Reactivity	The reactivity of a contaminant is a function of how quickly it will undergo chemical change, in this case in an aqueous system. Reactive compounds will rapidly undergo reactions such as oxidation or hydrolysis. Reactivity will typically depend on environmental variables such as temperature, pH, type of disinfectant, and the presence of any materials that might catalyze (speed up) or inhibit the reaction. A less reactive compound would undergo oxidation or hydrolysis at a slower rate, or not at all. Thus, reactivity will determine how quickly contaminants in a water distribution system will break down.
Solubility	Solubility is the amount of material that will dissolve in water under specific conditions of pH, temperature, and dissolved solids concentration. Contaminants that are insoluble in water may be removed by conventional treatment processes if they are introduced upstream of the treatment plant. If introduced into the distribution system, insoluble chemicals may precipitate and settle out in the pipes and joints, potentially reducing the public health consequences due to the reduced concentration in water. However, compounds with limited solubility that deposit on pipe materials may present a greater remediation challenge (see Module 6).
Implications of Oxidation	Oxidation is a chemical reaction process in which there is a loss of electrons from an atom or ion. Drinking water is often treated through the addition of an oxidizing agent (e.g., chlorine, chlorine dioxide, ozone, etc.) to accomplish disinfection. In this process, pathogens are inactivated through damage to the cell wall, and alteration and deactivation of the cell enzymes. Chemical compounds may also react with oxidizing agents. In some cases a sufficient oxidant concentration will fully break down chemical compounds to basic constituents such as carbon dioxide, water, or elemental nitrogen. In other cases such as phenol, low concentrations of oxidants such as chlorine will produce halogenated compounds, which may be more toxic than the original compound.
Volatilization	In an open system, such as a reservoir, the concentration of a volatile contaminant may be reduced as it evaporates into the atmosphere. However, while within the contained and pressurized portion of a water distribution system, volatilization is not expected to be a significant fate and transport process. Volatility is also a factor to consider during an assessment of potential public health consequences. Specifically, volatile chemicals are more likely to pose a threat to public health through inhalation and dermal pathways (e.g., while showering).

Table 5-5. Properties Applicable to Biological Contaminants

Property	Discussion
ID ₅₀ and Minimal Infective Dose (MID)	The infectious dose for 50 percent of the population (ID ₅₀) can be used to estimate the concentrations at which a significant portion of the exposed population (50% or greater) would develop disease. When human estimates for these parameters are available, they should be used, but in some cases it will be necessary to use data from animal studies. When data from animal studies are used, the type of animal used should be considered when estimating the number of pathogens necessary to cause disease in humans. Furthermore, it is important to consider that sensitive populations may develop the disease at exposures significantly below the ID ₅₀ . The minimal infective dose (MID) is the minimum number of pathogens required to infect an individual, and may be significantly lower than the ID ₅₀ for susceptible individuals.
Disease and Death Rates	The disease rate, or morbidity, is the rate of occurrence of a disease in individuals exposed to the pathogen. The death rate, or fatality, is the percentage of people infected who will likely die as a result of the disease. For example, plague is nearly always fatal unless treated within 12 to 24 hours, and thus has a fatality rate near 100%. Estimates of these rates may be important in determining the impact of the contaminant on public health and the additional burden that critical care facilities may face as a result of the incident.
Secondary Transmission	Some pathogens can be transmitted from person to person (i.e., a contagious disease), making direct exposure to the contaminated water unnecessary for infection. Thus, a terrorist attack with a non-contagious agent would be self-limiting, whereas an attack with a contagious agent could trigger an epidemic. Knowledge of this property will help determine whether public health responses beyond notification, such as patient quarantine, are necessary. For example, smallpox is a contagious disease with fairly high rates of secondary transmission, while anthrax is non-contagious.
Survivability in Water	The length of time that pathogens can survive in water and/or their capability to reproduce in water can contribute to the severity of a water contamination event. For example, pathogens that can survive for months or longer in spore or cyst form will pose a greater public health and remediation challenge than those organisms that can survive for only hours or a few days in water. In addition, pathogens that are capable of reproducing in water may have a longer-term impact than those that need a host or other conditions to reproduce.
Susceptibility to Disinfection	Generally, organisms that are susceptible to chemical disinfection pose less of a threat than those that are resistant to commonly used drinking water disinfectants. However, some disinfectants, such as ozone, UV, and chlorine dioxide, are only used in the plant and would not be effective against any contaminants introduced post-treatment. The maintenance of a chlorine residual in the distribution system provides some protection against contaminants that are susceptible to inactivation by low levels of chlorine. If biological contaminants that are more resistant to disinfection are detected, they may be inactivated by more aggressive disinfection practices as part of the remediation process (see Module 6).

Some of the information and data listed in Tables 5-3, 5-4, and 5-5 can be found in the following sources; however information about all items listed will likely not be available for each contaminant.

- US EPA Water Contaminant Information Tool (WCIT), which is being developed specifically for the water sector and is described in Module 2, Appendix 8.9 (US EPA, in preparation)
- US EPA's List of Drinking Water Contaminants & Maximum Contaminant Levels (MCLs): <http://www.epa.gov/safewater/mcl.html#mcls>.
- Agency for Toxic Substances and Disease Registry (ATSDR): www.atsdr.cdc.gov.
- CDC Emergency Preparedness and Response: www.bt.cdc.gov.
- Recognizing Waterborne Disease and the Health Effects of Water Pollution: A Physician On-line Reference Guide: www.waterhealthconnection.org.
- Physician Preparedness for Acts of Water Terrorism: www.waterhealthconnection.org/bt/index.asp.
- Registry of Toxic Effects of Chemical Substances (RTECS): www.cdc.gov/niosh/rtecs.html.
- Risk Assessment Information System (RAIS), which contains information taken from the US EPA Integrated Risk Information System (IRIS), the *Health Effects Assessment Summary Tables* (HEAST-rad HEAST-nonrad), US EPA Peer Reviewed Toxicity Values (PRTVs) Database, and other information sources: <http://risk.lsd.ornl.gov/index.shtml>.
- United States Army Medical Research Institute of Infectious Diseases (USAMRIID) Medical Management of Biological Casualties Handbook: <http://www.usamriid.army.mil/education/bluebook.html>.
- WaterISAC, which contains information on contaminants including various contaminant fact sheets as well as the United Kingdom Water Industry Research (UKWIR) database: www.waterisac.org.
- World Health Organization (WHO): www.who.int/search/en/.
- WHO's "Public health response to biological and chemical weapons" www.who.int/csr/delibepidemics/biochemguide/en/index.html.

As a final note, the information described in the tables above can be used not only to determine the level of threat that contaminants pose to water users, but also to aid in determining the type of response actions to take in the event of a contamination incident. Of particular importance are fate and transport processes that impact the persistence of a chemical contaminant in the water system. As shown in Table 5-4, the rate of hydrolysis of a contaminant is a parameter that has a significant impact on the amount of time that it will remain in the water system at concentrations of concern and, therefore, might influence the response decision. For example, if the identified contaminant rapidly hydrolyzes under typical drinking water conditions (i.e., has a relatively short half-life), the response action may be to simply restrict water use for a sufficient time, monitor the system to determine that the contaminant has fully degraded, and return the system to normal operation once the monitoring has demonstrated that the contaminant has degraded to acceptable levels.

3.2 Assessing the Spread of Contaminant in the System

The ability of a water utility to assess the spread of a contaminant in its water supply system depends largely on its understanding of the system hydraulics and operation. The drinking water utility is in the best position to characterize its system design and operation, flow and pressure patterns, and containment options. It is recommended that every utility perform a hydraulic assessment of its distribution system in order to better understand the potential spread of a

contaminant **before** an actual water contamination threat or incident. This type of analysis will facilitate an appropriate and timely response when a threat or incident actually occurs.

Information from a hydraulic assessment conducted by the water utility can:

- Facilitate the identification of available containment options.
- Assist in developing procedures for selecting and implementing the most appropriate containment option.
- Provide information necessary to make decisions regarding public health response actions, specifically identifying the area of the distribution system that would be subject to water use restrictions.
- Assist in identifying locations at which sampling and analysis may be most useful, thus reducing the amount of testing (and associated cost) that is required.
- Target “*reverse 911*” messaging to a specific area (i.e., calls are made to businesses and residences in the defined risk area notifying recipients of the public health danger that is present and providing them instructions for protection).
- Help in identifying feasible locations and methodologies for injection of disinfection to inactivate or reduce the threat posed by the contaminant.
- Support the system characterization phase of the remedial process (see Module 6, Section 3.2).

Two types of methods (namely, manual assessment methods and modeling) for assessing the spread of a contaminant in a distribution system are described below. The methods selected for use by specific water utilities will vary depending on their financial resources, size and characteristics of the system (i.e., number of pipes and nodes), and staff availability for training and utilization of the tools.

3.2.1 Manual Assessment Methods

Manual methods for assessing the spread of a contaminant are based primarily on the hydraulic operation of a system and use the utility’s knowledge of flow patterns and pressure zones in its system. The results of this hydraulic analysis, when combined with maps or other geographical and population information, can be used to estimate and identify the population potentially affected by a suspected contamination incident.

Much of the current literature regarding water distribution system assessment focuses on the use of computerized models. Such models certainly provide useful capabilities, especially for large and complex water systems. However, manual assessment methodologies continue to have advantages, particularly for small systems. These methods are often more efficient and cost effective. In addition, such methods avoid several of the potential drawbacks of more sophisticated computer-based methods. First-time users of any software often become absorbed in learning to successfully operate the software and, therefore, may not focus on the technical substance underlying their efforts. Manual methodologies have the potential benefit of allowing water system operators and engineers to focus primarily on understanding their system’s critical operating characteristics. For many small systems, use of computerized modeling may require outside assistance in the form of a consultant. Depending on how involved the system’s staff is in the ensuing evaluations, this may result in the consultant acquiring a greater understanding of

the system than the operating staff. Unfortunately, the consultant's staff may not be available when a contamination threat or incident arises.

In using manual methods, various types of scenarios should be created, to assist the utility in better understanding the range of flow and pressure patterns under various demand conditions that may be encountered during a contamination threat or incident. Examples of demand condition scenarios to be considered in the evaluation might include:

- Average day demand – Use the ratio of unaccounted for or leaked water to raise all demands such that total demand equals total water pumped.
- Peak demand – Estimate the ratio of peak day to average day demand from pumping records.
- Low-use day demand – Estimate the ratio of winter/low day to average day demand from pumping records.
- Variations in demand or flow patterns over the course of a 24-hour day (e.g., night versus day, morning and evening peaks versus average flow during the day) – Consider variations within each of the three scenarios described above.

Factors that will impact system behavior under various scenarios will include basic system configuration and hydraulic characteristics (pipe sizes, use of booster pumping stations, etc.), physical ability to isolate portions of the system using existing control structures, and system topography. In particular, relative line elevations will control the effects of any attempt to depressurize all or portions of the system, by possibly creating various isolated zones once the system is depressurized. Consideration of these characteristics under the various types of scenarios described above may reveal possible containment strategies that might be effective in response to various threat scenarios.

In general, the utility should strive to identify demand scenarios that will, to the extent possible, define the range of system behavior. For example, in a particular system, if daily cycles in water usage patterns result in reversal of flow in certain lines, response and recovery plans for those portions of the system should include consideration of the conditions that determine flow and include appropriate actions for both conditions.

Utilities may find it useful to develop a list of typical travel times from a reasonable number and spatial distribution of possible contaminant introduction points to large population centers or critical customers. Utilities may also apply basic hydraulic engineering methods, such as simple network analyses, to understand how water moves through their system during different circumstances. These simple analyses (often carried out using simple spreadsheet software primarily for convenience) allow the utility to estimate the likely spread of a contaminant under the known conditions of a hypothetical contamination incident. In situations where potential water contamination incidents are reported from public health surveillance (i.e., emergency room visits, hospital admissions, and disease reporting to public health agencies), the water utility can compare case density and location to distribution system maps. Large-scale maps can be created showing locations at which exposure is suspected (e.g., points of ingestion or other use) and likely introduction points of a contaminant. This information can facilitate the identification of affected areas and be used to guide initial public health response actions. As noted in Section 2.1, difficulties in data sharing between the public health agency and the utility should be

resolved during public health response planning. One example of how the public health agency and utility may resolve these challenges is to have the public health agency lead the assessment with input from the utility, thereby protecting patient information.

3.2.2 Water Distribution Models

In conjunction with the manual assessment methods, water distribution models can be used to provide additional information to predict the dispersion and dilution of a contaminant as it travels through the water distribution system. As with the manual assessment methods, water distribution system models may be run under various demand conditions to simulate the expected range of flow and pressure patterns in a system. Water distribution modeling should be performed as part of planning for a response to a water contamination incident.

A variety of water distribution models with various features are available. These are described below.

- The simplest of these are steady-state models. These basic models only allow for the analysis of flow under steady-state conditions (i.e., all flow rates are constant). While such conditions never really occur in an actual system, the analyses carried out using such models can provide a basic understanding of distribution system hydraulics. This is particularly the case for smaller, less complex systems.
- Dynamic models allow the more realistic simulation of changing flow conditions over time. As such, these more complicated models allow more realistic simulations of flow conditions in an actual system. The disadvantage of such models is their increased complexity and required level of expertise. They also require substantially more field data in order to be calibrated.

Both steady-state and dynamic models can be enhanced with the following capabilities:

- Water quality modeling capability allows a model to simulate dilution and production/decay of contaminants in the distribution system. This advanced feature should provide a better estimate of the contaminant concentration at any time or location in the system during an event. When using water quality modeling as a risk assessment tool, modelers should be very conservative in their use of inactivation/decay rates because the misuse of these rates can cause the model to significantly underestimate the contaminant concentration actually present in the water.
- Linkage to GIS allows model input and output to be easily and quickly linked to actual geographical areas and specific customers. GIS can provide users with an immediate visual graphic to locate areas of high contamination or low flow. For example, an ArcView shape file (i.e., *.shp) can be created with locations keyed to account numbers and nodes or model junctions from AutoCad.

These models allow a water utility to:

1. More readily assess the consequences to the population and infrastructure within the area suspected of being contaminated.
2. Examine the effects of isolating portions of the system by closing valves to prevent the spread of a contaminant.

3. Identify existing isolation options and potential modifications to the system that may increase or enhance the existing options.
4. Identify distribution options for providing an isolated area with water from adjacent areas or pressure zones.

Most distribution system models are used just for hydraulic assessments, and only a limited number have a water quality component that could be used to simulate a contamination incident. However, if the distribution system model has the ability to consider contaminant properties that impact fate and transport, water utility users can also simulate the fate and transport of contaminants introduced into the distribution system. Again, modelers should be conservative in their use of inactivation/decay rates to avoid significantly underestimating the concentration of contaminants.

For example, a pipe network hydraulic model, such as the industry standard EPANET, can perform extended period simulations (EPS) of hydraulic and water-quality behavior for water distribution systems. EPS are not steady-state, but rather dynamic models that change over extended periods. The program tracks the following for multiple time steps:

- The flow of water in each pipe.
- The pressure at each node.
- The water level in each tank.
- The concentration of chemical species throughout the network.

EPS accomplish this by continuously utilizing information from a number of time-variable factors, such as tank water levels, pump operation, and demand fluctuations. EPS can only calculate the concentration of chemical species if the decay parameters for the contaminant are known. However, for most contaminants, the decay parameters are unknown, and it is safer to assume no decay as a conservative approach.

EPS can be more accurate than steady-state models because typical system velocities range from about 0.1 to 10 feet per second, so contaminants can take hours or days to migrate through a distribution network. Additionally, system demands vary throughout the day, which cannot be accounted for in steady-state models.

EPANET is public domain software that may be freely copied and distributed. Other similar models that could be used in this capacity include, but are not limited to:

- MWH Soft H₂ONET (www.mpact.com/page/p_product/net/net_overview.htm)
- KYpipe PIPE2000 (www.kypipe.com)
- AdvanticaStoner SynerGEE Water (www.advantica.biz/stoner_software/synergee_water/)
- Haestad Methods WaterCAD™ (www.haestad.com/water/default.asp)
- PipelineNet (<http://eh2o.saic.com/iwqss/>)
- DH1 Software Mike Net (<http://www.dhisoftware.com/mikenet/>).

Note: The mention of these commercially available models is for illustrative purposes and does not imply endorsement by the US Government.

If calibrated and validated properly, the more sophisticated models can enable water utilities to simulate contamination incidents more accurately. Generally, these programs are able to import database files from spreadsheets, database applications, and other models. The benefit of these more sophisticated models is their ability to model contaminant spread on a near real-time basis. As an example, Appendix 8.7 describes the capabilities of PipelineNet, a complex model that was specifically developed to estimate the consequences of a terrorist incident on a city's drinking water infrastructure. This model incorporates census population information to help assess total population at risk, including sensitive populations at hospitals and schools.

Users should be able to use these more complex models to input points of contaminant introduction and simulate downstream affected areas, possible containment strategies, and potential points of disinfectant injection. These models allow the user to simulate the spread of a conservative tracer, like dye, through parts of the distribution system under various conditions. In addition, the user can simulate disruptions to critical system components and then evaluate different types of operational response options to deal with the loss of the component. Several models can also track the spread of multiple constituents introduced at different points in the network.

Computerized models can provide powerful analytical tools, particularly for large, complex water distribution systems. Nonetheless, like any tool they are not needed by all systems, and in some cases their drawbacks may outweigh their advantages. As noted above, for small simple systems, manual evaluation methods may be more efficient. Furthermore, model users may fail to adequately scrutinize model results, due to the seemingly definitive and complex outputs of many computer models.

In addition, to providing reliable results, models need to be "calibrated" and "validated" using actual system flow and pressure data. Failure to carry out adequate calibration and validation activities can result in a model that is not representative of system operating characteristics, which could lead to the development of ineffective response strategies.

4 Operational Response Options

As discussed in Module 2, the objective of *immediate operational response* actions is to minimize the potential for exposure of the public to the suspect water, as well as provide additional time to evaluate whether or not the threat is ‘credible’. Because these response actions may limit public exposure, they may also be considered an effective public health response. Operational response actions are typically suitable for implementation early in the threat management process, assuming that they will have minimal impact on the consumers. In general, containment will be the most likely option for an operational response, but other novel operational response options such as elevation of the disinfectant levels in a targeted area of the distribution system may be considered. Issues related to planning for, and implementation of, operational responses are discussed in this section. Note that distribution system flushing is not addressed in this Module as a potential public health response due to the ramifications of discharging potentially contaminated water. Module 6, Section 4.1.2 discusses distribution system flushing as a potential remedial action.

4.1 Containment of Suspect/Contaminated Water

Containment of contaminated water may be an appropriate immediate operational and public health response action, especially when at the ‘possible’ stage of the threat management process. The objectives of containment are to 1) prevent the spread of the contaminant to as yet uncontaminated sections of the system and 2) to the extent possible, preclude system users from drawing the contaminated water from the system. The decision to contain the water needs to be made quickly for the measure to be effective and should involve the appropriate agencies as identified during the planning process. The decision process for implementing containment is shown in Figure 5-2 and also discussed in Module 2. There are three key decision points in the process: 1) Can the area potentially affected by the contaminant be estimated? 2) Is it physically possible to contain the affected area? and 3) To what extent will containment negatively impact consumers and/or fire protection? The “Consequence Analysis,” which deals with the number of individuals affected, health effects on consumers, and impacts of response actions, will influence the evaluation of potential containment options. It is important to note that the fire department should always be contacted prior to implementing containment if the act of containment would impact firefighting capability in the area. Module 2, Section 2.3 describes a general approach for consequence analysis, while Section 3 of this module provides additional detail for assessing the public health consequences associated with a particular contaminant.

When responding to a contamination threat at the ‘possible’ stage, implementation of containment options may be limited by consideration of the impacts of containment on consumers or firefighting (as shown in Figure 5-2). If containment would have substantial, adverse impacts, it may be prudent to accelerate the threat evaluation to establish whether or not the threat is ‘credible’ such that a decision can be made regarding the implementation of a containment strategy. On the other hand, once a threat has been deemed ‘credible’, the most appropriate option may be to implement the containment strategy and manage the resulting impacts. In other words, the impacts of containment on consumers and/or fire protection may not be as critical if the contamination threat has been deemed ‘credible’. In addition, if a containment strategy was already implemented during the ‘possible’ stage, expanded containment strategies might be considered at the ‘credible’ stage.

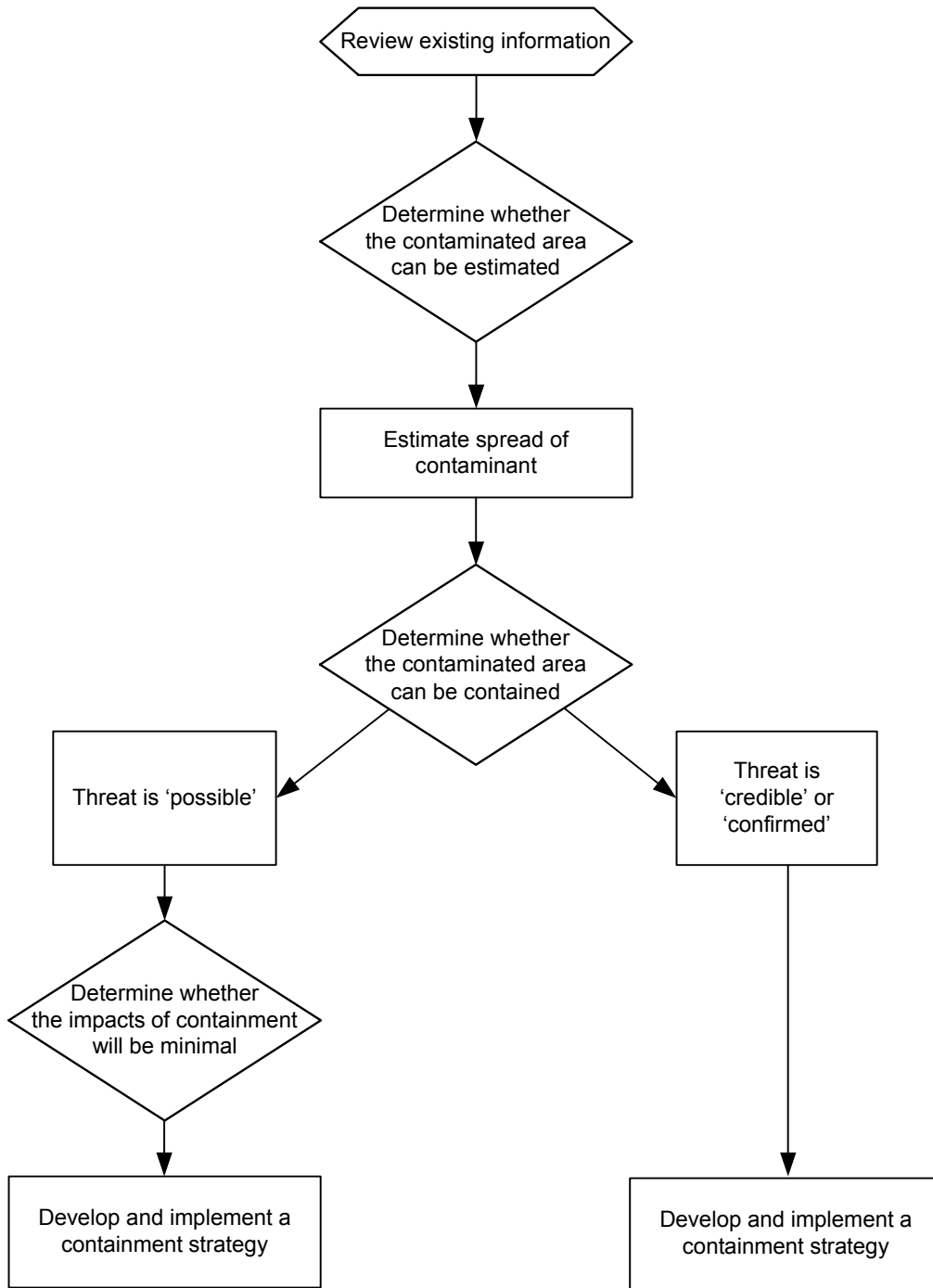


Figure 5-2. Decision Process for Containment as a Public Health Response

If there are consumers within the isolated area, it will likely be necessary to notify them of any restrictions regarding use of the water (i.e., public notification) and possibly provide them with

an alternate supply of drinking water. Public notification and provision of a short-term alternate water supply are discussed in Sections 5 and 6, respectively.

In preparing for the use of containment as an operational response, water utilities can use either manual methods or computerized hydraulic models coupled with GIS (discussed in Section 3.2) to estimate areas of their systems that could be affected by contamination, detect vulnerabilities in a water distribution network, and identify possible containment strategies **prior to the** occurrence of a water contamination threat. Using either manual methods or hydraulic models as a means of understanding system hydraulics should generally be considered a planning tool that will help the water utility understand the implications of containing various areas of the system, allowing for a prompt and informed response to contamination threats.

Containment or isolation is generally accomplished by closing specified valves in the network to create a closed loop or to stop the flow from one segment of the distribution network to another. However, utilities should be cautious when isolating a portion of the system with valves because the valves could leak making it unclear whether the contaminated water has been effectively contained. Other containment options might include hydraulically created reverse flow conditions or bypassing a segment of the network. Familiarity with the system dynamics such as knowing direction of flows (under specific circumstances) and various loops and location of isolation valves will increase the likelihood of a prompt and effective response.

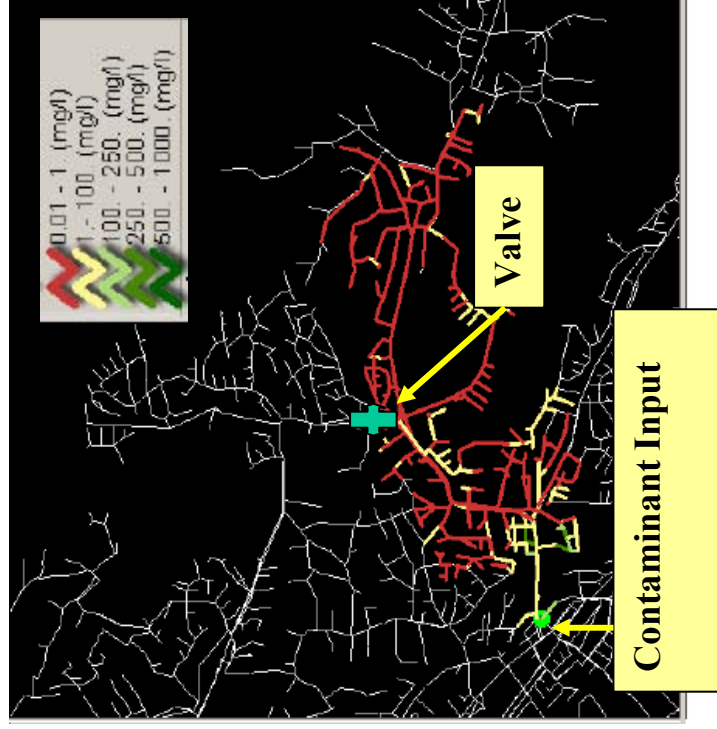
Situations in which containment is likely to be feasible include those in which a specific *contamination site* has been identified and can be easily isolated without significant impact to normal operation of the system. As an example, some distribution system storage tanks may be isolated using valves with minimal impact on system pressure and operation.

A more complicated situation arises when the suspected point of contaminant introduction is directly into a main or service line. In this situation, the utility may wish to physically prevent customers from drawing water, which would entail dispatching crews to close isolation valves or service line meter stops for each customer.

Figure 5-3 illustrates the potential effectiveness of isolation via a valve closure. The two graphics compare the spread of the contaminant, after 24 hours, through a portion of a hypothetical distribution system with the indicated valve open in one case and closed in the other. The pipe colors show contaminant concentration. In this case, closing the valve successfully prevents the spread of the contamination to the northern section of the distribution system. The hydraulic model output provides both spatial and temporal information on the dispersion of the contaminant.

For smaller systems there may be only a limited number of isolation options. For such systems, evaluation of potential containment strategies under a limited number of typical and critical conditions will often be sufficient to assess the viability of a particular isolation option. As with systems using computerized models to assess response options, the important point is to identify viable actions and to clearly define the conditions under which an action will be effective and appropriate before an incident actually occurs.

Valve Closed



Valve Open

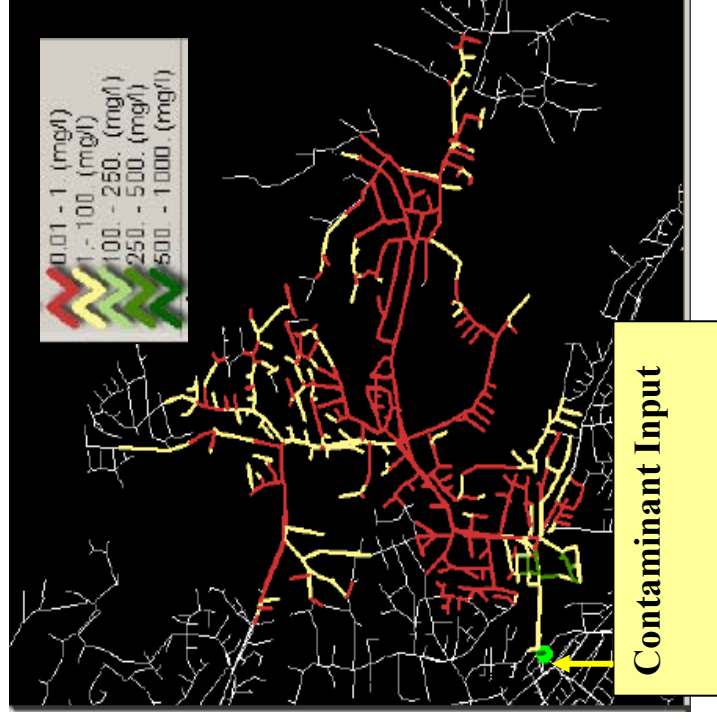


Figure 5-3. Comparison of Contaminant Spread With and Without Valve Closure.

4.2 Novel Operational Responses to Contamination

Intentional drinking water contamination incidents present the drinking water industry with a series of challenges, and current capabilities and practices may in some cases be insufficient. As a result, efforts to develop effective response measures and tools may at times require the development of new practices and equipment. The concepts discussed briefly below are not specifically recommended for any particular system. Instead, these as-yet untried measures are intended to illustrate the potential for “thinking outside the box” in developing approaches to responding to the new challenges posed by drinking water contamination threats and incidents. It is critical that novel approaches, such as those discussed below, only be considered if approved by the drinking water primacy agency.

One possible immediate operational response is increasing the level of disinfection at the treatment plant and/or injecting disinfectants in close proximity to the contaminants. Neither method is likely to adequately treat the water to allow the public to consume the contaminated water within the distribution system, but the elevated disinfection levels may aid in system remediation efforts, and may help in limiting the volume of contaminated water to be handled during remediation.

Manual or hydraulic assessment methods may provide a means of estimating the efficiency of adding disinfectant at various locations in the system. Utility operators can then compare scenario results and implement the most effective treatment. Injection of a disinfectant as an operational response at locations where disinfection currently does not take place would require the development of mobile disinfection capability. A mobile system would likely make use of an existing service connection for most systems, and there would be a need to train staff in its application. Most drinking water primacy agencies recommend or require the use of chlorine for emergency disinfection of the public water supply; thus some systems may already have some mobile disinfection capability.

To address instances of contamination of storage tanks or reservoirs, one challenge may be to rapidly and effectively disinfect the entire tank volume. The development of equipment to allow the rapid addition and mixing of disinfectant should be possible and may involve the use of portable equipment involving multi-port diffusers and a mixing capability.

In addition to chlorine, another potentially useful measure may be the point injection of food-grade colorants or dyes into the distribution system. The injection of the dye may discourage public consumption of the potentially contaminated water and act as a second layer of protection in addition to public notification. As with point injection of a disinfectant, this approach would require a thorough understanding of system hydraulics, such that the target areas are covered by the response.

Another response may be to reduce the pressure in all, or at least a portion of a system. This would reduce water availability to customers, and potentially facilitate containment measures. Depressurization could also have potentially serious hydraulic (possible damage to system components due to water hammer and related effects) and public safety (firefighting) consequences. Such consequences would need to be carefully considered prior to implementation.

5 Public Notification Strategy

The public notification strategy is a key component of public health response. Once it has been decided to implement public notification, the water utility and other appropriate agencies should be prepared to quickly and effectively issue the appropriate public notices. This section covers all of the essential components of a public notification strategy including the process of deciding when to issue a public notice; the type, format, and content of a public notice; the target audience for the public notice; and methods for delivering the notice.

It is important to note that public notification in response to a water contamination threat or incident may be required under the PN Rule (40 CFR Part 141, Subpart Q). Specifically, this rule may require public notification in a “situation with significant potential to have serious adverse effects on human health as a result of short-term exposure” as determined by the primacy agency in its regulations or on a case-by-case basis [141.201(b)]. In the PN Rule, this is called a Tier 1 public notice. The Tier 1 public notice requirements address who must be notified, when the notification must take place, and the required form and manner of the public notice. In responding to a ‘credible’ contamination threat, the utility needs to consult with the drinking water primacy agency, and potentially the public health agency, to determine whether or not the situation warrants public notification (in compliance with the Tier 1 public notice requirements in the PN Rule). If it is determined that the situation is subject to the PN Rule, then the water utility is required to ensure that the public notification complies with the requirements in the PN Rule. Throughout this section, the specific Tier 1 public notice requirements are presented where appropriate. Additional guidance regarding public notification and the requirements of this rule can be found in the “Public Notification Handbook” (US EPA, 2002a).

5.1 How to Decide What Type of Public Notification is Appropriate

This section describes the decision process for implementing public notifications in the overall context of threat management. Figure 5-4 illustrates an example decision process for public notification.

The decision process begins with an evaluation of threat credibility and the potential consequences to public health to determine if public notification is an appropriate response action. The first decision point in Figure 5-4 considers the operational response actions taken at the ‘possible’ stage (described in Section 4 of this module) and evaluates whether or not these actions are adequate to protect public health. If they are, then it may not be necessary to consider public notification. For example, if the suspect water has been confined to a tank, with some degree of confidence that the water has not spread beyond the tank, containment may provide adequate public health protection. However, if the operational response actions are determined to be insufficient to prevent or limit exposure, then public notification should be considered. Any decisions to issue public notification should be made in consultation with decision officials from the appropriate regulatory agency, such as the drinking water primacy agency and/or health department. (These agencies should have been identified in the Public Health Response Plan as well as the water utility’s ERP.)

Arrangements need to be made with these organizations prior to an incident in order to establish clear lines of communication, develop templates for notification, and ensure access to decision officials on a 24/7 basis.

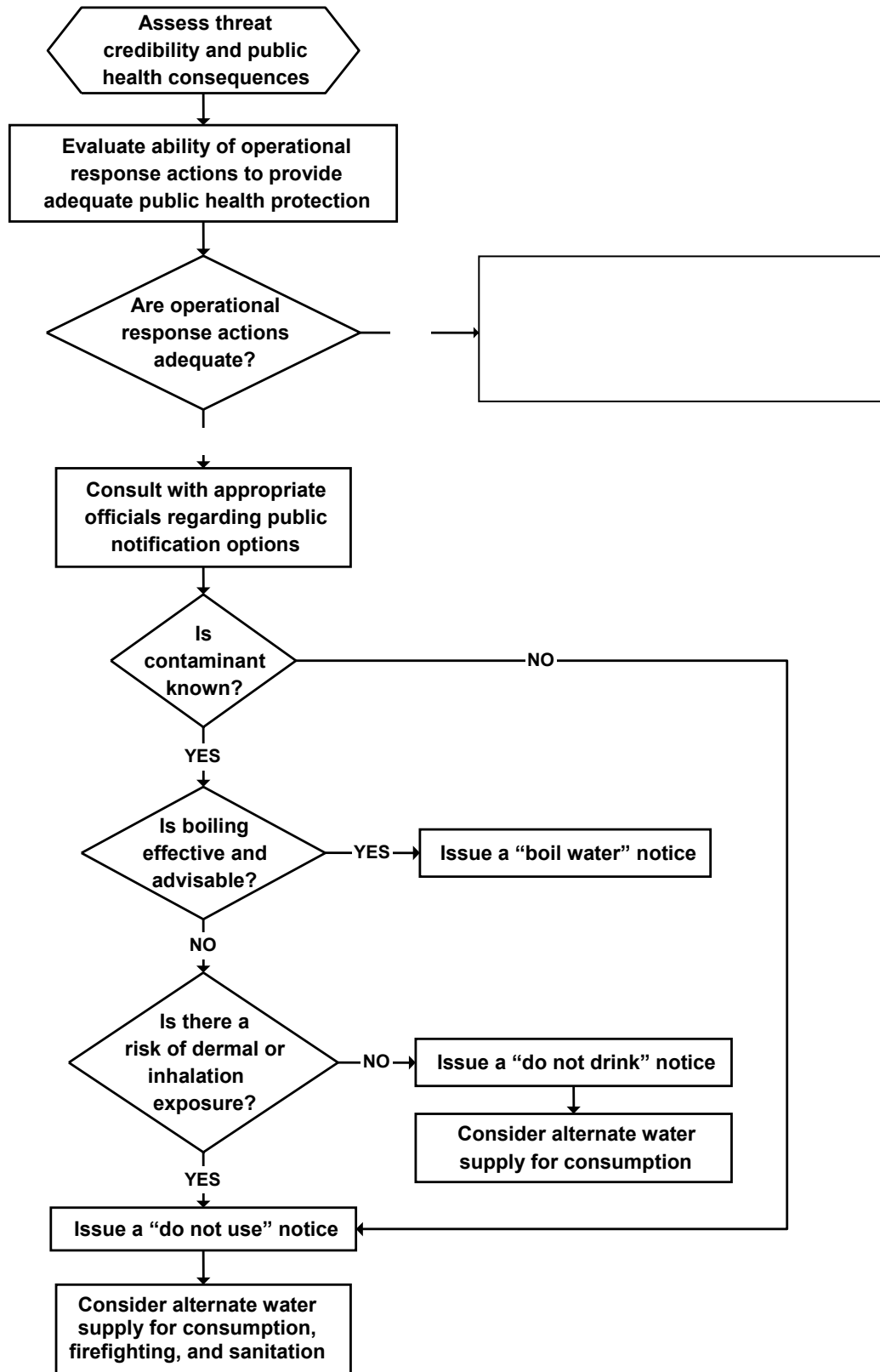


Figure 5-4. Example Decision Process for Public Notification

For a Tier 1 notification under the PN Rule, which is required for situations with significant potential to have serious adverse effects on human health as a result of short-term exposure, the utility must:

- 1) Provide a public notice as soon as practical, but no later than 24 hours after the system learns of the violation (or credible contamination threat);
- 2) Initiate consultation with the primacy agency as soon as practical, but no later than 24 hours after the public water system learns of the situation, to determine additional public notice requirements; and
- 3) Comply with any additional public notification requirements (including any repeat notices or direction on the duration of the posted notices) that are established as a result of the consultation with the primacy agency. Such requirements may include the timing, form, manner, frequency, and content of repeat notices (if any) and other actions designed to reach all persons served.

Once a decision has been made to consider public notification as a means of limiting exposure, it is necessary to evaluate the level of notification appropriate for the incident (i.e., the level of restrictions on water use that are necessary to protect the public). As indicated at the second decision point in Figure 5-4, any available information about the suspected contaminant will support the evaluation of notification options. If the identity of the contaminant is unknown, it may be necessary to adopt a conservative approach and issue a “do not use” notice, which will limit the potential for exposure via any route (but will also create the greatest burden on the community). If the identity of the contaminant is known with a sufficient degree of confidence as a result of the threat evaluation, then the public notification may be crafted to deal with the specific risks to public health posed by the contaminant (discussed in Section 3 of this module). For example, if boiling will easily destroy the contaminant without creating additional hazards through aerosolization, then issuance of a “boil water” notice may be preferred. If boiling is not an option, but the contaminant does not pose a risk through inhalation or dermal exposure pathways, issuance of a “do not drink” notice may be appropriate. A “do not drink” notice should restrict all use of the water in which ingestion is possible (i.e., the water should not be directly consumed or used in food preparation). Finally, if there is a risk to public health through inhalation or dermal exposure, or if the risk of exposure via these pathways is unknown, then a “do not use” notice should be considered. By considering these notifications in a progression from the least to greatest burden on a community, the impact on the public should be minimized while still making public health protection the priority consideration.

Figure 5-4 indicates that if the public is asked not to drink or use the water, then the response should also consider provisions for an alternate drinking water supply. If the restriction is only on consumption, then the suspect water can still be used for all other activities that do not involve ingestion of the water (e.g., flushing toilets), and it will only be necessary to provide an alternate drinking water supply for consumption and related activities such as food preparation. A “do not use” notice is much more restrictive, and decision-makers should consider how other needs of the community, such as sanitation and firefighting, will be met. The planning and preparation for short-term provision of water that may be necessary if restrictions are placed on drinking water usage are described in Section 6 of this module.

5.2 Target Audience

For notification under the PN Rule, the utility must provide public notice to persons served by the water system and to the owner or operator of any consecutive systems. Persons served by the water system include renters and transient populations in addition to billed customers. If the utility has a credible contamination threat or incident in a portion of the distribution system that is physically or hydraulically isolated from other parts of the distribution system, the primacy agency may allow the system to limit distribution of the public notice to only persons served by the portion of the system that is out of compliance. Permission by the primacy agency for limiting distribution of the notice must be granted in writing. The utility should also consider notifying mobile users of the water supply, such as airplanes or cruise ships that may have filled up with water from the area during the contamination event and traveled away from the area prior to notification.

In addition, when the water utility is identifying the list of entities to be notified during a water contamination threat or incident, customers with special needs should be considered. The water utility should maintain a list of customers with special needs as part of its ERP. Some of these users should be given priority notification due to their public health mission and/or because they may serve customers considered to be ‘sensitive subpopulations’ (e.g., children or the elderly). Specific notification procedures should be developed for these entities and those with special communication needs (see Section 5.3.3 of this Module for information regarding procedures for customers with special communication needs). These lists and procedures should be coordinated with the local public health department and the local health officer. The following list includes some customers with special needs served by the water system that may require immediate notification. Using this list as a guide, each utility should develop, during planning, its own list of specific customers with special needs:

- Critical care facilities
 - Hospitals
 - Clinics
 - Nursing homes
 - Dialysis centers
- Schools
- Day care facilities
- Businesses
 - Food and beverage manufacturers
 - Commercial ice manufacturers
 - Restaurants
 - Agricultural operations
 - Power generation facilities
 - Any other businesses identified by the water utility.

5.3 Content and Format of the Public Notification

Once the decision has been made to issue public notification as a public health response, the details of the instructions and information to be provided to the public need to be crafted. The general content and format for various public notices should be developed as part of planning – not during a crisis. These general templates can then be quickly customized according to the details of a specific situation. The water utility should work with appropriate public health officials to determine the

specific information and instructions to communicate in the notice as well as the format and means of dissemination.

5.3.1 Content

For notification required under the PN Rule, the utility must send a copy of the notice to the primacy agency.

The PN Rule requires that the following elements be included in a public notice:

- A description of the incident, including a description of the contaminant(s) and information regarding how the contaminant(s) entered the water (if this information can be shared).
- When the incident occurred.
- Potential adverse health effects.
- Population(s) at risk.
- Whether alternate water supplies should be used. If alternate water supplies should be used, the utility should consider listing the locations at which these alternate supplies are being provided.
- Actions consumers should take (e.g., do not use, do not drink, conserve water). **NOTE:** When issuing a boil water notice, the notice should include specific instructions for boiling the water (e.g., how long the water should be boiled) because of differences in the effect that boiling has on various potential contaminants as well as differences in recommended boiling times based on altitude. It is critical to confer with the drinking water primacy agency and health department prior to issuing a boil water notice to determine the appropriate instructions. Whenever possible, a standard (and conservative yet reasonable) boiling time should be adopted as a part of planning to reduce any confusion during an actual water contamination incident or threat.
- When consumers should seek medical help, if known (e.g., “If you have been exposed and are experiencing severe flu-like symptoms, call 911; if symptoms are mild contact your physician for assistance.”)
- Actions that are being taken to correct the situation. The utility should consider including information about how the utility, public health agencies, and law enforcement agencies are responding and if and why protection measures have a limited effectiveness.
- The expected duration of the emergency.
- Name, business address, and phone number for additional information.
- Standard language encouraging distribution to all persons served, where applicable.
- Information in the appropriate language if there is a large proportion of non-English speaking persons.

Other information that may be beneficial to include in a public notice, but is not required, includes:

- Geographical extent of the affected area.
 - Where the problem is.
 - Where the problem is NOT.
- Information regarding rehabilitation and recovery efforts.

- Notice that the water utility will keep the public informed through selected mechanisms. (The means by which information will be delivered to consumers should be identified.)

In addition to the above items, public notifications should also consider other potential consumer questions and concerns (e.g., can I water my plants, fill the aquarium, give it to my pets, etc.). Rather than on a printed notification, this information may be disseminated through a consumer hotline set up to answer these types of questions.

For more information regarding risk communication, see US EPA's Risk Communication in Action Case Studies from its Environmental Monitoring for Public Access and Community Tracking (EMPACT) Program (US EPA, 2002b) and CDC's videotape titled "Risk Communication and Bioterrorism" (CDC, 2001b).]

5.3.2 Format

The PN Rule under the SDWA requires that all public notices meet certain standards. These requirements help prevent the notice from being buried in a newspaper and help ensure that consumers can easily read and understand the notice. For notification under the PN Rule, notices must:

- Be displayed in a conspicuous way when printed or posted.
- Not contain overly technical language or very small print.
- Not be formatted in a way that defeats the purpose of the notice.
- Not contain language that nullifies the purpose of the notice.

The drinking water primacy agency may have special formatting requirements. Therefore, the water utility should check with the primacy agency to ensure that all notification format requirements are met.

Suggestions for effective notifications are identified below:

- Assume that consumers only read the top half of the notice (or what can be read in ten seconds). The most important information, especially instructions to protect consumers' health, should be placed on the top half of the notice in large print. Smaller type is appropriate for the less critical elements.
- Try to limit the wordiness of the notice. A question and answer format is easy to read and guides readers to the information that is likely to concern them. Bullets and bold text are also effective.
- Highlight the name of the water utility, especially where people in the area are served by more than one water system. The water utility may also want to prepare a map showing the area served, especially if it extends beyond city limits. The water utility may want to print the notices on its letterhead which, coupled with the title of the notice, will make people immediately recognize the importance of the notice.

Example "boil water," "do not drink," and "do not use" notices are provided in Appendices 9.3.1, 9.3.2, and 9.3.3. An example notice for an unknown contaminant is provided in Appendix 9.3.4. For more guidance on the preparation of notices refer to the "Public Notification Handbook" (US EPA, 2002a).

5.3.3 Notifications for Special Populations

The notification procedures should address the needs of special populations (within the water utility's service area) including but not limited to people with disabilities (e.g., sight, hearing impairment, etc.), non-English speaking residents, individuals who can't read or with low levels of literacy, students, migrant workers, homeless populations, and persons visiting public facilities (e.g., shelters, train stations, playgrounds, parks, etc.). In developing the procedures, the water utility should consider the means by which these population groups and communities access information.

Water utilities should identify ways to target visually and hearing impaired populations and meet their needs. Community centers or targeted word-of-mouth may be useful. Other suggestions can be found in US EPA's "Public Notification Handbook" (US EPA, 2002a).

For notification under the PN Rule, if a large proportion of the population served by the water utility does not speak English, then the water utility must provide at least partially multi-lingual notices. If translations are needed, the water utility notification must, at a minimum, contain information in the appropriate language(s) regarding the importance of the notice, or it must provide a phone number or address where a translated notice or assistance in the appropriate language is available. The drinking water primacy agency for the water utility may have established criteria for what constitutes a large proportion of the people served. If the drinking water primacy agency, or local government, does not determine what constitutes a large proportion of non-English speaking consumers, it may be up to the water utility to make this determination. The water utility should rely on its knowledge of its consumer base or contacts with community representatives. As a guideline in making this determination, some States have used a threshold of ten percent of the population or 1,000 people, whichever is less, for providing multi-lingual information in Consumer Confidence Reports (CCRs).

There are many ways to notify non-English speaking consumers; however, the water utility should establish its own methods and keep them as simple as possible. One way to reach non-English speaking consumers is to establish contacts with local foreign newspapers, foreign television and radio stations, and institutions and people who can translate notices into other languages (e.g., community centers and universities). Targeted word-of-mouth via religious organizations, community leaders, and activist groups is also an effective way to get the notice to non-English speaking consumers, especially if there are no television or radio stations or newspapers in those languages. Posting notices in grocery stores, laundromats, community centers, and other public facilities is also an effective way to get the notice to both non-English speaking populations and other special populations, including migrant workers, homeless populations, and persons visiting public facilities.

Water utilities should remember that some of their customers might have a low reading ability. In this situation, it is important that notices do not contain overly technical or confusing language. For example, a brochure written at an elementary school reading level will need simple explanations of technical information when addressing the general public or a more targeted audience that may have little or no knowledge about the subject matter. Water utility staff responsible for responding to questions about the notice should keep in mind that it might be necessary to read or explain the entire notice to a caller.

5.3.4 Data Visualization and Interpretation Tools

It is possible to use data visualization tools such as icons, maps, graphs, or other visual tools in place of language to convey risk information in public notifications. These visual tools are useful because they tend to transcend cultural boundaries and differing educational levels more easily than language does. For example, a running faucet with a large X over it conveys the message of do not use the water. Thus, more people may understand your message through data visualization than through text. However, use of these tools should be carefully considered because some information may be too complex to present without any language. It may be helpful to use an icon as a background picture in a written notice.

5.4 *Methods to Deliver the Public Notification*

For a Tier 1 notification under the PN Rule, the water utility must provide notice within 24 hours in a form and manner reasonably calculated to reach all persons served. The form and manner used by the utility are to fit the specific situation, but must be designed to reach residential, transient, and non-transient users of the water system. In order to reach all persons served, water systems are to use, at a minimum, one or more of the following forms of delivery: 1) Appropriate broadcast media (such as radio and television); 2) Posting of the notice in conspicuous locations throughout the area served by the water system; 3) Hand delivery of the notice to persons served by the water system; or 4) Another delivery method approved in writing by the primacy agency. Preferably, the approval of any additional methods of delivery should be done during public health response planning, so the utility is prepared when an actual contamination threat or incident occurs. Examples of other delivery methods include:

- Government access channels
- Web site (local government and others)
- Listserve e-mail
- Newspaper
- Phone banks
- Broadcast phone messages (“reverse 911” messaging)*
- Broadcast faxes
- Mass distribution through community centers (e.g., religious centers, shopping malls, restaurants)
- Door-to-door canvassing
- Town hall meetings
- Regular or special partner conference calls
- Another method approved by the primacy agency in advance or during consultation.

** Note that “reverse 911” messaging may only be effective if the accuracy of the phone numbers in the database are frequently verified.*

The water utility should be sure that all people associated with the response and/or impacted by the event understand the importance of notifying others who may travel through the contaminated area of the distribution system. For instance, people who patronize restaurants or work in office buildings in the distribution area but live elsewhere may not be aware of the water contamination incident unless steps are taken specifically to notify them. For notification under the PN Rule, the utility must

include the following language in its notice: “Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.”

Issues to consider include the population served, population density (i.e., whether the area is rural, urban, or suburban), available assistance, and proximity to and relationship with radio and television stations and newspapers. The methods chosen should reach all persons served by the water system, including residents, employees, and travelers. Also, during a water contamination incident, the area may also experience loss of power, which may affect television communications and potentially newspaper and telephone communications. The water utility should plan alternate delivery methods for such situations.

Any public notification issued should be coordinated with ICS and the Joint Information Center. At the same time, emergency notification of the public and affected businesses needs to be accomplished rapidly and should involve all possible media to be sure of the widest possible distribution. Local radio and television stations as well as web sites should be given the first consideration because of the rapidity with which news can be disseminated by these media. Local newspapers should receive news releases at the same time they are provided to the radio and television facilities; however, actual time of publication of the items will depend on the newspaper’s deadline. Notices posted on bulletin boards and the use of sound trucks may provide information quickly to those persons not immediately exposed to other media. Direct notification to customers with special needs (e.g., schools, hospitals, nursing homes, etc.) should be considered. (Customers with special needs are discussed in Section 5.2 of this module.) Recordings describing much of the available up-to-date information may be used on the water utility’s telephone system.

In communicating with the media, considerations should be given to establishing protocols for both field and office staff to respectfully defer questions to the personnel identified in the utility’s ERP or designated by the Incident Commander. It is essential that the water utility identify **ONE information officer** to interface with the media and disseminate public information. Once public health response actions beyond containment are implemented, public health officials may take responsibility for communication with the media. The severity of the emergency may result in the Governor’s office taking the lead for communication. The decision on who to assign as spokespersons and whether and when to change spokespersons will be up to the Incident Commander in consultation with State and Federal representatives. Regardless of the agency responsible for incident command, the drinking water utility and public health officials will need to be involved to ensure the accuracy of information being transmitted. Therefore, it is a good idea for the water utility to have a plan in place because they may be called upon to support the *lead agency* in crafting a message for the public. The water utility should be prepared by organizing basic facts about the crisis and its water system; developing key messages to use with the media that are clear, brief, and accurate; and making sure the messages are carefully planned and have been coordinated with local and State officials. Specific details on communicating with the media can be found in Chapter 4 of US EPA’s “Public Notification Handbook” (US EPA, 2002a).

Boiler plate news releases aimed at addressing various anticipated events should be prepared in advance to ensure their rapid distribution when a contamination threat or incident occurs. The list of

persons pre-authorized to prepare and release such news items should be layered to ensure that at least one person will always be available and have the authority to issue prompt publication. Preparation of typical press releases as part of planning can save precious hours during an actual emergency and possibly prevent serious health problems resulting from exposure through use of contaminated water. The water utility should explain to the newspaper or station what information it is trying to communicate and why. When a water utility sends a notice to radio and television stations and newspapers, they should write “PRESS RELEASE FOR PUBLIC SAFETY” at the top of the notice to emphasize its importance. Utilities can also have inactive web sites prepared with various informational bulletins that can be quickly activated at the time of an emergency.

The actual delivery of the public notification does not need to be the sole responsibility of the water utility; it can be a coordinated effort with the public health agency, law enforcement, and other agencies. The responsibilities for the delivery of public notification should be identified during public health response planning (discussed in Section 2.1.1 of this module).

6 Short-term Alternate Domestic Water Supply

If the public is asked not to drink or use the water, then provisions for an alternate drinking water supply should be considered. If the water use restrictions are implemented in response to a ‘credible’ contamination threat, the alternate water supply may be needed only on a short-term basis while efforts are taken to ‘confirm’ whether or not an incident has occurred. If the restriction is only on consumption (i.e., “do not drink”), then the suspect water can still be used for all other activities that do not involve ingestion of the water. In this situation, it will only be necessary to provide an alternate drinking water supply for consumption and related activities such as food preparation. A “do not use” notice is much more restrictive and may adversely impact public sanitation. Because water use restrictions will generally be of short duration while steps are taken to confirm the incident and identify the contaminant, they should not significantly impact firefighting. Strategies for short-term provision of an alternate water supply are presented in this section. Such strategies may be different from those used for a long-term alternate water supply that may be necessary during remediation and recovery (see Module 6, Section 5).

6.1 Alternate Supply for Consumer Use

The water utility will need to identify options for the provision of an alternate water supply for consumer use during public health response planning. To the greatest degree possible, plans for the provision of an alternate water supply should not rely on Federal and/or State support. During the planning stage, the utility and public health departments should:

- Identify agencies, companies, contractors, surrounding communities, and related utilities that could assist in providing alternate water supplies in the event of a water contamination incident.
- Establish *mutual aid agreements* with companies, contractors, surrounding communities, and related utilities, as appropriate.
- Maintain phone numbers for points of contact for entities that could assist in providing alternate water supplies.
- Advise consumers to maintain an emergency supply of water such as bottled water.
- Identify optimal locations for parking water tankers and distributing bottled water. Having a well-thought out plan regarding optimal locations for positioning these water supplies could greatly benefit the community.
- Identify ways to use only uncontaminated water sources if multiple contributing water sources are available.

Possible alternate water supply options, as previously listed in Table 5-2, include (but are not limited to) the following:

Table 5-6. Options for Short-term Alternate Supplies of Drinking Water

Type	Source
Bottled water	Local government agencies
	Local retailers
Bulk water	Certified water haulers
	Military assets (i.e., National Guard)
	Neighboring water utilities
Utility treated	Uncontaminated source water
	Uncontaminated water stored in the distribution system

The following is a list of entities that the utility and public health departments should consider contacting to assist in providing alternate water supplies in the event of a water contamination incident.

- Local businesses such as dairies, well drillers, or distributors may have tank trucks that can be made suitable for carrying water.
- Some companies may have equipment such as chlorinators or generators that can be used for emergency disinfection.
- Irrigation supply companies may have pipe that can be used to extend water supply lines.
- Other water utilities in the area may have spare parts (valves, pumps, pipe) available for use in an emergency and may be able to supply personnel to assist during emergencies.
- Bottle manufacturers may be able to provide milk jugs, cubitainers, and other types of plastic bottles that can be used to transport the water to the affected community. Providing bottles would avoid the potential public health problems associated with the public using contaminated containers to collect and haul drinking water from distribution sites.
- Hospitals and universities may maintain backup water supplies for consumption.
- Farms may maintain water supplies for livestock and agriculture.
- Local industries may maintain backup water supplies for industrial processes.
- Some local citizens and businesses may have well water sources that can be utilized.
- Local authorities may permit the utility to pump and treat an available surface water source.

Some of the sources listed above may not necessarily be connected to the public water system or may not be connectable due to regulatory restraints. The inclusion of a potential source of backup water in this list should not be interpreted as permission to use them.

6.1.1 Who Provides the Alternate Water

The water utility and local authorities may or may not have the resources to provide an alternate short-term water supply. In the event that resources are not adequate, the water utility may call upon State and Federal authorities for assistance. The USACE is authorized to provide clean drinking water to communities in cases where the existing drinking water supply is compromised or otherwise unavailable. FEMA, under the Disaster Relief Act Amendments of 1974, will provide various services including relief efforts during an emergency. Other Federal agencies such as US EPA may also provide assistance. Additional detail regarding responsibility of Federal agencies for the distribution of drinking water during an emergency is presented in Module 1, Appendix 6.2.

6.1.2 Potential Household Sources of Emergency Water Supply

In conjunction with providing an alternate water supply, the water utility should consider a public awareness program providing guidance to consumers on finding alternate water supply sources around the home, purifying water, and maintaining an emergency supply of water. This information could be included in pamphlet form along with the utility bill or with the CCR. Table 5-7, 5-8, and 5-9 contain information from FEMA that could be provided to the public **after** the decision has been made regarding the type of notice to post (FEMA, 2003c). This information can be provided to aid the public in meeting the restrictions of any “boil water,” “do not drink,” or “do not use” notices. Any notice to the public should include only the options listed in the following tables that are appropriate for the particular situation. For example, most of the purification techniques are only appropriate for biological contamination and would not be provided to consumers in the case of chemical or radiological contamination.

Table 5-7. Alternate Water Sources in the Home

<p><i>Any of the listed sources may contain contaminated water if filled in the timeframe of the contamination incident.</i></p> <ul style="list-style-type: none"> • Ice cubes • Chilled water stored in the refrigerator • Hot water tank – Turn off the power and let the tank cool. Place a container underneath and open the drain valve at the bottom of the tank. Do not turn the tank on again until water services are restored. • Toilet tank – The water in the tank (not the bowl) is safe to drink unless chemical treatments have been added to the tank water, such as drop-in cleaners. • Water pipes – Release air pressure into the plumbing system by turning on the highest faucet in the house; then drain the water from the lowest faucet. • Rain water, spring water, and water from streams, ponds, rivers, lakes, and garden hoses – Purify these water sources before use. <p>Caution: Avoid water from waterbeds as a source for drinking water. Pesticidal chemicals are in the plastic casing of the bed and chemicals have probably been added to the water to prevent the growth of algae, fungi, and bacteria. The water is safe only for hand washing and laundering.</p>
--

Table 5-8. Public Guidance on Water Purification

- **Water that local officials report has been contaminated with toxic chemicals or radioactive materials should not be purified using home decontamination methods.** Although some home decontamination methods may be able to remove toxic chemicals or radioactive material, they should not be relied upon as the sole means of decontamination because it may not be possible to determine the effectiveness of these devices (i.e., adsorptive material that might remove chemicals could have been saturated during previous use and may not remove the contaminant of immediate concern).
- **Straining.** Water containing sediment or floating material should be strained through a cloth or paper filter as the first step in the purification process. Some cloth and paper filters work better than others; practice is required to use this technique to remove sediment and floating material.
- **Boiling.** (See Section 5.4.1).
- **Chemical sterilization (chlorine bleach).** In some situations, boiling may not be an option. The alternative is to treat the water chemically. Plain household chlorine bleach may be used. Be sure the label states that hypochlorite is the only active ingredient. Bleaches containing soap or fragrances are not acceptable. With an eyedropper, add 8 drops of bleach per gallon of water (16 drops if the water is cloudy), stir, and let stand. After 30 minutes, the water should taste and smell of chlorine. At this point, it can be used. If the taste and smell (and appearance in the case of cloudy water) has not changed, add another dose and let stand. If after one half hour the water does not have a chlorine smell, do not use it. Chlorine bleach has a finite shelf life and tends to lose its effectiveness over time. This may require that larger quantities be used than the ones specified. It is advisable to check the expiration date and to periodically refresh your supply.
- **Chemical sterilization (iodine).** Disinfection with iodine is an alternative method of water treatment when it is not feasible to boil water. Two well-tested methods for disinfection with iodine are the use of tincture of iodine and tetraglycine hydroperiodide tablets (e.g., Globaline, Potable-Aqua, or Coghlan's). Tincture of iodine (2%) can commonly be found in medicine chests or first-aid kits. The recommended doses are 5 drops for clear water or 10 drops for cloudy water. Water should then stand for a minimum of 30 minutes before it is safe to use. Very turbid or cold water can require prolonged contact time; if possible, such water should be allowed to stand several hours before use. To ensure that *Cryptosporidium* is killed, water would need to stand for 15 hours before drinking. The tetraglycine hydroperiodide tablets are available from pharmacies and sporting goods stores. Users should follow the manufacturers' instructions. If water is cloudy, the number of tablets used should be doubled; if water is extremely cold (<5 °C; <41 °F), an attempt should be made to warm the water, and the recommended contact time should be increased to achieve reliable disinfection.
- **Filtration devices**, such as those used for camping and backpacking, may also be used to purify water from natural sources (e.g., lakes and streams) provided that these devices are rated as "purification systems," which means they can remove viruses.

Caution: Any water that is obtained from sources outside the home or water that does not appear clear should be sterilized. Non-sterilized water may be contaminated with various harmful microorganisms.

Table 5-9. Public Guidance on Water Storage

- Store the water in a clean and sanitary glass or plastic container. Opaque plastic containers are good because they are lightweight, sturdy, and limit the entry of light, which can shorten the shelf life of the water. Metal containers should be considered as a last resort because they may corrode and give water an unpleasant taste.
Caution: Do not use pesticide containers to store water.
- Store 1 to 2 gallons per person per day for drinking and 1 to 2 gallons per person per day for basic sanitation (e.g., brushing teeth and washing hands). Consumers with infants and young children, nursing mothers, and people who are ill will want to store additional water.
- Store containers in a cool, dry place away from direct sunlight.
- Store plastic container away from heat and light to prevent leakage.
- Store water in plastic containers away from gasoline, kerosene, pesticides or similar substances because vapors from these products can penetrate plastic and contaminate the water.
- Make sure the shelf or storage area is strong enough to support the weight of the water (over 8 pounds per gallon).
- Replace stored water every six months to maintain quality. For commercially bottled distilled or drinking water, check the label for an expiration date. If none is given, the shelf life of commercially bottled water is unknown and a conservative six-month replacement practice should be followed.
- Water can also be stored in a freezer. In the case of a power outage, the frozen water provides the added benefit of keeping foods frozen until power is restored. Leave 2 to 3 inches of air space in the top of containers before freezing to prevent the container from bursting as water expands during freezing. Some thin-walled glass containers may break regardless of the air space provided. Water stored in the freezer should be replaced periodically to avoid its accumulation of tastes and odors from the food stored with the ice.
- If you are on a municipal water supply, the water you are currently using for drinking and cooking should also be suitable for storing for emergencies. While you can expect that water from a public water supply will be safe, remember that the container used to collect and store the water should also be clean in order to maintain the quality of the stored water.

6.2 Alternate Supply for Firefighting Needs

A “do not use” notice will have implications with respect to water used for firefighting. Because firefighting does not generally involve direct contact with the water, it may be possible to use the contaminated water for this purpose; however, certain contaminants may pose a hazard even during firefighting activities. For instance, if a disinfection resistant pathogen that poses a health risk via inhalation were suspected as the contaminant, use of the water for firefighting could expose firefighters and the public to aerosol release and possible inhalation or dermal exposure to these harmful microorganisms. Thus, in this case, it may be necessary to identify an alternate supply of water for firefighting.

In deciding whether or not to permit use of the contaminated water for the purpose of firefighting, the decision officials (i.e., public health, utility, fire chief, local government, etc.) will need to consider the following:

- Whether the contaminant will be spread by use of the water during firefighting.
- Whether the contaminant will pose a greater or more adverse/severe threat than the threat posed by lack of water for firefighting.
- Whether the contaminant will pose a threat to firefighters.
- Whether the contaminant will have an adverse environmental impact if used for firefighting.

If public health officials determine that the contaminant does not pose an inhalation or dermal exposure threat, the Incident Commander, in conjunction with local officials, may choose to permit use of the water for fire protection. However, if a readily available alternate supply of water for firefighting does exist, it may be preferable to use this source in any case in order to eliminate any possibility of exposure via firefighting as well as to allay public concern. Note that firefighters may wear protective suits and/or respirators that may provide some level of protection from some contaminants. In any event, the fire chief should always be involved in deciding whether or not to use contaminated water.

If the contaminant is determined to pose a significant risk during firefighting, an alternate source of water for firefighting would need to be secured. As part of public health response planning and emergency response preparations, water utilities should make agreements with surrounding communities to utilize their water sources for firefighting purposes. During an emergency, pumper trucks could be filled at the community water source and kept at the fire department for firefighting purposes. State offices of emergency services may assist with the acquisition of bulk water trucks from unaffected areas within the State for firefighting purposes. Planning with these State offices is critical to determine the types of resources available and the procedures to acquire them. Federal agencies such as the USACE, FEMA, and the US Forest Service may be able to provide firefighting equipment and water for firefighting purposes. Under the NRP Emergency Support Function (ESF) #4, Firefighting Annex, the US Forest Service serves as the primary agency for firefighting support. Responsibilities under ESF #4 include detection and suppression of wildland, rural, and urban fires resulting from, or occurring coincidentally with, a major disaster or emergency requiring Federal response assistance. ESF #4 manages and coordinates fire-fighting activities, including the detection and suppression of fires on Federal lands, and provides personnel, equipment, and supplies in support of State and local agencies involved in rural and urban firefighting operations (FEMA, 2003b).

The reality is that it may take some time to mobilize alternate water supplies for firefighting; therefore, in that short time period, the contaminated water may need to be used for the purpose of firefighting.

7 Returning to Normal Operation and Use

Following the issuance of a public notification in response to a credible contamination threat or confirmed incident, it will be necessary to notify the public once the situation has been resolved and the appropriate officials have determined that it is safe to resume normal use of the public drinking water supply. The same communication methods discussed in Section 5.4 of this module (e.g., posting or hand-delivery of public notices, broadcast media, web sites, etc.) for notifying the public of use restrictions can be used to efficiently inform the public that normal use of the water can be resumed. In addition, it will be necessary to demobilize any alternate water supplies that have been implemented. The following two examples illustrate when this type of situation might occur:

Example #1: A “do not use” notice was issued in response to a ‘credible’ contamination threat to the drinking water supply. The following day, results from laboratory analysis of samples collected throughout the distribution system became available. The Incident Commander, along with officials from the utility, public health department, and drinking water primacy agency reviewed this data, along with additional new information, and concluded that the water had **not** been contaminated. The public was notified, through a variety of vehicles such as broadcast media, that it was safe to resume normal use of the water. A press conference was held that evening to provide more detailed information regarding the steps that were taken to ensure that the water was safe and to explain the rationale for issuing the “do not use” notice to begin with.

Example #2: A “do not drink” notice was issued to consumers of the entire distribution system in conjunction with implementation of a containment strategy in response to a ‘credible’ contamination threat. The distribution system was extensively sampled both within and outside of the contained area. Twenty-four hours later, analytical results were available that identified trace amounts of a contaminant within the contained area of the system, while all results from the rest of the system were below the detection limit for the same contaminant. Based on this information, the Incident Commander, in conjunction with officials from other organizations, determined that the containment strategy was successful. The public was notified through the use of broadcast media that they could resume normal use of the water outside of the contained area. Since there were only a few dozen residents, and no businesses, within the contained area, each resident was directly contacted and instructed to continue use of only bottled water for drinking and cooking. During a press conference that evening, officials provided more detail regarding the contaminant, the steps taken to isolate the contaminated water, and ongoing sampling throughout the system to verify that the contaminant had not spread beyond the contained area.

Returning to normal operations after treatment and rehabilitation of a contaminated water supply is addressed in Module 6, Sections 5.5 and 7.3.3.

8 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 upcoming CD version of this module, although readers should consult the referenced URL for the latest version.

AdvanticaStoner. 2003. "SynerGEE Water"

http://www.advantica.biz/stoner_software/synergee_water/

AWWA. 2002. Protecting Our Water: Drinking Water Security in America After 9/11. Denver, CO.

ATSDR. 2004. "Home" <http://www.atsdr.cdc.gov>

ATSDR. 1997a. "ToxFAQs™ for Cyanide" <http://www.atsdr.cdc.gov/tfacts8.html>

ATSDR. 1997b. "Toxicological Profile for Ethylene Glycol and Propylene Glycol"

<http://www.atsdr.cdc.gov/toxprofiles/tp96.html>

CDC. 2004. "Emergency Preparedness and Response" <http://www.bt.cdc.gov>

CDC. 2001a. The Public Health Response to Biological and Chemical Terrorism: Interim Planning Guidance for State Public Health Officials. Atlanta, GA.

<http://www.bt.cdc.gov/Documents/Planning/PlanningGuidance.pdf>

CDC. 2001b. "Risk Communication and Bioterrorism"

<http://www.phppo.cdc.gov/PHTN/1206FactSheet.pdf>

CDC. 2001c. "Registry of Toxic Effects of Chemical Substances (RTECS)"

<http://www.cdc.gov/niosh/rtecs.html>

FEMA. 2003a. "Emergency Personnel" http://www.fema.gov/tabs_emergency.shtm

FEMA. 2003b. "Federal Response Plan" <http://www.fema.gov/rrr/frp>

FEMA. 2003c. "Locating Safe Drinking Water" <http://www.fema.gov/rrr/waterf.shtm>

FEMA. 2003d. "Mobile Operations Capability Guide for Emergency Managers and Planners"

<http://www.fema.gov/rrr/mers01.shtm>

Haestad Methods. 2004. "WaterCAD™" <http://www.haestad.com/water/default.asp>

KYpipe. "PIPE2000" <http://www.kypipe.com>

Meinhardt, Patricia L. MD, MPH, MA. 2002. “Recognizing Waterborne Disease and the Health Effects of Water Pollution: A Physician On-line Reference Guide.”

<http://www.waterhealthconnection.org>

Meinhardt, Patricia L. MD, MPH, MA. 2002. “Physician Preparedness for Acts of Water Terrorism.” <http://www.waterhealthconnection.org/bt/index.asp>

USAMRIID. 2001. “Medical Management of Biological Casualties Handbook Fourth Edition”

<http://www.usamriid.army.mil/education/bluebook.html>.

MWH Soft, Inc. 2004. “H₂ONET” http://www.mpact.com/page/p_product/net/net_overview.htm

Science Applications International Corporation. 2003. “PipelineNet” <http://eh2o.saic.com/iwqss/>

US DHS. 2004. “National Response Plan, Draft #1”

US DOE. 2003. “Risk Assessment Information System” <http://risk.lsd.ornl.gov/index.shtml>

US EPA. In prep. Water Contaminant Information Tool. Office of Water.

US EPA. 2004. “List of Drinking Water Contaminants & MCLs”

<http://www.epa.gov/safewater/mcl.html#mcls>

US EPA. 2004a. Small and Medium Water System Emergency Response Plan Guidance to Assist Community Water Systems in Complying with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002. EPA/816/R-04/002. Office of Water.

US EPA. 2003. Large Water System Emergency Response Plan Outline: Guidance to Assist Community Water Systems in Complying with the Public Health Security and Bioterrorism Preparedness and Response Act of 2002. Office of Water.

US EPA. 2002a. Public Notification Handbook. EPA/816/R-00/010. Washington DC.

<http://www.epa.gov/safewater/pws/pn/handbook.pdf>

US EPA. 2002b. Risk Communication in Action: Environmental Case Studies. EPA/625/R-02/011.

Cincinnati, OH. <http://www.epa.gov/ordntrnt/ORD/NRMRL/Pubs/625R02011/625R02011.html>

WHO. 2003a. “Search” <http://www.who.int/search/en/>.

WHO. 2003b. “Public health response to biological and chemical weapons: WHO Guidance, 2nd edition (Draft, May 2003)” <http://www.who.int/csr/delibepidemics/biochemguide/en/index.html>

9 Appendices

9.1 Contaminant Characterization and Transport Worksheet

INSTRUCTIONS

*The purpose of this worksheet is to help organize information that will lead to the identification of the contaminant to facilitate decisions on appropriate operational responses and provide more accurate information for public communication/notification. Contaminant identification will most likely first be a presumptive identification followed by more lengthy procedures to verify the identity of the contaminant. While validated analytical results are typically the most reliable means of contaminant identification, other information collected during the **threat evaluation** and **site characterization** may provide valuable insight regarding the identity of the contaminant.*

SITE CHARACTERIZATION/THREAT EVALUATION SUMMARY

Describe the contaminant's odor, if applicable. _____

Describe the *reported* taste of the contaminant, if applicable. _____

Caution: Do NOT taste the water.

What was the physical form of the contaminant?

- | | | |
|--------------------------------------|---------------------------------|-----------------------------------|
| <input type="checkbox"/> Solid | <input type="checkbox"/> Liquid | <input type="checkbox"/> Gas |
| <input type="checkbox"/> Slurry | <input type="checkbox"/> Powder | <input type="checkbox"/> Granules |
| <input type="checkbox"/> Other _____ | | |

What color was the contaminant? _____

Summarize additional information obtained during site characterization/threat warning that is relevant to contaminant identification. _____

Summarize the on-line monitoring data, consumer complaints, or witness accounts that are relevant to contaminant identification. _____

Field Analysis Summary

Summarize the results of the field analysis for the following parameters:

Radiation _____
Chlorine residual _____
pH, conductivity _____
Cyanide _____
Volatile chemicals _____
Chemical weapons _____
Biotoxins _____
Pathogens _____
Other _____

Public Health Information

Have death or disease in the population been reported? Yes No Unknown

Type/symptoms _____

Is there information on unusual sales of pharmaceutical supplies (e.g., diarrhea medication)? _____

Number of people affected _____

Number of fatalities _____

Location/area affected _____

Was an epidemiological investigation conducted? Yes No Unknown

Results _____

Was a clinical investigation conducted? Yes No Unknown

Results _____

Is the contaminant acutely toxic and what are the acute effects? Yes No Unknown

Describe _____

LABORATORY ANALYSIS SUMMARY

Results of analysis _____

Reporting units _____

Analytical method _____

Minimum reporting level _____

Precision (relative standard deviation) _____

QA/QC (e.g., recovery of matrix spikes, standard checks, etc.) _____

Summarize additional information obtained during laboratory analysis that is relevant to contaminant identification.

CONTAMINANT CHARACTERISTICS

What is the class of the contaminant?

Biological Chemical Radiological

Unknown _____

Can any conclusions regarding the contaminant properties be made? (Place an 'X' in the appropriate column)

	Yes	No	Unknown	Comment/Additional Information
Is the contaminant susceptible to disinfection or chemical oxidation?				
Does the contaminant hydrolyze into less toxic products?				
Does the contaminant hydrolyze into more toxic products?				

Does the contaminant react at certain pHs?				
Is the contaminant water soluble?				
Does the contaminant have a discernable taste, odor, or color?				
Is the contaminant volatile or semi-volatile?				
Does the contaminant impact the pH?				
Does the contaminant impact conductivity?				
Does the contaminant impact other water quality parameters?				
Does the contaminant react with certain disinfectants (i.e., chlorine, chloramines, etc.)?				
What is the contaminant's half life?				

Contaminant Public Health Effect Information

What are the primary routes of exposure?

- Ingestion Inhalation Dermal Contact
 Unknown _____

What are the acute health effects for the exposure routes identified? _____

What is the contaminant's LD₅₀/ID₅₀? _____

What is the length of time to first onset of symptoms after exposure? _____

What are the chronic health effects associated with exposure to the contaminant? _____

Does the contaminant have a method of secondary transmission?

- Yes No Unknown

Describe _____

Is an approach available to prevent undesirable health effects from the contaminant?

- Yes No Unknown

Describe _____

Are there treatments available for individuals exposed to the contaminant?

- Yes No Unknown

Describe _____

Are health standards for the contaminant available?

Yes No Unknown

Describe _____

By which exposure route(s)?

Ingestion Inhalation
 Dermal Ocular

List the levels for each exposure route.

Contaminant Treatment Information

Treatment Types	Could be used to treat the contaminant?	Degradation products formed as a consequence of treatment	Rating of effectiveness (poor, fair, good) of percent effectiveness
Lime softening	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Reverse osmosis	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Standard chlorination	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Enhanced chlorination	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Standard filtration	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Enhanced filtration	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Membrane filtration	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Nanofiltration	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Electrodialysis	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Cation exchange resin	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Anion exchange resin	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Activated alumina	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Chloramine	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Chlorine dioxide	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Standard UV	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Enhanced UV	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Standard ozone	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Enhanced ozone	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Standard GAC	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Enhanced GAC	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Standard air stripping	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Enhanced air stripping	<input type="checkbox"/> Yes <input type="checkbox"/> No		
Other Methods	<input type="checkbox"/> Yes <input type="checkbox"/> No		

Access to contaminant information (effects and properties)

In-house information

Contact/phone no. _____
 Internal database _____

Public Health officials

Contact/phone no. _____
 Web site/database _____

US EPA Water Contaminant Information Tool
 Web site/access code _____

Resources

- US EPA water contaminant information tool (WCIT), which is being developed specifically for the water sector and is described in Appendix 8.9 of Module 2.
- US EPA’s List of Drinking Water Contaminants & MCLs: <http://www.epa.gov/safewater/mcl.html#mcls>.
- Agency for Toxic Substances and Disease Registry (ATSDR): www.atsdr.cdc.gov.
- CDC Emergency Preparedness and Response: www.bt.cdc.gov.
- Recognizing Waterborne Disease and the Health Effects of Water Pollution: A Physician On-line Reference Guide: www.WaterHealthConnection.org.
- Physician Preparedness for Acts of Water Terrorism: www.waterhealthconnection.org/bt/index.asp.
- Registry of Toxic Effects of Chemical Substances (RTECS): www.cdc.gov/niosh/rtecs.html.
- Risk Assessment Information System (RAIS), which contains information taken from US EPA’s Integrated Risk Information System (IRIS), the *Health Effects Assessment Summary Tables* (HEAST-rad HEAST-nonrad), US EPA Peer Reviewed Toxicity Values (PRTVs) Database, and other information sources: <http://risk.lsd.ornl.gov/index.shtml>.
- United States Army Medical Research Institute of Infectious Diseases (USAMRIID) Medical Management of Biological Casualties Handbook: <http://www.usamriid.army.mil/education/bluebook.html>.
- WHO: www.who.int/search/en/.
- WHO’s “Public health response to biological and chemical weapons:” www.who.int/csr/delibeidemics/biochemguide/en/index.html.

CONTAMINANT TRANSPORT

Summarize what is known regarding the location of contaminant introduction.

How much material was used _____ (lbs., tons, gal, etc.)

How was it added? Single dose Over time Unknown

Time period of suspected contaminant introduction. _____

Elapsed time. _____

Method of estimating the spread.

- | | | |
|---|--|---|
| <input type="checkbox"/> Manual calculations | <input type="checkbox"/> Hydraulic model | <input type="checkbox"/> Water flow analysis |
| <input type="checkbox"/> GIS | <input type="checkbox"/> Field analysis | <input type="checkbox"/> Areas of customer complaints |
| <input type="checkbox"/> Areas of people with health-related symptoms | | |
| <input type="checkbox"/> Other _____ | | |

Estimate the contaminated area. _____

Estimate the population affected. _____

Identify any customers with special needs that are within the affected area.

- Critical Care Facilities
 - Hospitals
 - Nursing Homes
 - Other _____
- Clinics
- Dialysis Centers

MODULE 5: Public Health Response Guide

- Schools
 - Day Care Facilities
 - Businesses
 - Food and Beverage Manufacturers
 - Restaurants
 - Power Generation Facilities
 - Other _____
 - Commercial Ice Manufacturers
 - Agricultural Operations
-

SIGNOFF

Name of person completing form

Print name _____

Signature _____

Date/Time: _____

9.2 Public Health Response Action Worksheet

INSTRUCTIONS

The purpose of this form is to help organize information to aid in the evaluation of containment and public notification options. The objectives of public health response actions (operational and public notification) are to prevent or limit public exposure to potentially contaminated water by either restricting further propagation of the contaminant through the distribution system or restricting use of the water through public notification. This worksheet assumes that the "Contaminant Characterization and Propagation Worksheet" in Appendix 9.1 has been completed to the extent possible.

ASSESSMENT OF PUBLIC HEALTH IMPACT

Identity of the contaminant Suspected Known Unknown
Describe _____

Contaminant properties (if known):
 Toxic or infectious dose (LD₅₀/ID₅₀): _____
 Route of exposure:
 Ingestion Inhalation Dermal Contact
 Other _____
 Symptoms of exposure to high dose: _____
 Symptoms of exposure to low dose: _____
 Other: _____

EVALUATION OF CONTAINMENT OPTIONS

Describe the location and extent of the contaminated area. _____

Containment options
 Valve closures Reverse flow conditions By-pass
 Isolate zone(s)
 Other _____

Critical equipment within contaminated area
 System equipment Zones Pump stations
 Hydrants
 Other _____

Customers with special needs within contaminated area
 Critical Care Facilities
 Hospitals Clinics
 Nursing Homes Dialysis Centers
 Other _____
 Schools
 Day Care Facilities
 Businesses
 Food and Beverage Manufacturers Commercial Ice Manufacturers
 Restaurants Agricultural Operations
 Power Generation Facilities
 Other _____

Effectiveness of containment options

- Complete contaminant isolation
- Unknown
- Other _____
- Reduction in spread of contaminant

Is containment expected to provide adequate public health protection?

- Yes
- No
- Unknown

Timeline for implementation of containment options

Containment procedures to begin: _____

Containment procedures to end: _____

EVALUATION OF PUBLIC NOTIFICATION OPTIONS

Is public notification necessary? Yes No

Collaboration Agencies (identified in Public Health Response Plan and Utility's ERP)

- Public health agencies
- Hospitals/clinics
- Regional Poison Control Center
- Other _____
- Police departments
- Laboratories
- Fire departments
- Drinking water primacy agency

Type of notification (Follow steps shown)

Is the contaminant known? Yes No
If no, issue a "Do Not Use" notice.

- If yes, is boiling effective and advisable? Yes No Unknown
If yes, issue a "Boil Water" notice.

- If no, is there a risk of dermal or inhalation exposure? Yes No Unknown
**If no, issue a "Do Not Drink" notice.
 If yes/unknown, issue a "Do Not Use" notice.**

Content of public notification

- Has the contamination incident been confirmed? Yes No
- Is the contaminant known? Yes No
- If yes, identity of the contaminant _____
- Characteristics of the contaminant _____
- Restrictions on use _____
- Ingestion exposure Inhalation exposure Dermal exposure
- Exposure symptoms _____
- Medical treatments _____
- Transmission mode (if biological) _____
- Duration of restriction _____
- Alternate water supply _____
- Additional instructions to consumers _____
- Other information about the incident _____
- Other _____

Notification to customers with special needs

- Critical Care Facilities
 - Hospitals
 - Nursing Homes
 - Other _____
- Clinics
- Dialysis Centers

- Schools
- Day Care Facilities
- Businesses
 - Food and Beverage Manufacturers
 - Restaurants
 - Power Generation Facilities
 - Other _____
- Commercial Ice Manufacturers
- Agricultural Operations

Are there subpopulations that will be affected at a greater rate than general population?

- Yes No Unknown

Describe _____

Notification to consecutive system.

- Yes No Not Applicable

Method of dissemination (check all that apply)

- | | |
|--|---|
| <input type="checkbox"/> Broadcast media (radio and television) | <input type="checkbox"/> Government access channels |
| <input type="checkbox"/> Web site | <input type="checkbox"/> Listserve email |
| <input type="checkbox"/> Newspaper | <input type="checkbox"/> Letters by mail |
| <input type="checkbox"/> Newsletters (water utility/partner organizations) | <input type="checkbox"/> Phone banks |
| <input type="checkbox"/> Broadcast phone messages | <input type="checkbox"/> Broadcast faxes |
| <input type="checkbox"/> Posting in conspicuous locations | <input type="checkbox"/> Mass distribution through partners |
| <input type="checkbox"/> Hand delivery | <input type="checkbox"/> Door-to-door canvassing |
| <input type="checkbox"/> Town hall meetings | <input type="checkbox"/> Conference calls |
| <input type="checkbox"/> Other _____ | |

Notification/restriction timeline

Notification/restriction to begin: _____

Notification/restriction to end: _____

ALTERNATE WATER SUPPLY NEEDS

Is an alternate water supply needed?

- Drinking water Firefighting
- Other _____

Where can customers obtain the alternate water supply?

- Bottled water provided by local government agencies
- Bottled water provided by local retailers
- Bulk water provided by certified water haulers
- Bulk water transported or provided by military assets
- Bulk water providing by neighboring water utilities
- Water treated at plant and hauled to distribution centers (i.e., in the case of distribution system contamination)
- Other _____

What customers with special needs should be notified of the alternate water supply availability?

- Critical Care Facilities
 - Hospitals
 - Nursing Homes
 - Other _____
- Schools
- Day Care Facilities
- Businesses
 - Food and Beverage Manufacturers
 - Restaurants
 - Power Generation Facilities
 - Other _____
 - Clinics
 - Dialysis Centers
 - Commercial Ice Manufacturers
 - Agricultural Operations

SIGNOFF

Name of person completing form

Print name _____

Signature _____

Date/Time: _____

9.3 Example Notifications

The subsections that follow contain examples of notices, as listed below.

- 9.3.1 Example Boil Water Notice
- 9.3.2 Example Do Not Drink Notice
- 9.3.3 Example Do Not Use Notice
- 8.3.4 Example Notice for an Unknown Contaminant

The contaminant (*E. coli*) used in the example in Appendix 9.3.1 has mandatory language on health effects, which must be included exactly as written according to 40 CFR 141.205(d). This mandatory language is presented in *italics*.

All notices must also contain the following italicized language, where applicable [40 CFR 141.205(d)].

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand or mail.

Information in brackets in each example is to be filled in with specific details relevant to the situation.

9.3.1 Example Boil Water Notice

WARNING

BOIL YOUR WATER BEFORE USING

[The Holly County Water System] water is contaminated with [fecal coliform/E. coli]

[Fecal coliform or E. coli] bacteria were found in the water supply on [November 5th]. These bacteria can make you sick and are of particular concern for people with weakened immune systems.

What are Fecal Coliforms and E. Coli?

- *Fecal coliform and E. coli are bacteria whose presence indicates that the water may be contaminated with human or animal wastes.*

What should I do?

- DO NOT DRINK THE WATER WITHOUT BOILING IT FIRST OR USE BOTTLED WATER. Bring all water to a boil, let it boil for [three minutes], and let it cool before using. Boiled or bottled water should be used for drinking, making ice, brushing teeth, washing dishes, and preparing food until further notice. Boiling kills bacteria and other organisms in the water.

What are the symptoms of illness caused by these organisms?

- *Microbes in these wastes can cause diarrhea, cramps, nausea, headaches, or other symptoms. They may pose a special health risk for infants, young children, some of the elderly, and people with severely compromised immune systems.*
- The symptoms above are not caused only by organisms in drinking water. If you experience any of these symptoms and they persist, you may want to seek medical advice. People at increased risk should seek advice about drinking water from their health care providers.

What happened? What is being done?

The water distribution system was contaminated with fecal coliform. We are working with law enforcement and the public health department to investigate/resolve this issue. We are currently increasing the chlorination levels at the treatment plant as well as at other locations throughout the system. Therefore, your water may have a stronger chlorine smell than usual. In addition, we are evaluating all available information and conducting tests to confirm the extent of the contamination of the system. We will inform you when tests show no bacteria and you no longer need to boil your water. We anticipate resolving the problem within the next 48 hours.

Who do I contact for more information?

For more information, please contact [Joseph Smith] at [555-555-6789]. General guidelines on ways to lessen the risk of infection by microbes are available from the US EPA Safe Drinking Water Hotline at 1-800-426-4794, Poison Control at 1-800-222-1222, and [the Public Health Department Hotline at 1-800-123-4567].

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand.

This notice is being sent to you by [Holly County Water System]. State Water System ID# [10001]. Date distributed: [November 6, 2003]

9.3.2 Example Do Not Drink Notice

WARNING**DO NOT DRINK THE WATER**

[Paraquat] found in the [City of Rolling Brook] water supply on [October 10th]

Bottled water can be obtained at [Islington Station High School and Penn Road High School 24 hours per day].

What is Paraquat?

Paraquat is a chemical usually used to kill weeds. This chemical can make you sick and may result in death.

What should I do?

- DO NOT DRINK THE WATER. Do *not* use the water for drinking, making ice, brushing teeth, washing dishes, or preparing food until further notice.

What are the symptoms of illnesses associated with paraquat poisoning?

- Symptoms associated with exposure to paraquat include abdominal pain, nausea, vomiting, hematemesis, diarrhea, convulsions, lethargy to coma, and death.
- If you or someone you know exhibits any of these symptoms, immediately contact your health care provider. In addition, please notify [the public health department at 1-800-123-4567].

What happened? What is being done?

On October 10th, the water distribution system was contaminated with paraquat. We are working with law enforcement and the public health department to investigate/resolve this issue. We have tested the water in various parts of the distribution system to verify the extent of the paraquat contamination. Based on these tests, we have isolated the portion of the system located north of Aspen Street and east of River Road. Everyone in this portion of the system **should not drink the water**. We have implemented additional security procedures to protect the system against further contamination. Additional information will be provided 24 hours/day on Channel 57- the local government television channel.

Who do I contact for more information?

For more information, please contact [Joseph Smith] at [555-555-6789]. Additional information is available from the US EPA Safe Drinking Water Hotline at 1-800-426-4794, Poison Control at 1-800-222-1222, and [the Public Health Department Hotline at 1-800-123-4567].

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand.

This notice is being sent to you by [City of Rolling Brook Water System]. State Water System ID#[50005]. Date distributed: [October 10, 2003]

9.3.3 Example Do Not Use Notice

WARNING

DO NOT USE THE WATER

[Parathion] found in the [Lyonelle Water System] water supply on [November 14th]

Bottled water can be obtained at [Murray High School and Central High School 24 hours per day].

What is Parathion?

Parathion is a chemical usually used to kill insects. This chemical can make you sick and may result in death.

What should I do?

- DO NOT USE THE WATER. Do **not** use the water for drinking, making ice, brushing teeth, washing dishes, washing clothes, bathing/showering, food preparation, or toilet flushing. Bottled water should be used for all of the above necessities until further notice.

What are the symptoms associated with the exposure to parathion?

- It can cause constriction of the pupils, blurred vision, muscle and abdominal cramps, excessive salivation, sweating, nausea, vomiting, dizziness, headaches, convulsions, diarrhea, weakness, labored breathing, wheezing, and unconsciousness. Exposure can even lead to death.
- If you or someone you know exhibits any of these symptoms, immediately contact your health care provider. In addition, please notify [the public health department at 1-800-123-4567].

What happened? What is being done?

The water distribution system was contaminated with parathion. We are working with law enforcement and the public health department to investigate/resolve this issue. We have tested the water in various parts of the distribution system to verify the extent of the parathion contamination. Based on these tests, we have isolated the portion of the system located north of Lincoln Avenue and east of Maple Road. Everyone in this portion of the system **should not use the water**. We have implemented additional security procedures to protect the system against further contamination. Additional information will be provided 24 hours/day on Channel 57 - the local government television channel.

Who do I contact for more information?

For more information, please contact [Joseph Smith] at [555-555-6789]. Additional information is available from the US EPA Safe Drinking Water Hotline at 1-800-426-4794, Poison Control at 1-800-222-1222, and [the Public Health Department Hotline at 1-800-321-4567].

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand.

This notice is being sent to you by [Lyonelle Water System]. State Water System ID# [90008]. Date distributed: [November 14, 2003]

9.3.4 Example Notice for an Unknown Contaminant

WARNING

DO NOT USE THE WATER

**[Contamination Event] of the [Masterson Water System] water supply on
[November 14th]**

Bottled water can be obtained at [Fairmont High School and
North High School 24 hours per day].

Local authorities have found evidence of contamination of the Masterson Water System.

What should I do?

- DO NOT USE THE WATER. You should *not* use the water for drinking, making ice, brushing teeth, washing dishes, washing clothes, bathing/showering, food preparation, or toilet flushing. Bottled water should be used for all of the above necessities until further notice.

What happened? What is being done?

The water distribution system was contaminated with an unknown contaminant. We are working with law enforcement and the public health department to investigate/resolve this issue. We are conducting tests in attempts to identify the contaminant and verify the extent of the contamination. We have implemented additional security procedures to protect the system against further contamination. Additional information will be provided 24 hours/day on Channel 57- the local government television channel.

Who do I contact for more information?

For more information, please contact [Joseph Smith] at [555-555-6789]. Additional information is available from the US EPA Safe Drinking Water Hotline at 1-800-426-4794, Poison Control at 1-800-222-1222, and [the Public Health Department Hotline at 1-800-321-4567].

Please share this information with all the other people who drink this water, especially those who may not have received this notice directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this notice in a public place or distributing copies by hand.

This notice is being sent to you by [Masterson Water System]. State Water System ID# [90018]. Date distributed: [November 14, 2003]

9.4 Description of the PipelineNet Distribution System Model

PipelineNet was developed by US EPA to simulate the fate and transport of contaminants in water distribution systems, particularly as related to use and application in an emergency response situation. The PipelineNet model allows a user to model the flow and concentration of a biological or chemical contaminant within a water system, thus giving *Water Utility Emergency Response Managers* (WUERMs) real-time information for estimating the risks to public water supplies. This model assesses the effects of water treatment on the contaminant, models the flow and concentration of the contaminant through the water distribution system within a municipality, and estimates the population and infrastructure (e.g., hospitals, schools) at risk. PipelineNet works by integrating the two following computer programs: EPANET and ArcView.

- EPANET performs extended period simulations of hydraulic and water quality behavior within pressurized pipe networks. A network can consist of pipes, nodes (pipe junctions), pumps, valves and storage tanks or reservoirs. EPANET tracks the flow of water in each pipe, the pressure at each node, the height of water in each tank, and the concentration of a chemical species throughout the network during a simulation period comprised of multiple time steps. In addition to chemical species, water age and source tracing can also be simulated.
- ArcView is a GIS-based desktop mapping software package created by Environmental Systems Research Institute (ESRI) that provides data visualization, query, analysis, and integration capabilities along with the ability to create and edit geographic data. GIS systems use hardware, software, and geographic data to manage geographically referenced information.

This integration gives PipelineNet all the computational (hydraulics and water quality) capabilities of EPANET and all the functionality of ArcView. The integrated system calculates, locates, and maps the population at risk from the introduction of contaminants to the public water supply. The model performs the following functions:

- Simulates the flow and concentration of biological or chemical contaminants in a city or municipality's water distribution system from single and multiple sources if single contaminant.
- Simulates water quality (fate and transport), water tracing, and water aging
- Assesses the effects of water treatment on the contaminant.

Capabilities

Based on an ArcView platform, PipelineNet provides user interfaces to assist with a range of real-time responses and planning scenarios. Although no formal GIS training is required to run PipelineNet, some understanding of these systems will help the user. PipelineNet key capabilities are highlighted below.

Ranking/Prioritization Methodology for Determining Contamination Threat Monitoring Locations. The key questions in the design of a monitoring protocol for a contamination threat is how many samples and where should the samples be collected. Typical sampling and monitoring

locations in distribution systems may include points close to water treatment systems, core business locations, secondary water storage reservoirs, re-pumping or re-treatment facilities and change in water quality. Selection of appropriate monitoring locations should reflect a mix of utility concerns and priorities including:

- Protecting customers with special needs (e.g., hospitals).
- Tracking water quality at or near locations vulnerable to contamination.
- Facilitating suitable response actions to contamination incidents (e.g., ability to isolate the system, or boost chlorine residuals).

US EPA's PipelineNet can be used for determining optimal placement of sampling equipment in the system, to help develop monitoring programs for routine screening of distribution system water quality, and to predict/track the fate and transport of contaminants in a system to effectively respond to a contamination incident. These sampling locations would be tapped for monitoring during a contamination threat.

Figure 5-5 provides a conceptual view of how US EPA's PipelineNet can be used to determine the location of potential monitoring sites for a contamination event.

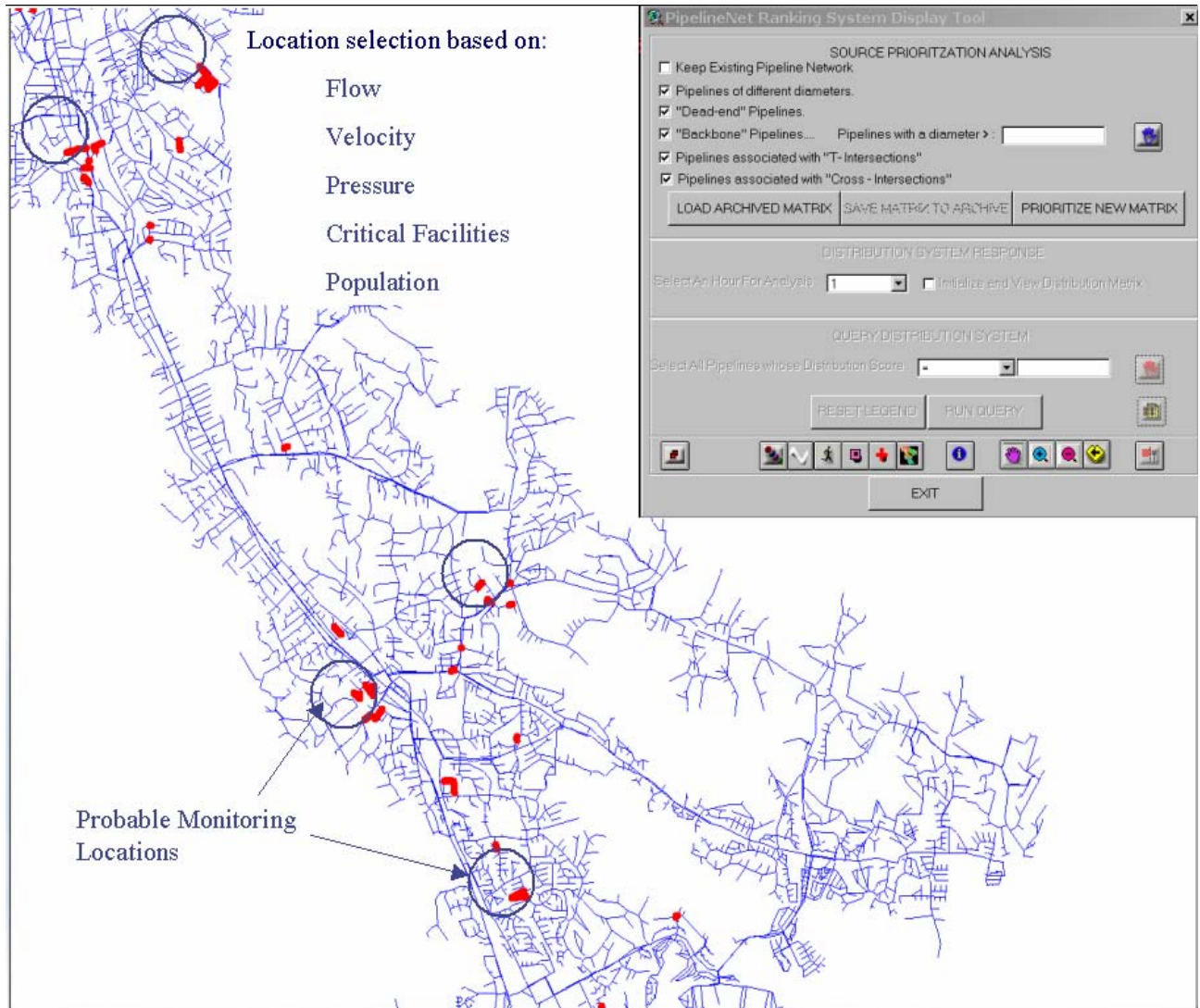


Figure 5-5. Output of Selection Process Showing Potential Monitoring Locations.

Water Quality Simulation. A water quality simulation is initiated through PipelineNet's point and click interface. The user points to a node to introduce a contaminant. An instantaneous or continuous release may be simulated. Additional inputs include mass or concentration, half-life or decay coefficient, length of simulation, and time step. Note that these input parameters are unknown for most contaminants. Therefore, the ability of the model to predict contaminant concentrations that result from decay is limited. Any existing EPANET Pipeline concentration result may be displayed to simulate the contaminant's hourly flow through a pipeline network at anytime (see Figure 5-6). All pipeline concentration results are placed directly in PipelineNet's GIS table of contents.

Water Tracing. Source tracing tracks over time what percent of the water reaching any node in the network had its origin at a particular node. The source node can be any node in the network, including storage nodes. Source tracing is a useful tool for analyzing distribution systems that draw water from two or more different raw water supplies. It can show to what degree water from a given source blends with water from other sources, and how the spatial pattern of this blending changes.

Water Aging. Water age is the time spent by a parcel of water in the network. It provides a simple, non-specific measure of the overall quality of delivered drinking water. New water entering the network from reservoirs or source nodes enters with an age of zero. As this water moves through the pipe network, it splits apart and blends together with parcels of varying age at pipe junctions and storage facilities. EPANET internally treats age as a reactive constituent whose growth follows zero-order kinetics with a rate constant equal to one (i.e., each second the water becomes a second older).

Consequence Assessment Tool. The PipelineNet Consequence Assessment Tool (see Figure 5-7) allows the user to select an area of interest (i.e., region of contaminated pipes) by drawing a rectangle with the help of the cursor on the map in the view. This tool performs the following calculations within the selected area:

- Total population.
- Number of taps.
- Miles of pipe.
- Total number of hospitals and beds for each hospital.
- Total number of schools and enrollment of students.

Isolation Tool. The PipelineNet Isolation Tool (see Figure 5-8) is a post-processing tool that allows the user to change the status (open or closed) of a pipe in the EPANET input file. The model can then be re-run to determine what will happen to the flow by changing the status of the pipe. This tool can be used for public health response planning to determine how best to isolate a portion of the system once it has been contaminated.



Figure 5-6. Water Quality Simulation.

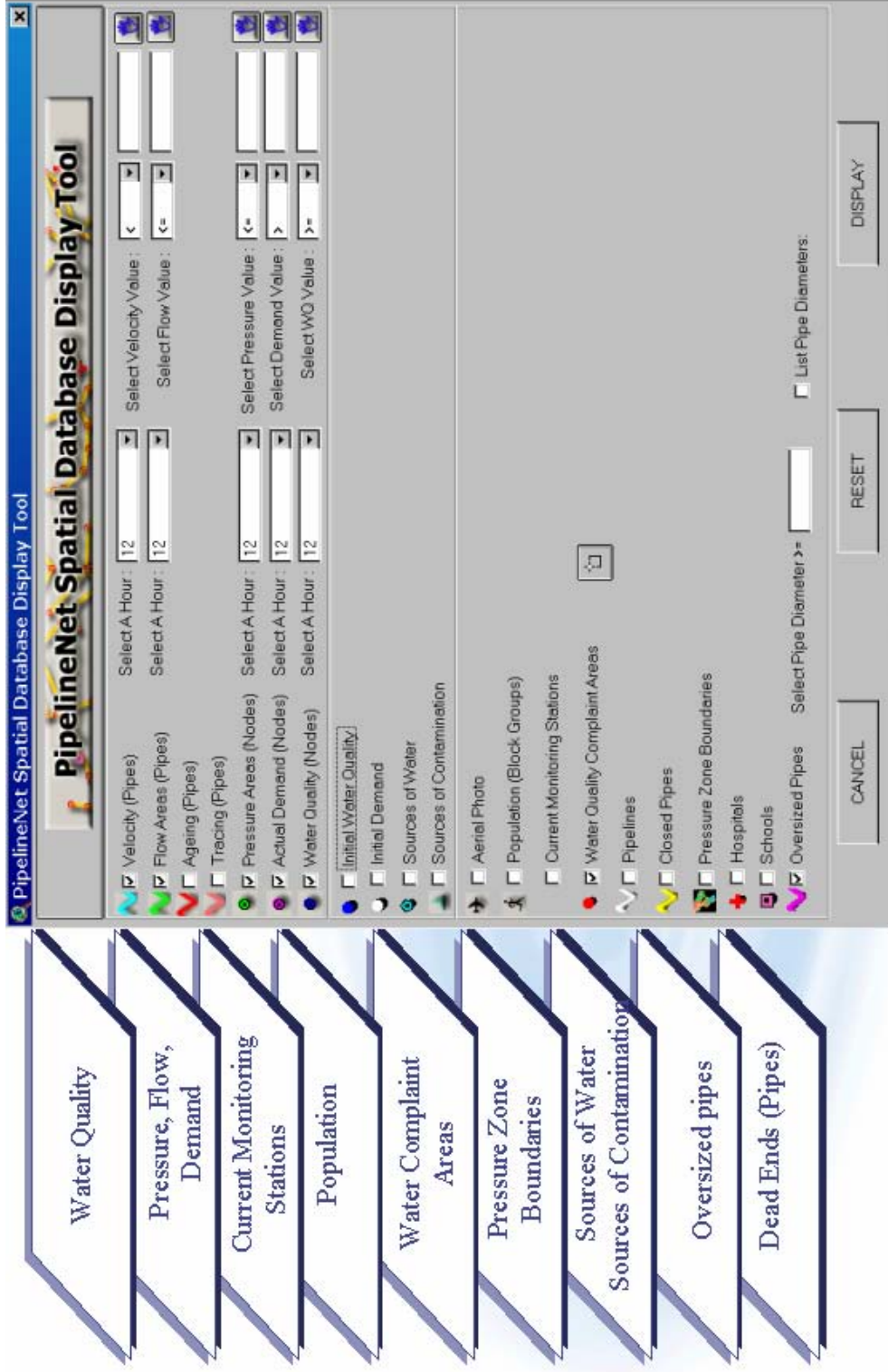


Figure 5-7. Consequence Assessment Tool.

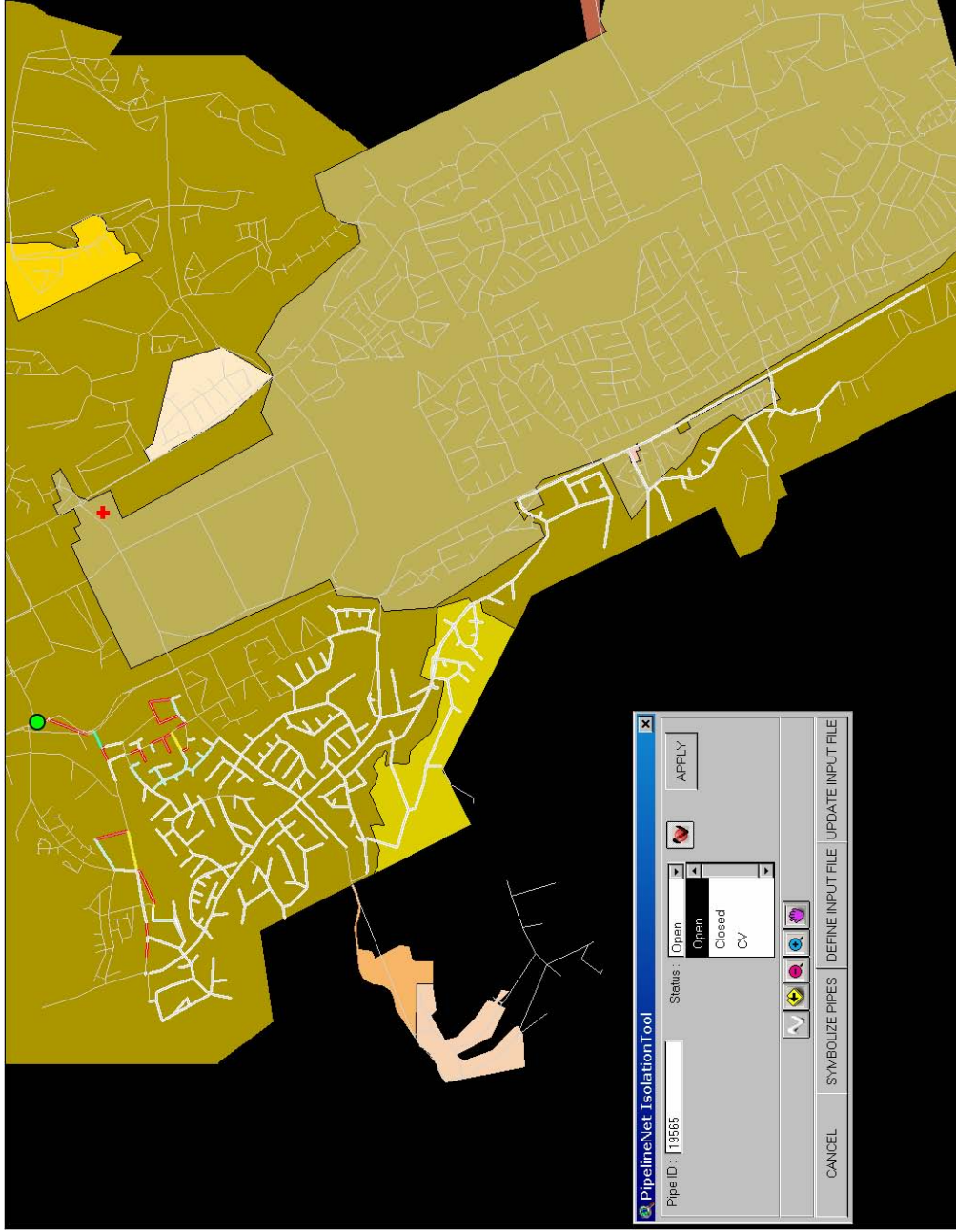


Figure 5-8. Isolation Tool Interface.

