Protecting Wastewater Infrastructure Assets...

Planning for Decontamination Wastewater:

A Guide for Utilities

NACWA

A Clear Commitment to America's Waters

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Understanding the Risks Associated with Decontamination Wastewater*

Substances that may be contained in decontamination wastewater

- ☐ Chemical warfare agents such as blood, nerve, blistering, choking or tear-inducing agents, as well as toxic industrial chemicals.
- ☐ Chemical compounds used in the decontamination process.
- ☐ Biological warfare agents including disease causing bacteria, viruses and toxins.
- ☐ Radioactive materials.

Means of decontamination wastewater entering the sewer system

- ☐ Runoff from decontamination activity by inflow around manhole covers, through catch basin inlets in the case of combined sewer systems, or through floor drains in the case of interior decontamination activities.
- ☐ Direct discharge into a manhole or inlet by the personnel responsible for decontamination activities.
- ☐ Decontamination showers at hospitals or other facilities that drain to the building sewer connecting to the sewer system.
- ☐ Sewage from a building in which persons exposed to Chemical, Biological, or Radioactive (CBR) substances had bathed or laundered clothes.
- ☐ Urine and feces from persons exposed to CBR agents via plumbing fixtures that are connected to the sewer system.
- ☐ Disposal of contaminated drinking water from reservoirs, water treatment facilities, and water distribution systems.

Reducing the Risk through Planning, Coordination and Communication

Within the utility

- ☐ Develop an Emergency Response Plan that includes: (1) A decision-making framework for responding to incidents where decontamination wastewater may be generated; (2) Procedures for preparedness, response and incident management for such incidents; (3) Contact information for organizations to assist with recovery, and agencies to notify in case of a decontamination event.
- ☐ Maintain and distribute supplies and equipment, as needed, to contain decontamination wastewater, and reduce its impacts on the wastewater system.
- ☐ Provide personal protective equipment for those employees that are appropriately trained, and may be assigned to assist emergency personnel.
- ☐ Develop mutual aid agreements with adjacent wastewater utilities, and contracts with hauling companies to assist in providing services should a portion of the wastewater system be temporarily out-of-service.

With local emergency managers and first responders

- ☐ Establish protocols, agreements and memoranda of understanding with local emergency management agencies and first responders to assure the utility is notified of incidents that may generate decontamination wastewater.
- ☐ Invite representatives from local emergency management agencies and first responders to train with utility staff, and request utility participation in their training exercises.
- ☐ Assist local emergency managers and first responders to develop procedures and identify laboratories for rapidly determining type and concentration of CBR substances in decontamination wastewater.
- ☐ Collaborate with local emergency managers and first responders in designing methods for containing as much decontamination wastewater on-site as possible, or diverting decontamination wastewater to holding tanks or diked-in areas, where testing and treatment can be accomplished.
- ☐ Provide local emergency managers and first responders with the information they need to acquire and deploy equipment and materials to prevent decontamination wastewater from entering the sewer system.
- ☐ Discuss with first responders the appropriateness of adding a safe tracer dye to water used for decontamination so that the resulting wastewater can be tracked prior to, and after entering the sewer system.
- ☐ With the assistance of local emergency managers, prepare "standby" public notices to be used to inform persons involved in an incident the steps to take to avoid discharge of CBR wastes into the sewer system.

With customers and agencies that may discharge decontamination wastewater

- ☐ Meet with key staff members of hospitals, clinics, laboratories and industrial customers to explain the possible impacts of decontamination wastewater, and offer assistance in developing methods for notification, analysis and containment.

**Decontamination wastewater is generated as a result of decontamination activities performed after a terrorist attack with chemical, biological or radioactive substances.*

- ☐ Incorporate into pretreatment control instruments, the appropriate requirements for customers to immediately notify the utility of any incident that may result in decontamination treatment and resulting wastewater discharge from their building or facility.
- ☐ As necessary, amend local pretreatment regulations or ordinances to require all appropriate users such as hospitals, clinics, laboratories and other selected non-domestic customers to develop and maintain plans for containment, testing and decontamination of wastewater.
- ☐ Work with water utilities, local, state and federal government agencies to establish procedures for disposing of contaminated water in ways that would not adversely impact the sewer system, such as isolation and in-situ treatment, or temporary storage prior to discharge.

Reducing the Risk and Impact through Physical Measures

Preventing decontamination wastewater from entering the sewer system

- ☐ Barrier methods prevent decontamination wastewater from reaching the collection system by placing a physical obstacle in the way of the runoff (e.g., drain seals, manhole shields, pan inserts, berms and drain plugs).
- ☐ Containment methods keep decontamination wastewater at the location where it is generated. Examples consist of sumps, pools, or dikes that retain the runoff from decontamination activities.
- ☐ Sorbents can absorb and retain small amounts of decontamination wastewater. They are available in a wide variety of materials such as gels, foams and solids that are specifically designed for individual classes of hazardous materials.

Mitigating the impact of decontamination wastewater that reaches the sewer system

- ☐ In many cases, the adverse impacts of CBR substances on the sewer system will be minimized by dilution from water used in the decontamination activities and from existing wastewater in the sewer system. However, some CBR substances will still be harmful at very low concentrations.
- ☐ The effects of many chemical agents can be minimized through the use of calcium hypochlorite, sodium hydroxide or the U.S. Military's Decontamination Solution No. 2, depending on the specific agent.
- ☐ Some bacteria, viruses and toxins can be inactivated with a sufficient contact time with chlorine compounds such as sodium hypochlorite or ultraviolet (UV) light.
- ☐ Some radioactive materials can be removed from decontamination wastewater through processes not typically found at wastewater treatment facilities, such as lime softening, ultrafiltration, and reverse osmosis.
- ☐ In any instance where decontamination wastewater is disposed of through the sewer system, controlling rates of entry to minimize interface, pass-through, and air emissions, and maximize worker health and safety is important.

Reducing the Risk through Training and Information Updates

- ☐ Provide periodic training for utility staff in emergency preparedness, response, and recovery, including an overview of CBR substances and courses such as those describing FEMA's National Incident Management System (NIMS).
- ☐ Test and evaluate emergency plans and procedures through tabletop, functional, and full-scale exercises. Participate with other utilities, local emergency management agencies, regulators and first responders.
- ☐ Stay abreast of new legislation and regulations, industry research and newly developed guidance and protocols.

The response to a CBR attack will be managed by personnel from local, state and federal agencies who have received extensive training, and are equipped with protective and specialized equipment. During such an incident, wastewater utility managers are urged to coordinate closely with on-site lead agencies, while protecting employees and the utility system. Ensuring that the response to a CBR attack is well coordinated and ultimately protects human health and the environment, relies heavily upon pre-incident planning, which involves all key stakeholders, including wastewater utilities.

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Introduction

Terrorists are working to obtain biological, chemical, nuclear and radiological weapons, and the threat of an attack is very real.[1]

This is the conclusion of the U.S. Department of Homeland Security as presented on their Internet website. Should such weapons be used against targets in the United States, it is possible that some amount of the chemical, biological, or radiological (CBR) substances may find their way into sanitary and/or combined sewer systems by various pathways.[2] Thus, to better protect their employees, customers, infrastructure, and the environment, it is imperative that utility managers plan for such an incident both within their organization and through cooperation with emergency managers and first responders.

Purpose of the Guide

The primary purpose of this guide is to ensure managers of wastewater utilities are cognizant of the pre-planning necessary to prevent, detect, respond to and/or recover from the impacts of *decontamination wastewater* containing CBR substances. For the purposes of this guide, *decontamination wastewater* is defined as wastewater generated as a result of decontamination activities performed after a terrorist attack with CBR substances. While decontamination activities associated with an accidental release of a CBR substance may also generate wastewaters that could be managed consistent with this guide, such cleanup activities are not the focus of this guide.

Utility managers may find that the information presented in the following chapters can benefit their organizations through:

- Incorporation into the utility's emergency response plan (ERP);
- Use in a curriculum for employee emergency preparedness and response training;
- Use in development of a scenario for a tabletop exercise;
- Initiation of dialogue with governing bodies regarding vulnerabilities and available funding for remediation;
- Initiation of dialogue between the utility and first responders;
- Incorporation of issues when negotiating wholesale agreements for satellite systems;
- Use as a guidance for assessing risk associated with decontamination wastewater; and
- Use as information for enhancing sewer use ordinances and pretreatment programs.

Overview of the Guide

Chapter 2 begins with an overview of the types of CBR substances that may be used in a terrorist attack. The chapter continues with a discussion on how decontamination activities in response to such a malevolent incident may result in CBR substances entering the wastewater system through contaminated runoff or other means (referred to as *decontamination wastewater*).

Recognizing that the response to and management of a terrorist incident will rest with state and local emergency management agencies and first responders, Chapter 3 provides important elements for effective planning, communi-

[1] U.S. Department of Homeland Security, www.ready.gov/overview.html

[2] Seperate storm sewers that convey stormwater directly to a waterbody are a concern from an environmental protection perspective, but are not within the scope of this utility planning guide.

cation and coordination between utility staff and those persons in command at a CBR incident. Using the concepts presented in Chapter 3, utility managers can minimize the impact of CBRs on their wastewater systems and employees through joint planning, preparation and cooperation with local emergency personnel.

Chapter 4 presents a summary of tactics and equipment that may be employed to prevent decontamination wastewater from entering the sewer system, or minimize the amount that does enter. This chapter also includes methods used to reduce the adverse impacts of chemical and biological substances in decontamination wastewater on wastewater operations and facility personnel.

Chapter 5 emphasizes the importance of a knowledgeable workforce in mitigating the effects of decontamination wastewater on the wastewater utility. Tips for keeping up-to-date with information on security and emergency response are included. Examples of training courses are presented, along with a discussion on the benefits of engaging in training exercises, especially in joint exercises with emergency management agencies and first responders.

Chapter 6 concludes this guide with a review of on-going and recently completed research that may provide useful information to wastewater professionals looking to mitigate the risks of decontamination wastewater. Suggested research projects may help close the current knowledge gap by providing new information on the transport, fate and impacts of CBR substances that enter a utility's sewer system through decontamination wastewater.

While providing information to help utilities plan for CBR incidents where decontamination wastewater is produced, this guide does not address malevolent attacks directed at the wastewater system or any other asset owned or operated by the wastewater utility. In addition, this guide does not address CBR detection methods or protocols for quantitatively determining concentrations of substances in decontamination wastewater or within the sewer system. Refer to the NACWA security website, http://www.nacwa.org/advocacy/security/, for information on these topics. Other resources include the Water Information Sharing and Analysis Center [3] (WaterISAC), www.WaterISAC.org, a fee-based system providing extensive information covering these topics including sensitive contaminant and other information that can only be shared in a secure environment, and the Water Security Channel, http://www.watersc.org/, a free service of the WaterISAC. Also, Chapter 5 has additional information resources.

Guiding Principle

Wastewater utility managers are urged to remain aware of the following guiding principle:
The response to a CBR attack will be managed by personnel from local, state and federal agencies who have received extensive training, and are equipped with protective and specialized equipment. During such an incident, wastewater utility managers are urged to coordinate closely with on-site lead agencies, while protecting employees and the utility system. Ensuring that the response to a CBR attack is well coordinated and ultimately protects human health and the environment, relies heavily upon pre-incident planning, which involves all key stakeholders, including wastewater utilities.

[3] *The WaterISAC is an Internet-based, highly secure, rapid notification system and information resource regarding threats to wastewater and drinking water systems. Visit www.WaterISAC.org for additional information.*

Why Decontamination Wastewater is a Concern

There is a wide spectrum of chemical, biological and radiological (CBR) substances that have been, and can be, used as weapons in war, as well as in terrorist attacks. Even before September 11, 2001, federal agencies, the military, and research organizations have been working to identify CBR substances that could be acquired or synthesized by terrorists and used in an attack in the U.S., or on U.S. interests abroad. Since 2001, the focus on CBR substances as potential terrorist weapons has increased, although much is still unknown.

This guide provides an overview of the types of CBR substances that have the potential for use by terrorists, and therefore could enter sewer systems in the form of decontamination wastewater generated in response to a terrorist attack. It is important to realize that if a CBR attack produces decontamination wastewater, the effect on a wastewater utility will depend on a variety of factors. These factors include the properties and characteristics of the individual substances, such as volatility, persistence, solubility and lethality. Other factors include the amount of the CBR substances used in the attack, the location of the release, the dispersal method, and the type of decontamination activities employed.

The following discussion of CBR substances is meant only to introduce utility personnel to the general characteristics of the substances. Additional information regarding potential impacts of a particular substance may be obtained through other sources, such as websites listed in Chapter 5.

CBR Substances

Chemical Agents

Certain chemicals can rapidly disrupt basic body functions causing illness and death from inhalation, ingestion or contact. Over the centuries, many chemical compounds have been specifically developed for use as weapons. These chemicals are typically referred to as chemical agents. Some examples include sulfur mustard, sarin and VX. In addition, chemicals that are commonly used for commercial and industrial purposes have been weaponized for use in warfare, including chlorine gas, phosgene and organophosphates. Chemical agents are typically categorized as shown in Table 2-1. There are also toxic chemicals that are derived from living organisms, which have been used to kill or injure. These chemicals, termed toxins, are discussed in the subsection on Biological Agents which follows.
Most chemical agents cause illness or death when absorbed through the skin as a liquid or inhaled as a vapor. Poisoning may also occur from drinking liquids or eating food tainted by these agents.

The release of a chemical agent may be evident from its distinctive odor. Symptoms of exposure are typically immediate, ranging from headache, nausea and salivation to burns, respiratory failure and death. Chemical agents generally contaminate only the immediate area around the release, but the actual extent of contamination will be dependent upon weather conditions, the amount of agent, and the chemical stability of the agent.

Biological Agents

Biological agents include many bacteria, viruses and other organisms that induce disease in human beings. They are sometimes considered more of a concern than chemical agents because large amounts of biological agent can be grown from a tiny initial supply, and in many instances, the illness caused can be transmitted to other persons. Also, the dosage needed to induce illness can be very low, an amount much smaller by weight than required of chemical

Table 2-1. Categories of Chemical Agents

Category	Description
Blood Agents	Interfere with the absorption of oxygen by blood in the lungs. They are typically volatile liquids or gases, and may be lethal within minutes.
Nerve Agents	Interrupt the transmission of electrical discharges across the nerves in the body resulting in paralysis and respiratory failure. They are typically liquids that are aerosolized for inhalation or absorption.
Blistering Agents	Also referred to as mustard agents, and are typically in liquid or solid form. They attack the skin, eyes, lungs and gastrointestinal tract causing wounds that resemble burns and blisters, and destroy tissue.
Choking Agents	Cause lung damage that can be lethal within 24 hours, although their persistence in the environment is only a few minutes. They can be in either liquid or gas form.
Lacrimating Agents	Tear gasses that cause burning, tearing and coughing, but are rarely fatal. In higher concentrations they may cause nausea and vomiting, and are sometimes referred to as vomiting agents.
Industrial Inorganics	Include alkalies, acids, metal salts, chlorine and other gases, and inorganic pigments. Physical effects depend on the chemical.
Industrial Organics	Include pesticides, herbicides, petrochemicals, distillates, adhesives, dyes, and resins. Physical effects depend on the chemical.

agents. Most biological agents must be inhaled or ingested in order to cause illness, although some agents can infect through contact with broken skin and mucus membranes. Some biological agents, such as many viruses, are not viable outside of human tissue.

Biological agents are classified by their taxonomy (i.e., their biological type) as shown in Table 2-2.

The Centers for Disease Control and Prevention (CDC) has also categorized biological agents by their ease of dissemination, ease of causing disease, and extent of health impact. The categories are defined as follows:

- **Category A** agents are given the highest priority by the CDC. They include pathogens that are rarely seen in the United States and organisms that pose a risk to national security because they (1) can be easily disseminated or transmitted from person to person; (2) result in high mortality rates and have the potential for major public health impact; (3) might cause psychological and economic impacts; and (4) require special action for public health preparedness;
- **Category B** agents are given the second highest priority by the CDC. They include agents that are (1) are moderately easy to disseminate; (2) result in moderate morbidity rates and low mortality rates; and (3) require specific enhancements of CDC's diagnostic capacity and enhanced disease surveillance; and
- **Category C** agents include emerging pathogens that could be engineered for mass dissemination in the future because of their (1) availability; (2) ease of production and dissemination; and (3) potential for high morbidity and mortality rates and major health impacts.

Radioactive Materials

Radioactive materials are chemicals with unstable atoms that naturally release energy in the form of alpha particles, beta particles and gamma rays. These particles and rays are referred to as radiation. All persons are subjected to some levels of radiation due to natural phenomenon such as sunlight, and exposure through commonly used industrial and medical devices. However, radiation can have devastating effects depending upon the type and amount of radioactive material, the proximity of a person to the source of the radiation, and the length of exposure time. Inhalation or ingestion of alpha or beta particles pose the highest health risk. External exposure to beta particles, and especially to gamma rays that can penetrate the body, is of greatest concern. Table 2-3 lists several radionuclides (an unstable atom of an element that releases radiation), the type of radiation released, and the most common use or origin.

Table 2-2. Classes of Biological Agents

Class	Description
Bacteria	Microscopic, free-living, single-celled organisms that reproduce by simple division. The organisms have a structure consisting of nuclear material, cytoplasm, and cell membrane. The diseases they produce often respond to specific therapy with antibiotics.
Viruses	Organisms that require living cells in which to replicate. They are therefore intimately dependent upon the cells of the host that they infect. They produce diseases which generally do not respond to antibiotics but which may be responsive to antiviral compounds, of which there are few available, and those that are available are of limited use. In some cases, vaccines are available to prime immunity to a limited number of disease-causing viruses.
Rickettsiae	Microorganisms that have characteristics common to both bacteria and viruses. Like bacteria, they possess metabolic enzymes and cell membranes, utilize oxygen, and are susceptible to broad spectrum antibiotics. Like viruses, they grow only within living cells.
Chlamydia	Intracellular parasites incapable of generating their own energy source. Like bacteria, they are responsive to broad-spectrum antibiotics. Like viruses, they require living cells for multiplication.
Fungi	Primitive plants that do not utilize photosynthesis, are capable of anaerobic growth, and draw nutrition from decaying vegetable matter. Most fungi form spores, and free-living forms are found in soil. The spore forms of fungi are significant because they can remain dormant for long periods of time before activating.
Toxins	Poisonous substances produced and derived from living plants, animals, or microorganisms. Some toxins may also be produced or altered by chemical means. Toxins may be rendered harmless by specific antiserums and other drugs.

Radiation is colorless, odorless, tasteless and invisible. It can be detected only with specialized equipment. Radioactive materials may be solid (metal, crystalline, ceramic, powder, salt), liquid (dissolved or suspended), or gaseous (gases, vapors, mists, and airborne dust) depending on the particular chemical and physical form. Radioactive materials may or may not be water soluble.

Sources of Decontamination Wastewater

In response to an attack with CBR agents, local, state or federal emergency personnel will commence decontamination activities. The type and timing of decontamination activities will depend upon a variety of factors, including the type of CBR substance, the severity of the contamination (e.g., the concentration of CBR exposure), the spatial extent of the CBR contamination, the weather conditions, the safety and security of the site, and the number of people exposed to the CBR substance.

Decontamination of Victims

In general, decontamination of persons exposed to the CBR substances will begin as soon as practical and as close to the site as safety and security allow. Decontamination of people is typically accomplished by removing clothing and washing the body with or without soap. The washing can be accomplished through improvised sprays from garden or fire hoses, or through decontamination showers. Decontamination showers are available as portable devices that are transported to a site, quickly erected and connected to a safe water supply. Victims stand under a shower nozzle or walk through a tent-like structure while being showered through several nozzles. Victims can also be wheeled on a gurney through the portable showers if they are unable to walk. Many of these portable decontamination showers are manufactured with an integrated pool or sump to contain the water used to wash-off the contamination (i.e., the *decontamination wastewater*). Small sump pumps can be connected to the pool or sump and the decontamination wastewater transferred to a holding tank.

Decontamination showers are also available in trailers that can be towed to a site. These trailers contain one or more shower stalls or corridors that are connected to a safe water supply. Some of the more sophisticated shower trailers are manufactured with tanks or bladders to contain the decontamination wastewater. Other shower trailers have drains that must be connected to an external holding tank through a portable pump.

Table 2-3. Examples of Radionuclides

Radionuclide	Radiation Type			Use or Origin		
	alpha	beta	gamma	Industrial	Medical	Defense
Cobalt-60		X	X	X	X	
Strontium-90		X		X	X	
Molybdenum-99		X	X		X	
Iodine-131		X	X		X	
Cesium-137		X	X	X	X	
Iridium-192		X	X	X	X	
Radium-226	X	X	X	X		
Uranium	X	X	Weak	X		X
Americium-241	X		X	X		X
Plutonium	X	X	Weak			X

Victims of a CBR attack may also be decontaminated at hospitals or other locations where special decontamination shower facilities have been constructed. Ideally, these facilities are designed to contain the decontamination wastewater and transfer it by gravity or by pumping to an onsite holding tank. In some communities these showers have been built and connected to the sewer system without storage and without the knowledge of wastewater utility personnel. If inspection shows that the facilities are not properly constructed, steps can be taken to prevent unauthorized discharge to the sanitary sewer.

While emergency personnel responding to a CBR incident will make all efforts to detain victims and assure they are properly decontaminated, some victims are likely to leave the site and wash or shower at home or another location where the sink and shower drains are connected directly to the public sewer system. Also, while the clothing of victims who are decontaminated by emergency personnel will be properly discarded, victims who leave without proper decontamination will most likely launder their clothes, thereby generating decontamination wastewater that will drain directly to the public sewer system. These uncontrollable sources of decontamination wastewater are factors in facility planning activities as discussed in Chapter 3.

Although not strictly defined as decontamination wastewater, urine and feces from victims exposed to biological or radioactive substances may contain certain concentrations of pathogens or radioactivity that will end up in the public sewer system. (Persons exposed to chemical agents will generally not excrete significant quantities of the chemical agent.)

Decontamination of Site and Equipment[4]

The decontamination of structures, public infrastructure, vehicles, equipment and other items exposed to CBR contamination will usually be accomplished after victims are cared for and with careful and deliberate planning. Decontamination methods will be chosen based on the criteria discussed above, as well as the availability of the decontamination materials and equipment.

Methods most likely to be employed to decontaminate surfaces include:

- Water (with or without detergents);
- High pressure, high temperature steam;
- Surfactants;
- Oxidizing chemicals;
- Caustic chemicals;
- Microemulsions; and
- Hot air.

[4]The required procedures and the necessary exemptions/approvals for conducting site and equipment decontamination are beyond the scope of this document. This discussion is intended only to introduce the possible sources of decontamination wasteeater.

Except for hot air, and oxidizing chemicals in gaseous form (e.g., chlorine dioxide gas used to decontaminate anthrax in office buildings), all of these decontamination methods will create wastewater. Furthermore, cleanup activities, including those that use chlorine dioxide gas or other gaseous chemicals, will generate decontamination wastewater when personnel conducting the cleanup are washed down. With proper planning and equipment, decontamination wastewater can be contained, and then properly treated and disposed. When the contamination is spatially limited or within an enclosed structure, it may be possible to contain the decontamination wastewater by using dikes, berms or sorbents (see Chapter 4). Treatment and disposal can then be accomplished, possibly over a period of weeks or months.

Other Sources of Decontamination Wastewater

Should a community or non-community potable water system become contaminated, large quantities of water may have to be drained from the distribution system, storage tanks, or treatment units. Because of the urgency necessary to supply safe drinking water to the public and maintain adequate pressure and quantities of water for fire suppression, the sewer system may be an efficient means of disposing of contaminated drinking water prior to, or after, decontamination activities. Though this contaminated drinking water is not usually considered decontamination wastewater, Chapter 3 addresses the planning and coordination that wastewater utility managers may have with their colleagues at the water supply utility to assure adverse impacts are properly mitigated and not just transferred from one utility to another.

Another source of decontamination wastewater is the runoff produced from fighting fires at the site of a CBR event. Containment of this runoff may not be practical, and as discussed below, the contaminated runoff may find a pathway into the sewer system.

Runoff from precipitation is also a concern. Precipitation falling through an atmosphere contaminated with a CBR substance will produce decontamination wastewater that would enter a combined sewer system.

Medical laboratories may also become a source of decontamination wastewater from their analysis of body fluids and tissue of CBR victims. Likewise, environmental laboratories and materials testing laboratories may generate decontamination wastewater as part of chemical, biological or physical analysis, or from the clean-up of those activities. Wastewater utilities must work with laboratories to assure such decontamination wastewater is contained and properly treated and disposed rather than allowed to enter drains and the public sewer system (see Chapter 3).

Decontamination Wastewater Pathways to the Sewer System

In general, emergency management personnel and first responders are aware of the importance of containing decontamination wastewater for proper treatment and disposal. The training curriculum for emergency workers includes protocols and procedures for containing decontamination wastewater at the site of a CBR event. Decontamination equipment typically includes holding tanks or other containers for decontamination wastewater. However, it must be recognized that the primary goals of first responders are protection of life, safety and security of the emergency personnel and victims of the CBR attack. Measures to contain decontamination wastewater will always be secondary to the protection of life and safety, as noted in a Federal Emergency Management Agency (FEMA) publication: "In a mass casualty setting, life safety takes precedence over containing runoff."[6] Additionally, where CBR attacks result in numerous victims, cover a widespread area, or ignite fires, containment of any significant portion of the decontamination wastewater generated may be impractical or impossible.

Consequently, wastewater utility personnel's awareness of the various pathways that decontamination wastewater can enter the sewer system is a key consideration. Some of these pathways include:

- Runoff from decontamination activities, fire fighting or stormwater entering by inflow around manhole covers or through catch basin inlets in the case of combined sewer systems;
- Wastewater from interior decontamination activities entering through floor drains;
- Direct discharge into a manhole or inlet by the personnel responsible for decontamination activities;
- Discharge from showers at hospitals or other facilities draining to the building sewer connected to the sewer system;

[6]Emergency Response to Terrorism, Job Aid – *Edition 2.0, FEMA, U.S. Department of Homeland Security, February 2003*

- Sewage from a building in which persons exposed to CBR substances have bathed, showered, or laundered clothes;
- Urine and feces from persons exposed to CBR agents via plumbing fixtures that are connected to the sewer system.

Potential Impacts of Decontamination Wastewater on Utility Operations

The effect of decontamination wastewater on a wastewater utility will depend on a variety of factors, including the properties of the CBR substance or substances present. Other major factors include the routes of entry into the sewer system, how much decontamination wastewater enters the sewer system, the location of the release, the dispersal method, and the type of decontamination activities employed. Utility managers may want to consider the possible impacts of decontamination wastewater on treatment processes, biosolids, air emissions, and pass-through into the environment. Chapter 4 contains some basic information on the behavior of CBR substances in various stages of the wastewater system. In addition, the fate and transport of various CBR substances is the subject of ongoing research (see Chapter 6).

The uncertainty associated with these potential effects makes it difficult to prepare for such incidents. Nevertheless, as explained in more detail in Chapter 3, utilities can have plans in place that will guide their activities in the event decontamination wastewater is discharged to their system. For example, decisions regarding the management of biosolids (such as the cessation of land application or incineration) following an incident are better thought through in advance of an incident and can be considered regardless of the specific CBR substance involved.

REDUCING THE RISK THROUGH

Planning, Coordination and Communication

The most important step a wastewater utility may take to protect against the risks of decontamination wastewater is to pick up the telephone—not after a CBR event has occurred, but today, while planning is possible. As in all municipal activities, relationship building will bring favorable results because we function better as a team than as a single player. First responders have their own goals, teams, and actions during an emergency. It is the job of the wastewater utility to familiarize first responders with the functions and requirements of sewer systems and the treatment plant, and learn how utility personnel can best assist in the event of decontamination wastewater release. This chapter provides information to assist the wastewater utility with planning for a decontamination wastewater event, coordinating with emergency personnel, and communicating within the utility and with customers or outside agencies.

Chapter 2 identified various pathways that decontamination wastewater can enter the sewer system. Discharges to some of these pathways can be controlled or at least minimized. For example, collaborative planning, coordination and communication between the wastewater utility and emergency management agencies and first response organizations are critical. The interaction ensures that the proper equipment will be available and that responders will be more aware of the importance of preventing the discharge of as much decontamination wastewater as possible.

Some of the pathways identified, however, can be difficult, if not impossible, to manage. Possible sources of uncontrollable discharges, for example, are urine and feces from persons exposed to CBR agents, sewage from a residence in which persons exposed to CBR substances have bathed, showered, or laundered clothes, and runoff from decontamination activities due to precipitation or exceeding physical barrier capacity. To the extent possible, event planning may take into account both controllable and uncontrollable sources of decontamination wastewater.

Although expected to be rare, there may be an instance where the intentional discharge of untreated decontamination wastewater appears to be the best option. For example, where the existing treatment system may be able to breakdown and/or effectively treat certain kinds of chemical and biological contaminants or where the need to get certain contaminants away from population centers outweighs the potential harm to the wastewater system (i.e., a worst case scenario). These types of scenarios are beyond the scope of this document and may have serious implications for wastewater treatment plants if they knowingly accept a wastewater stream that may negatively affect their plant or receiving water. Careful pre-planning is critical in these instances to ensure wastewater utilities are involved in any decision-making process from the beginning.

It is important that utility managers plan for decontamination wastewater incidents both within their organization and through cooperation with emergency managers and first responders in order to minimize the discharge of decontamination wastewater and better protect employees, customers, infrastructure, and the environment in the event that discharges occur.

Planning Within the Utility

Although there are uncontrollable sources of decontamination wastewater, utilities' preparedness to minimize impacts to their system merits attention. Suggested utility actions related to decontamination wastewater are relevant to other emergencies, too. As with any emergency, defining clear planning steps and training utility workers will improve responses during an event. The utility may:

1. Develop an Emergency Response Plan (ERP), updated at least yearly, that includes:
   - A decision-making framework for responding to incidents where decontamination wastewater may be generated;
   - Procedures for preparedness, response and incident management for such events; and
   - Contact information for organizations including principal individuals and alternates to assist with recovery, and agencies with their appropriate individual contacts and alternates to notify in case of a decontamination event. ERPs may include information and a checklist on protective actions for a decontamination wastewater event.

The Vulnerability Self Assessment Tool™ (*VSAT*™) has emergency response planning (ERP) modules for both water and wastewater. The module incorporates links and resources of ERP tools and includes direct linkages between the Environmental Protection Agency's Response Protocol Toolbox (which is currently focused on drinking water) and the Water Environment Research Foundation's ERP guidance. *VSAT*™ software is available, free of charge, for wastewater utilities (*VSATwastewater*™), drinking water utilities (*VSATwater*™), and for utilities providing both services (*VSATwater/wastewater*™) at http://www.vsatusers.net. For more information on emergency response planning, see the websites listed in Chapter 5;

2. Maintain and distribute supplies and equipment that could be used to contain decontamination wastewater, and reduce its impacts on the wastewater system. These may be drain seals for stormwater inlets, or other equipment such as that identified in the next chapter;
3. Provide personal protective equipment (PPE) for those appropriately trained employees who may be assigned to assist emergency personnel. Yearly training on PPE use is suggested; and
4. Develop mutual aid agreements with adjacent wastewater utilities and contracts with hauling companies to assist in providing services should a portion of the wastewater system be temporarily out-of-service. Discussions and written agreements with adjacent wastewater utilities and hauling companies can allow for transfer of unaffected wastewater in the event that one system is compromised and cannot operate in all portions of the service area.

Coordination with Local Emergency Managers and First Responders

Wastewater utility managers can contact their local emergency managers and first responders to discuss protocols should an event occur that produces decontamination wastewater. Ideally, wastewater personnel will be included in regional committees or discussion groups involving municipal security and emergency response planning, such as the Local Emergency Planning Committee (LEPC) established by a state's Emergency Response Commission. If you are unsure whom to call regarding these groups, begin by contacting the local fire department. HAZMAT teams and emergency response organizations should either be a part of the fire-fighting organization or be closely affiliated with them. Refer to the textbox for an example discussion.

An example discussion between a wastewater utility manager and the local HAZMAT Team Coordinator from the Fire Department:

Ms. Utility had called the local fire department and asked to speak to the person in charge of the Hazardous Materials (HAZMAT) team last week. She then asked Mr. HAZMAT if he would meet for an hour to discuss how the wastewater utility can best coordinate with his team and other first responders. Here are some of their discussion points…

Ms. Utility: *I'd like to talk to you about the effects of a Chemical, Biological or Radiological attack in the city, and your HAZMAT team's response activities that may result in a discharge of wastewater to our system.*

Mr. HAZMAT: *O.K., what would you like to know?*

(Continued>>)

<<Example Discussion (Continued)

Ms. Utility: *I certainly understand that your first responsibility is to protect human life. However, what actions do you take to prevent decontamination water from entering storm sewers or the sanitary sewer system? We're concerned, because any of this decontamination wastewater that enters the sewer can potentially impact the health of our workers, effect treatment efficiency, our biosolids, or pass through the plants into the environment.*

Mr. HAZMAT: *Well our trucks carry storm drain seals and booms to contain waters associated with decontamination activities. We also have access to mobile showers with sumps to catch the waters used to decontaminate people who may have been contaminated.*

Ms. Utility: *That's all good, but what if there's too much of the decontamination wastewater to contain, or a boom system is breached? Do your procedures require an immediate call to the wastewater facility to let us know, regardless of the quantity?*

Mr. HAZMAT: *We have a list of folks to contact through the 911-call center. I'll make sure you all are on it. Do you have your own emergency response plan with contact information and has your staff been trained in the Incident Command System (ICS)?*

Ms. Utility: *Our staff has taken some online training on the National Incident Management System (NIMS) and ICS. But it would be great if our staffs could meet and discuss respective roles and responsibilities during a CBR incident.*

Mr. HAZMAT: *Sounds like a plan. I could do some presentations on ICS, so that your staff understands how we work together in the field.*

Ms. Utility: *Great. You know we really need to be involved in your emergency exercises, and I hope we can host at least one exercise per year ourselves. We need to practice coordinating with you, so we are ready if a CBR incident ever happens, even though we all hope this is training we never need to use.*

To best prepare your utility and community for response to a CBR event, consider hosting a meeting with all the organizations potentially involved in such an event. If possible, ask to join in local emergency exercises (most communities hold them at least yearly), or host one involving a decontamination wastewater scenario. Consider contacting the types of organizations shown in Table 3-1. EPA's *Emergency Response Tabletop Exercises for Drinking Water and Wastewater Systems* CD-ROM (January 2005, EPA 817-C-05-001) may be helpful in preparing practice scenarios.
In addition to training and meetings, a wastewater utility may also decide to:

1. Establish protocols, agreements and memoranda of understanding with local emergency management agencies and first responders to assure the utility is notified of incidents that may generate decontamination wastewater;
2. Assist local emergency managers and first responders in developing procedures and identify laboratories for rapidly determining type and concentration of CBR substances in decontamination wastewater;
3. Collaborate with local emergency managers and first responders in designing methods for containing as much decontamination wastewater on-site as possible, or diverting decontamination wastewater to holding tanks or diked-in areas, where testing and treatment can be accomplished;

Table 3-1. Organizations to Participate in Meetings or Emergency Exercises Involving Decontamination Wastewater Scenarios

Organization	Type
Wastewater Utility	Local
Water Utility	Local
Fire Department	Local
HAZMAT Team	Local or State
Police and Sheriff Departments	Local or State
Laboratory that can perform analysis for contaminants	Private, Local or State
Hospitals	Private or Local
Health Department	Local and State
Emergency Services	Local
Local Emergency Planning Committee	Local

Table 3-1. Organizations to Participate in Meetings or Emergency Exercises Involving Decontamination Wastewater Scenarios (Continued)

Organization	Type
Neighboring Wastewater Systems	Local
Department of Environmental Quality or Services	State
U.S. Environmental Protection Agency (USEPA) Security Contact or Coordinator	Federal by Region
USEPA Spill Response Team	Federal by Region
Department of Homeland Security	State or Federal
Federal Bureau of Investigation (FBI)	Federal by Region

4. Provide local emergency managers and first responders with the information they need to acquire and deploy equipment and materials to prevent decontamination wastewater from entering the sewer system;
5. Discuss with first responders the appropriateness of adding a safe tracer (dye or other substance) to water used for decontamination so that the resulting wastewater can be tracked prior to, and after entering the sewer system; and
6. Prepare "standby" public notices, with the assistance of local emergency managers, to be used to inform persons involved in an incident the steps to take to avoid discharge of CBR wastes into the sewer system.

Coordination and Communication with Customers and Agencies that May Discharge Decontamination Wastewater

Customers can be an important element to successfully managing decontamination wastewater. Through pretreatment programs, wastewater systems will have a list of industrial and commercial customers who may inadvertently contribute to decontamination wastewater production. Utilities can meet with key staff members of hospitals, clinics, laboratories and industrial customers to explain the possible impacts of decontamination wastewater, and offer assistance in developing methods for notification, analysis and containment.

Pretreatment programs provide an easy link to planning for decontamination wastewater. Utilities may incorporate appropriate requirements into pretreatment control instruments so that customers can immediately notify the utility of any incident requiring decontamination that may result in wastewater discharge from their building or facility. The utility can also ensure that all appropriate customers such as hospitals, clinics, laboratories and other selected non-domestic dischargers develop and maintain plans for properly managing any decontamination wastewater that may result from normal activities or result from malevolent incidents.

Although not a decontamination wastewater issue per se, it is also important to work with water utilities to establish procedures for disposing of contaminated water from reservoirs, water treatment facilities, and water distribution systems in ways that would not adversely impact the sewer system, such as isolation and in-situ treatment, or temporary storage prior to discharge. The water utility, and all other agencies, must have a current name and contact phone numbers at the wastewater utility for after hours as well as business hours.

Responsibilities, Decontamination Regulations and Guidelines for First Responders

It is important for wastewater utility personnel to understand their basic responsibilities, and those of first responders, should a CBR incident occur. Although these responsibilities will vary from one locality to another, the basic principle remains the same: trained emergency responders (such as local or State HAZMAT teams or federal WMD teams) will take primary responsibility at an event where dangerous substances have been released. First responders will use the Incident Command System[7] to organize all response personnel. Wastewater staff will fit into that response, typically under the "Operations" function. Wastewater staff may play an advisory role, but are unlikely to

[7]More information on ICS and the National Incident Management System (NIMS) can be found through the NIMS integration center at www.fema.gov/nims

Example Scenario:

Consider conditions at a scene where decontamination wastewater is produced. Emergency responders are responsible for controlling and containing runoff to minimize spread of a contaminant. Large volumes of water runoff will be difficult to mitigate. Contained water will need to be tested and monitored to determine the appropriate disposition. This may be closely coordinated with the U.S. EPA and local environmental agencies. Uncontained runoff may have long-term environmental effects due to the level of contamination and the release of massive quantities of water into the environment. Contained water should be monitored and approved for discharge or properly classified for disposition as a hazardous/chemical waste.

be commanders at the incident. The more often wastewater staff have interacted with emergency responders during planning sessions or exercises, the more likely they will be recognized during an actual emergency.

Responders must attend to all of the preceding issues, while putting life safety first. These issues may be discussed with key players during planning workshops. Before attending a workshop, wastewater personnel may consider the following regulations and guidelines for emergency responders:

- The U.S. Environmental Protection Agency (U.S. EPA) has stated that runoff due to a decontamination event is not considered an act of negligence when emergency responders undertake the necessary actions to save lives and protect the public. U.S. EPA's standing on contaminated water runoff does not eliminate the responsibility to control the flow of water into the local environment. After the imminent threats to human health and lives are addressed, all reasonable efforts to contain the contamination or mitigate the contamination would then be taken;[8] and
- Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 107, the good Samaritan provision states, "no person shall be liable...for costs or damages as a result of actions taken or omitted in the course of rendering care, assistance, or advice in accordance with the National Contingency Plan (NCP) or at the direction of the on-scene coordinator appointed under this plan, with respect to an incident creating a danger to public health or welfare or the environment as a result of any releases of hazardous substance or threat thereof."[9]

[8]*First Responders' Environmental Liability Due to Mass Decontamination Runoff, USEPA, July 2000, U.S. EPA 550-F-00-009*

[9]*Comprehensive Environmental Response, Compensation, and Liability Act 1980 (CERCLA). Section 107(d)(1).*

REDUCING THE RISK AND IMPACT THROUGH Physical Measure

A wastewater utility's primary line of defense is to prevent decontamination wastewater from entering the collection system. While the wastewater utility has ultimate authority over what is discharged to its system, CBR incident scenes will be under the control of emergency managers and first responders whose first priority must be protection of human life. As discussed in Chapter 3, collaborative planning, coordination and communication between the wastewater utility and emergency management agencies and first response organizations is critical to ensure that the proper equipment will be available and that responders will be more aware of the importance of preventing as much decontamination wastewater runoff as possible.

Standard protocols for decontamination activities include procedures to prevent runoff of decontamination wastewater and contain it on-site or in holding tanks until it can be analyzed and disposed of safely. However, efforts to preserve the life, health and safety of victims will always remain paramount, and as such, it is likely that preventing all decontamination wastewater from running off the site may not be practical. This can be especially true for incidents involving mass casualties or large areas of contamination, where the quantity of decontamination wastewater will overwhelm the capacity of holding tanks, constructed berms or sorbents. In addition, uncontrollable sources such as urine and feces from persons exposed to CBR agents, sewage from a residence(s) where persons exposed to CBR substances have bathed, showered, or laundered clothes, and runoff from decontamination activities due to precipitation will occur despite any prior planning efforts.

When decontamination wastewater cannot be contained, planning and coordination can better control the routes of entry into a utility's system, possibly limit the rate of entry into the system, and ensure the wastewater utility is aware of the discharge and prepared to minimize any downstream impacts.

Ultimately, the wastewater utility must be prepared for the discharge of decontamination wastewater, whether from emergency operations or uncontrollable sources, and understand what can be done to protect utility personnel and ensure the quality of the plant effluent and biosolids.

Preventing Decontamination Wastewater from Entering the System

When taking actions to prevent the discharge of decontamination wastewater, it is critical to determine what CBR substances may be contained in the decontamination wastewater as quickly as possible. In order to prevent decontamination wastewater from entering the sewer system, the appropriate equipment must be available to first responders. Proper training and knowledge of the collection system for those responsible for deploying the equipment are important considerations. This is where wastewater utility management can assure joint planning, coordination and training, as discussed in Chapter 3.

Three physical methods are available for preventing decontamination wastewater from entering the system: (1) barriers; (2) containment; and, (3) sorbents. While they can be used individually, the most effective means of keeping decontamination from reaching the collection system will include a combination of all three methods, provided that they are in good working order. This section describes these methods.

Barriers

Barrier methods prevent decontamination wastewater from reaching the collection system by placing a physical obstacle in the way of the runoff. Barriers work best when well-maintained and properly installed. Examples of barriers include the following:

Drain seals are placed on the top of inlet grates. These drain seals are made of non-absorbing, chemical resistant materials such as reinforced polyurethane or neoprene. They are available in a variety of sizes and shapes and can be stored in a facility or on trucks for rapid deployment.

Manhole shields are placed on top of a manhole rim, extending the height to which surrounding water must reach before flowing into the manhole. Manhole shields have an inflatable bladder to form a watertight seal between the shield and the manhole rim.

Pan inserts prevent runoff that passes through holes in manhole covers, or between the cover and rim, from reaching the sewer. The pans, which are made of stainless steel, aluminum, or other corrosive-resistant material, are placed under manhole covers. The lip of the pan sits on a gasket that rests on the manhole rim to make a watertight seal. Pan inserts are frequently supplied with a locking device because they also serve to secure the manhole from unauthorized access.

Portable berms are flexible strips of non-absorbing material weighted down to stay in place. They are typically available in varying lengths and also by modules to accommodate corners and connect separate strips. These berms can be kept in stores or on trucks and rolled-out for use when needed.

Drain plugs are available as tapered wedges that fit into drains to prevent runoff from entering the drain. They are made of flexible, non-absorbing material and are available in various sizes to fit differently size drains.

Containment

Containment methods are intended to keep decontamination wastewater near its area of production. They consist of sumps or pools that retain the runoff from decontamination procedures. Since containment devices have limited capacities to hold the contamination wastewater, pumps are typically added to transfer the decontamination wastewater from the sump or pool to 55-gallon drums or holding tanks for later disposal. Many portable decontamination showers, corridors and wash kits include a sump or pool to contain the decontamination wastewater.

Sorbents

Sorbents are most effectively used to absorb and retain small amounts of decontamination wastewater, such as the runoff that may seep under a barrier, or overflow a containment sump. Sorbents are available in a wide variety of materials including gels, granules, and polypropylene. Most are specifically designed for individual classes of hazardous liquids, such as acids, caustics, toxins, body fluids and petroleum products. Used sorbents are typically placed in salvage drums for proper disposal.

Mitigating the Impacts of Decontamination Wastewater

If it is not possible or practical to prevent decontamination wastewater from entering the sewer system, utilities and emergency agencies can work together to minimize the impact that the CBR substances may have on the sewer system, treatment processes, biosolids, air emissions, facility personnel, and the environment. Again, it is critical to determine which CBR substances may be present in the decontamination wastewater as quickly as possible. Controlling the rate of flow into the sewer, or providing several entry points through different manholes may be considered, depending upon specific site conditions. One method to help manage decontamination wastewater when it cannot be prevented from entering the sewer system, is to have first-responders add a tracer compound to the water they use for decontamination. The tracer compound should be stable under UV light, environmentally safe, non-toxic, economical, and readily detectable in small concentrations. Protocols for decontamination in the United Kingdom call for fluorescein, a commonly used tracer dye, to be added to water used for decontamination. In some cases, especially where partial containment is possible, first responders may be able to perform some measure of pretreatment before discharging to the sewer system.

Decontamination Wastewater Containing Chemical Agents

Though every effort should be made to prevent unauthorized discharges of decontamination wastewater, with the large quantities of water that will be used to decontaminate victims at the site of an attack with chemical agents, it is likely that concentrations of the chemical agent in the decontamination wastewater will be minimal.

Chemical agents in the decontamination wastewater, whether inorganic or organic, are not likely to cause damage to the infrastructure. However, some chemical agents release hydrochloric acid when they are dissolved in water. Some are extremely volatile and may not reach the collection system even if initially contained in the decontamination wastewater. Also, the agents that do reach the collection system are likely to volatilize there, especially where the flow is turbulent and exposed to the atmosphere. Consequently, dangerous vapors or aerosols may be released at manholes, but more likely at the following points:

- Pump station wet wells;
- Manholes receiving discharges from force mains;
- Treatment plant influent channels;
- Unenclosed screw pumps;
- Bar screens and grit chambers;
- Primary settling tanks using water jets to control foaming;
- Aeration basins;
- Trickling filters, where wastewater splashes onto the filter media;
- Rotating biological contactors;
- Oxidation ditches (depending on the type of aeration equipment used) and where high-pressure water jets are used to control foam formation on the water surface; and
- Belt filters.

Once in the treatment process, a chemical agent may be removed by volatilization to the atmosphere, sorption onto biomass with loss through wastage of the biomass, and biodegradation. Sorption and desorption of chemicals may be reversible or irreversible, and may involve complex chemical reactions. Biodegradation may occur as microorganisms use the chemical as a source of carbon for growth and energy. Physical removal mechanisms may also occur and affect the concentration of chemicals that are present in the treatment effluent. Chemical agents not removed by the treatment process may undergo degradation, or pass through to be present in wastewater effluent and biosolids.

It is also possible that some chemical agents such as hydrogen cyanide, and to a lesser extent arsenic trihydride, tabun and VX, may ignite and explode if sufficient concentrations of the agent enter the sewer system.

Table 4-1 lists decontamination methods for several chemical agents that may be used by first responders. Wastewater utilities should be aware that decontamination wastewater discharges may also contain these substances.

Table 4-1. Examples of Decontamination Methods for Selected Chemical Agents

Chemical Agent	Class	Decontamination Method
Nitrogen mustard	Blister Agent	2-6 percent aqueous sodium hypochlorite solution, DS-2
Sulfur mustard	Blister Agent	2-6 percent aqueous sodium hypochlorite solution, DS-2
Lewisite	Blister Agent	7 percent aqueous slurry or solid calcium hypochlorite (HTH), DS2
Sarin	Nerve Agent	Sodium hydroxide, DS-2
Tabun	Nerve Agent	Sodium hydroxide, DS-2
VX	Nerve Agent	7 percent aqueous slurry or solid calcium hypochlorite (HTH), DS-2

Note: DS-2 is U.S. Military's *Decontamination Solution No. 2,* 70 percent diethylenetriamine, 28 percent ethylene glycol, monomethyl ether, and 2 percent sodium hydroxide. DS-2 is less corrosive to metals than bleach-based decontamination solutions, but it can damage painted surfaces and plastics. DS-2 is commercially available.

Decontamination Wastewater Containing Biological Agents

In concentrations much lower than chemical agents, biological agents can cause illness and death. Many biological agents are not persistent in the environment, and may die off due to exposure to sunlight or the residual chlorine that may be in the water used for decontamination. However, there are some bacteria, viruses and toxins that remain persistent under normally adverse conditions and can survive prior to and during travels through the collection system. Secondary treatment systems may not remove biological agents, so effective disinfection of effluents is important. High temperature processes, such as anaerobic digestion, heat drying and incineration, designed to significantly reduce the number of pathogens normally present in biosolids should also result in deactivation of most biological agents entering the treatment plant via decontamination wastewater.

Chlorine, applied to the effluent stream in the treatment plant's contact chamber, can be effective for deactivating most biological organisms. Chlorine may also be added to containerized decontamination wastewater if containment is possible and the wastewater does not have any substances that will react with chlorine to cause adverse impacts. For example, prior to discharge to the sewer system, a sodium hypochlorite solution was used, under the direction of the wastewater authority, to deactivate anthrax spores in the decontamination wastewater generated in the cleanup following the anthrax attacks of 2001. Other possible disinfectants first responders may use include the U.S. EPA's Office of Solid Waste and Emergency Response list of liquids (see Table 4-2) for decontaminating surfaces.

Table 4-2. Examples of Biological Agent Disinfectants

Disinfectant	Concentration	Contact Time
Bleach & Vinegar	1:1:8 (Bleach:Vinegar:Water)	60 minutes
Chlorine Dioxide	500 mg/l	30 minutes
Peroxyacetic Acid with Hydrogen Peroxide	5000 mg/l	10-20 minutes

Decontamination Wastewater Containing Radioactive Substances

Radioactive materials contained in decontamination wastewater may result in contamination of pipes, pumps, valves, or biomass. Also, certain treatment processes may reconcentrate radioactive materials causing higher levels of radiation in screenings, grit and biosolids, depending upon the solubility and other properties of the radionuclide involved, as shown in Table 4-3. Radiation in biosolids can become further concentrated as biosolids are dried or burned. It is important to remember that no chemicals can decontaminate or neutralize radiological contamination. The U.S. EPA has participated with several other federal agencies constituting the Interagency Steering Committee on Radiation Standards (ISCORS), which has prepared guidance for management of radiation at wastewater utilities. The information on radionuclide occurrence in wastewater treatment plants and biosolids, and radiation protection in general can be found at: *www.epa.gov/radiation*.

Table 4-3. Characteristics of Various Radionuclides

Radionuclide	Fate
Cobalt-60	Some will be retained in biosolids, may be in grit if metal pieces
Strontium-90	Some will be retained in biosolids, may be in grit if ceramic pieces
Molybdenum-99	Soluble
Iodine-131	Soluble
Cesium-137	Soluble
Iridium-192	Some will be retained in biosolids, may be in grit if metal pieces
Radium-226	Soluble and insoluble; some may precipitate on metal surfaces or be retained in biosolids
Uranium	Soluble and insoluble; some will be retained in biosolids, may be in grit if metal pieces
Americium-241	Some will be retained in biosolids, may be in grit if metal pieces
Plutonium	Some will be retained in biosolids, may be in grit if metal pieces

Mitigating Impacts on Utility Personnel

Employees of wastewater utilities are regularly exposed to chemical and biological agents at their workplace. The main hazard, which is present in nearly all stages of the wastewater treatment process, is the risk of exposure to biological aerosols. It is important to realize that the potential microbial exposure hazards are not the same at different steps of the wastewater treatment process. Furthermore, even for a given step of the process, much of the exposure risk depends on the plant-specific configuration.

The amount of CBR substances to which wastewater workers may be exposed will be substantially less than if they were exposed at the site of the release. First, the water used to decontaminate the site and victims of the incident will dilute the substance. Second, many chemical and biological agents, as discussed in previous sections, may not be stable and will partially or completely volatilize before reaching the sewer system. However, once decontamination wastewater is generated from a site, wastewater utilities may assume that some CBR substances may have entered the sewer system, and take appropriate measures to protect their workers. Wastewater managers may have their engineers calculate travel times within the collection system and detention times within the treatment plant to determine when agents, if contained in the wastewater, may reach certain points in the collection system and different process units in the treatment plant. Predictive models, as described in the next section, may also be used. Safety measures that can be considered include the following:

- Prevent personnel from entering manholes;
- Suspend sewer inspections and cleaning operations;
- Prevent personnel from entering wet wells and dry wells of pump stations;
- Suspend manual cleaning of bar screens and removal of grit;
- Restrict access to aeration basins, trickling filters and other areas of the treatment plant where aerosols may be released;
- Suspend manual handling of biosolids;
- Divert effluent and reclaimed water to holding tanks or ponds, if possible; and
- Store biosolids for analysis.

It is emphasized that the detection, analysis and handling of wastewater that may have been contaminated with chemical, biological or radiological agents, can be handled by emergency responders trained to handle hazardous materials (such as a HAZMAT Team), and not by utility workers. Only after the "All Clear" is given by emergency responders would wastewater utilities allow their personnel to resume normal operations. HAZMAT personnel can also be relied upon to give direction to the utility on what personal protective equipment (PPE) should be worn by wastewater utility workers to perform critical tasks.

Predictive Models

The fate of some CBR substances in wastewater collection systems may be estimated by the use of models. Several available software models can be adapted to predict the emissions of hazardous agents that have entered into a wastewater collection system through decontamination efforts.

The **Interceptor Model** is a computer-based model that was developed to predict the transport, generation, and fate of hydrogen sulfide and volatile organic compounds (VOCs) in wastewater collection systems. This model can currently model up to 400 VOC compounds. Input information includes: segment length, diameter, flow rate, slope, friction factor, and the slime layer growth constant.

The **BASTE Model** is a computational model that estimates pathway losses (volatilization, sorption, biodegradation) from wastewater for strings of processes that constitute treatment trains. If a hazardous compound washed into the sewer system is not already one of those modeled by the Interceptor Model or BASTE, it can be added to the list of modeled compounds by inputting parameters such as Henry's constant and molecular weight.

The **Hydra V6** is a comprehensive hydraulic model used for challenges of storm and sanitary sewer modeling.

The **Sewer CAD** is a complex design, analysis, and planning tool, handling both pressurized force mains and gravity hydraulics.

The **TOXCHEM+v3** estimates emissions of organic and metallic contaminants from wastewater treatment and collection systems.

Water 9 estimates air emissions of waste constituents in wastewater collection, storage, treatment, and disposal facilities.

For radioactive substances, conservative estimates of emissions could be modeled by assuming that the compound stays in its initial form. Radioactivity does not directly affect volatility or Henry's Law; therefore, the emissions of the parent compound can be estimated. However, the geometry of pipes, tanks, pools, sewage and sludge is so complex that it is difficult to model the radioactivity in each process.

REDUCING THE RISK THROUGH

Training and Information Updates

Information related to homeland security is being produced at an astounding pace. Government agencies, the military, research institutions, academia and industry are sponsoring and undertaking research and development to better understand vulnerabilities, evaluate risks, provide better early warning devices, and develop better response and recovery mechanisms. Many of these efforts will assist wastewater utilities either directly or indirectly in preparing their emergency response plans and mitigating the consequences of an incident involving decontamination wastewater. Consequently, it is imperative that wastewater utility managers stay abreast of the rapid evolution taking place in homeland security information, and assure that their staffs are knowledgeable and trained to perform their duties safely and effectively under difficult circumstances.

What follows are suggestions for training utility personnel and others who interact with the wastewater utility, a description of emergency exercises, and a description of reference sources to provide up-to-date information related to decontamination wastewater.

Training for Staff

Providing periodic training for utility staff is imperative for a positive outcome should a real emergency with decontamination wastewater occur. Basic training needs for personnel include emergency preparedness, an overview of CBR substances and protective measures, and a basic understanding of the National Incident Management System (NIMS), as well as the Incident Command System (ICS) that will be used by all emergency responders. Homeland Security Presidential Directive 5 (HSPD-5), Management of Domestic Incidents, asserts that all governmental entities and supporting organizations, including utilities, immediately adopt NIMS, and outlines steps to take to achieve NIMS compliance. Convenient on-line training options are available, and are described along with others in Table 5-1.

Basic training for workers can be addressed during preparation of the wastewater utility's emergency response plan. Some training modules are especially important for those personnel that may be reacting to decontamination wastewater incidents. For example, workers can have some basic hazard communication training (HAZWOPER 29 CFR 1910.1200) which deals with hazardous chemicals in the workplace. Awareness Level training can also be provided and cover the wastewater emergency response plan (ERP), site safety, appropriate selection, use of personal protective equipment (PPE), and decontamination procedures. While utility personnel are not expected to take the lead role in the event of a CBR attack or decontamination effort, in some circumstances utility managers may want to ensure that their employees have available PPE and are trained to assist emergency personnel to contain decontamination wastewater. Individuals required to wear PPE can be trained to know when PPE is necessary, what kind of PPE is needed, how to properly wear PPE, limitations of PPE, and the proper care of PPE. For instance, individuals who must use a respirator can be trained to know the capabilities and limitations of the respirator and know how to wear it. Please note that many training modules require annual refresher courses.

Table 5-1. Training Suggestions

Training Type	Purpose	Description	Resources to Provide Training
Understanding the Emergency Response Plan	To familiarize staff with the plan. Enhances efficiency in emergency response.	Consists of a walk-through of the sections; reviews location of information.	City/County Safety Coordinator; Consultant.
Table-top Emergency Response Drills	To familiarize staff with the emergency response process and participants. Increases efficiency, effectiveness, and interagency cooperation and coordination	Presents scenario with each of the necessary key players involved participating. Advances participants through the scenario; lessons learned are presented.	Consultant; Fire Department; Police; Local Emergency Response Agency.
Full-scale Emergency Response Drills	To enhance knowledge and capabilities during an emergency response. Increases efficiency, effectiveness, and interagency cooperation and coordination.	Presents scenario where the key players are located at their respective agency locations during a mock emergency. Lessons learned are presented.	Consultant; Fire Department; Police; Local Emergency Response Agency.
General Emergency Management Training	To provide general emergency management courses offered on FEMA's Emergency Management Institute training campus. Improves coordination during an emergency.	Provides a concentrated emergency training experience. Held at FEMA's Emergency Management Institute and Training Facility in Emmitsburg, MD: www.training.fema.gov.	FEMA's Emergency Management Institute.
Incident Command System (ICS)	To learn the principles of the ICS and to acquaint the staff with the structure and terminology. Enhances understanding of the ICS allowing for future participation in an emergency.	Includes modules designed to start with the basic structure of ICS up to becoming an Incident Commander and the responsibilities associated with that position.	State or Local Emergency Response Agency; FEMA Emergency Management Institute online course
National Incident Management System (NIMS): An Introduction	Presents the advantages of common communication and information management systems. Using a consistent nationwide template to enable all government, private-sector, and non-governmental organizations to work together during domestic incidents.	Describes the key concepts and principles underlying NIMS, the benefits of using the national incident management mode, and when it is appropriate to institute an Area Command, a Multiagency Coordination System., and a Joint Information System (JIS) for public information. Online course http://training.fema.gov/emiweb/is/is700.asp	FEMA's Emergency Management Institute.
HAZWOPER (Hazardous Waste Operations and Emergency Response)	To familiarize staff with hazardous material handling and requirements. Fulfills federal regulations and prevents hazards from occurring.	Fulfills HAZWOPER training required under 29CFR1910 for personnel who handle, ship, or dispose of hazardous materials, or who are assigned to emergency response teams for hazardous materials. Initial and annual training is required.	FEMA; Fire Department; Local Emergency Planning Agency; Consultants.

Table 5-1. Training Suggestions (Continued)

Training Type	Purpose	Description	Resources to Provide Training
First Aid/Cardio-Pulmonary Resuscitation (CPR)	To provide care to another person. Assists another person when injured prior to emergency care.	Teaches the steps to baby, child, and adult CPR. Learn basic first aid to provide initial care to an injured person.	The Red Cross; Consultant; City/County Safety Coordinator.
Utility Introduction for Emergency Personnel	To familiarize emergency personnel (e.g., police, fire) with utility facilities. Increases communication and decreases response time during an emergency.	Provides a tour and brief classroom training relative to the utility's system components, normal conditions, chemicals stored onsite, vulnerable points, etc.	Operating Staff; Consultants.
On-line Monitoring	To use on-line monitoring equipment throughout the system. Alerts staff to a contaminant before it reaches the wastewater plant or the receiving water body.	Teaches use and maintenance of specific monitoring equipment.	Vendors; Operating Staff; SCADA Operators.
800 megahertz (MHz) Radios	To know the capabilities and operations of an 800 MHz radio. Teaches effective use of a 800 MHz radio, which police and fire use.	Teaches the operations, channel, code, and general maintenance of the radio; practice using a radio.	Local Emergency Planning Agency; Police; Fire Department.
Other Safety Equipment	To teach how to use other types of safety equipment, company and OSHA laws. Prevents a hazard from occurring by properly knowing how to use safety equipment.	Teaches various types of equipment that exist, their uses, capabilities, and limitations (e.g., breathing apparatus).	City and County Safety Coordinators.
Public Information Training	To qualify managers and other personnel to communicate properly with the public	Anyone identified as a spokesperson for the utility can complete this training to prepare for public interaction, including press conferences.	Local public information officer, Consultants

Emergency Exercises

A decontamination wastewater scenario is an ideal situation to provide as an emergency exercise. Such periodic training exercises can be conducted to ensure personnel are able to respond adequately to identified problems and ensure equipment and resources are adequate prior to an actual event. Exercises and drills are intended to provide wastewater system personnel with an opportunity to evaluate the effectiveness of ERPs and identify data and procedural gaps that may occur in an actual emergency. In addition, communication procedures and cooperation among responders (utility and external organizations) can be evaluated and streamlined by completion of exercises and drills. This is a critical step that identifies potential issues to be resolved so that in the event of an actual emergency, response actions are efficient and effective. The activities also provide personnel with an opportunity to practice response protocols and procedures prior to an actual emergency situation.

Records and documentation of completed exercise and drills can be maintained by the wastewater system. These records can be reviewed and evaluated to identify lessons learned. ERP updates and revisions can resolve and incorporate these lessons to improve emergency response effectiveness and efficiency.

Exercises may be held in the classroom, called tabletop exercises, or in the field, called functional exercises. Tabletop exercises can involve utility staff, or include outside agencies as well. The latter is an ideal way to facilitate communication and understanding between agencies regarding a coordinated response to decontamination wastewater.

Full scale exercises take several steps beyond tabletop or functional exercises to evaluate the operational capability of emergency management systems in an interactive manner over a substantial period of time. This type of exercise includes mobilization of personnel and resources, and the actual movement of emergency workers, equipment, and resources required to demonstrate emergency coordination and resource capability. The emergency operating center can be activated and field command posts established. Extensive use of outside agencies can occur, as if this were an actual event.

Information Updates

Keeping informed about security and emergency response issues is made easier by using the internet. In many cases, water security references contain wastewater security information as well. It is impractical to list all the related references and websites here, but the following sites related to decontamination wastewater can link utilities to additional resources and updates:

- The NACWA website security link accessed through http://www.nacwa.org/advocacy/security
- The Water Information Sharing and Analysis Center (WaterISAC) at http://www.WaterISAC.org provides a library (with a robust search capability) offering subscribers a compilation of data about vulnerabilities, emergency response, training opportunities, security solutions, research and government policy. Subscribers can rapidly study chemicals and potential contaminants, review past and current threat information, utilize vulnerability assessment tools and explore security solutions. Sensitive information not available from non-secure sources is included.
- The U.S. EPA website at http://cfpub.epa.gov/safewater/watersecurity, provides comprehensive resources on water and wastewater security including the latest enhancements in research and technology.
- The U.S. EPA Environmental Response Team website at http://www.ert.org, provides a list of available training courses and other relevant information.
- The U.S. EPA website at www.epa.gov/radiation/ provides comprehensive information on radiation protection, emergency response and cleanup of radiation contaminated sites, and management of radiation at drinking water treatment and wastewater treatment facilities.
- The Water Environment Research Foundation at http://www.werf.org provides a search engine to locate research reports and on-going studies related to wastewater security, emergency response planning, the transport and fate of contaminants, and wastewater employee safety.
- Johns Hopkins University, Bloomberg School of Public Health at http://www.jhsph.edu/PublicHealthNews/preparedness/index.html provides on-line public health emergency preparedness training, information on bioterrorism, dirty bombs, and a link to the Terrorism Knowledge Database.
- University of Minnesota, Center for Infectious Disease Research and Policy http://www.cidrap.umn.edu provides details specific to several biological agents, and information on chemical terrorism.
- United Kingdom Department of Health, Policy and Guidance on Intentional Releases of Chemical and Biological Agents at http://www.dh.gov.uk/PolicyAndGuidance/EmergencyPlanning/DeliberateRelease/fs/en provides detailed information on CBR substances along with downloadable monographs, checklists and guidelines for preparedness and response.
- Edgewood Chemical and Biological Center at http://www.ecbc.army.mil provides links to products, services and commodities for detection and decontamination of chemical and biological agents.
- Office of the Surgeon General Medical NBC at http://www.nbc-med.org provides information on the medical effects of nuclear, biological and chemical substances, and has a link to the Army's text, Medical Aspects of Chemical and Biological Warfare.
- Occupational Safety and Health Administration (OSHA) Office of Science and Technology Assessment (OSTA) at http://www.osha.gov/dts/osta/ provides a link to occupational safety training and to the OSHA Technical Manual, which offers technical information on occupational safety and health issues
- Centers for Disease Control and Prevention at http://www.bt.cdc.gov/ provides comprehensive information on chemical and biological agents, as well as information on radiological incidents.
- The Water Security Channel (WaterSC) at http://www.WaterSC.org provides a free, rapid, Email notification to wastewater systems of water security alerts and other information issued by federal government agencies.
- United Kingdom, Civil Contingencies Secretariat at http://www.ukresilience.info/home.htm provides extensive information on CBR terrorism, including procedures for preparedness and response.

Chapter 6

REDUCING THE RISK THROUGH

Continued Research

The U.S. EPA through its Office of Research and Development's Homeland Security Research Center in Cincinnati and its Water Security Division manages the vast majority of water and wastewater security research. U.S. EPA uses both its own staff, the staffs of other agencies such as the National Institute of Standards and Technology (NIST) through interagency agreements, and the private sector and academic institutions through cooperative agreements with industry associations. Other water and wastewater security research is performed through the Department of Homeland Security, by national laboratories such as Pacific Northwest National Laboratory and Sandia National Laboratories, and by private enterprise. Organizations in other countries, such as Kiwa in the Netherlands, are also involved in water and wastewater security research.

Much of the ongoing research has targeted drinking water security, although several important projects have specifically focused on assessing threats to wastewater systems, as well as developing methods and technologies to reduce risks to wastewater. However, a significant number of research projects for drinking water systems have applicability to wastewater systems as well. Projects addressing physical and cyber security, online monitoring and early warning devices, emergency planning, communication, and public health, have value to wastewater professionals as well as those involved only with drinking water.

U.S. EPA's Water Security Research and Technical Support Action Plan[10], issued in March 2004 provides the foundation for identifying critical security issues facing water and wastewater systems, developing the research needs to address the issues, and conceiving the projects to respond to the needs.

Ongoing Research

Several research projects currently underway may provide important information to wastewater utilities as personnel plan for incidents where decontamination wastewater may be generated. Table 6-1 lists these projects.

Table 6-1. Ongoing Research with Applicability to Decontamination Wastewater

Project Title	Description	Manager
Water Contaminant Information Tool (WCIT)	A secure electronic database for tracking and managing current information on priority, nontraditional water contaminants, such as those that are not significant from a regulatory or operational perspective, but which could have substantial adverse consequences to the public and/or utility if accidentally or intentionally introduced into the drinking water.	EPA

[10] *Office of Research and Development, USEPA, Cincinnati, Ohio, March 2004*

Table 6-1. Ongoing Research with Applicability to Decontamination Wastewater (Continued)

Project Title	Description	Manager
Feasibility Testing of Support Systems to Prevent Upsets	A prototype framework for a system of software designed to provide wastewater facility managers with online, near real-time support to assist in diagnosing, rectifying, and recovering from treatment plant upsets arising from malicious attacks.	WERF[11]
Identify, Screen and Treat Contaminants to Ensure Wastewater Security	Guidance for treatment facilities to become better equipped to safely respond to, remediate, and recover from direct or secondary intentional introduction of hazardous materials into wastewater collection and treatment systems.	WERF
Integrated, GIS-based, Simulation Models for Consequence Assessment of Sanitary Sewer and Stormwater Collection Systems Affected by Contamination Events	Software to allow wastewater utilities to perform a comprehensive evaluation of wastewater system performance affected by contamination events.	WERF
Detailed Protocols for Treatment Process, Standard Response, and Collection System Disruptions	Develop and compile detailed standard response protocols that can be used in decision-support tools that allow operators to effectively respond to inputs of chemical, radiochemical or biological toxins.	WERF
Contingency Planning for Wastewater Treatment Facilities	Guides wastewater systems in the development of emergency response plans for natural or manmade (i.e., terrorist related) events, and presents a reference for the information and data that should be included in an emergency response plan.	WERF
Upset Early Warning Systems for Biological Treatment Processes - Phase II-: Fundamental Studies on Source-Cause-Effect Relationships	Studies the root causes of upset in order to establish a clearer relationship between the biochemical causes of process upset and the corresponding physical, chemical, and biological effects on activated sludge treatment process	WERF
Assessing and Characterizing Relationships Between Monitoring Variables and Process Changes: Development of New Intelligent Sensing and Real-time Monitoring Devices to Detect Toxins and Other Contaminants that Disrupt Wastewater Plants	Assess current information linking chemicals or pathogens with specific process disruption events so that the output from the sensor predicts the nature (and possibly the extent) of the process upset. This information will then be used to develop sensing devices that detect key CBR substances and other contaminants that can result in process disruption.	WERF
Emergency Communications with Your Local Government and Community	Provides increased utilization of emergency communication in preparation for and response to crisis events, whether technologically-induced or the result of natural disasters	WERF
Experiences and Research Gaps to Secure Wastewater Infrastructure and Protect Public Health	An ongoing project to develop a comprehensive, prioritized list of research project concepts that ultimately will result in security information and processes that will help protect the nation's public wastewater agencies and human health.	WERF

[11] *Water Environment Research Foundation (WERF)*

Table 6-1. Ongoing Research with Applicability to Decontamination Wastewater (Continued)

Project Title	Description	Manager
Integrated Program for Early Warning Systems Sensors	A series of online monitoring studies, including use of probes, HPLC and GC analysis, chemical optical sensors, as well as an analysis of single and multiple sensors, and establishment of alarm procedures.	AwwaRF[12]
Standard Operating Procedures (SOPs) for Decontamination of Water Infrastructure	Begins developing practical standard operating procedures and guidelines for decontaminating distribution systems for known or suspected contaminants.	AwwaRF

Research Needs

The management of decontamination wastewater is unique in the realm of water and wastewater security. While findings of many research projects can and will contribute to better management of decontamination wastewater, there are several areas where more specific research is needed to enhance the knowledge, planning and response by wastewater managers, emergency managers, and first responders, as follows:

- Collaboration between the utility, emergency managers and first responders;
- Better understanding of the range in characteristics of decontamination wastewater; and
- Fate of CBR substances in wastewater at concentrations likely to be found after a CBR incident.

The list of possible research projects in Table 6-2 should provide a better understanding of the current gaps in knowledge regarding decontamination wastewater issues. As more utilities become aware of the need for additional information on this subject, research organizations and EPA will likely begin to focus more resources on these areas.

Table 6-2. Suggested Example Research Projects to Promote Understanding of Decontamination Wastewater Issues

Possible Project Examples	Objective
Health and Safety Implications of Decontamination Wastewater on Wastewater Worker Health and Safety	Identify the risks of wastewater workers exposed to decontamination wastewater after it enters the sewer system and throughout the treatment process.
Guidance for Wastewater Workforce Management During a Community Catastrophe	Develop guidance to help wastewater managers balance the needs and concerns of employees with the operational demands during a community catastrophe, such as a CBR incident that will generate decontamination wastewater.
Identification of Training Needs for Wastewater Workers with regard to CBR Incidents	Identify the type and depth of information wastewater workers can receive training on to know how to remain safe and effective in their job during a CBR incident that may generate decontamination wastewater.
Identification of Collaborative Programs to Improve the Planning, Response, and Recovery from CBR Incidents.	Working with organizations representing emergency managers and first responders, identify areas where knowledge and training can be improved to better manage decontamination wastewater.
Development of Practical Methods for Emergency Personnel to Contain Decontamination Wastewater	Working with organizations representing emergency managers and first responders, evaluate current methods for containing decontamination wastewater and develop improved and more effective methods.
Estimation of Concentrations and Levels of Concern of CBR Substances in Decontamination Wastewater	Develop an approach to estimate the concentrations and levels of concern of CBR substances in decontamination wastewater based on the quantities of water used in various decontamination activities, and the range of CBR quantities that may be used in a terrorist attack.

[12] *American Water Works Association Research Foundation (AwwaRF)*

Table 6-2. Suggested Example Research Projects to Promote Understanding of Decontamination Wastewater Issues (Continued)

Possible Project Examples	Objective
Fate of CBR Substances in Wastewater Collection and Treatment Systems	Study the persistence and viability of CBR substances throughout a sewer system, with a focus on concentrations that would likely be present in decontamination wastewater
Fate of CBR Substances in Anaerobic Digestion	Study the persistence and viability of CBR substances processed through anaerobic digestion.
Fate and Levels of Concern of CBR Substances in Biosolids	Evaluate which CBR substances contained in decontamination wastewater will end up in biosolids, and in what concentrations. Assess which biosolids processes effect the concentrations of CBR substances in biosolids.
Fate and Levels of Concern of CBR Aerosols in Wastewater Collection and Treatment Systems	Evaluate which CBR substances contained in decontamination wastewater may become aerosolized in collection systems, pump stations and treatment facilities, and recommend methods for controlling such aerosols that may reach levels dangerous to humans.
Effectiveness of UV and Other Disinfection Processes on Raw Wastewater to Reduce the Viability of Biological Agents	Assess the efficacy of UV light and other disinfectants on reducing the risk from biological agents in raw wastewater, by disinfecting in a collection system or at a plant headworks.
Efficacy of Tracers to Determine Pathways of Decontamination Wastewater and Aerosol Distributions	Evaluate whether a tracer dye added to water used for decontamination could help determine the routes of decontamination wastewater in the sewer system and the extent of aerosolization. Rank the effectiveness of tracers.
Feasibility of a "One-Button" Control to Place All Equipment into an Emergency Position or Mode	Assess the feasibility, advantages and disadvantages of allowing an operator to place all valves, gates, pumps, motors, etc., in a previously determined emergency mode by using one-button. This would allow workers to escape a hazardous situation more quickly.
Feasibility of Remote Treatment Plant Operation for Incidents Requiring Operator Abandonment	Assess the feasibility, advantages and disadvantages of transferring treatment plant operations to a remote location should a plant need to be abandoned in an emergency.
Assessing the Viability of In-Situ Treatment of Decontamination Wastewater	Evaluate the methods and logistics of containing and treating decontamination wastewater at the site of its production rather than having it run off the site or hauling it off-site for treatment. Recommend equipment and protocols for emergency personnel to deploy in order to accomplish on-site treatment.

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South Orange County Wastewater Authority, Dana Point, CA
Union Sanitary District, Union City, CA
Vallejo Sanitation & Flood Control District, Vallejo, CA
West County Wastewater District, Richmond, CA
Yucaipa Valley Water District, Yucaipa, CA
Boxelder Sanitation District, Fort Collins, CO
City of Greeley Water and Sewer Department, Greeley, CO
City of Pueblo Wastewater Department, Pueblo, CO
Colorado Springs Utilities Environmental Services, Colorado Springs, CO
Littleton/Englewood Wastewater Treatment Plant, Englewood, CO
Metro Wastewater Reclamation District, Denver, CO
Platte Canyon Water and Sanitation District, Littleton, CO

Ridgefield Water Pollution Control Authority, Ridgefield, CT
The Metropolitan District, Hartford, CT
D.C. Water & Sewer Authority, Washington, DC
City of Wilmington Department of Public Works, Wilmington, DE
Broward County Office of Environmental Services, Pompano Beach, FL
City of Altamonte Springs Public Works Department, Altamonte Springs, FL
City of Boca Raton Utility Services Department, Boca Raton, FL
City of Clearwater, Clearwater, FL
City of Hollywood, Hollywood, FL
City of Orlando, Orlando, FL
City of St. Petersburg, St. Petersburg, FL
City of Tallahassee Water Utility, Tallahassee, FL
City of Tampa Howard F. Curren Advanced WWTP, Tampa, FL
Collier County Public Utilities, Naples, FL
Emerald Coast Utilities Authority, Pensacola, FL
Hillsborough County Water Department, Tampa, FL
JEA (Electric, Water & Sewer), Jacksonville, FL
Miami-Dade County Water and Sewer Department, Miami, FL
Orange County Utilities, Orlando, FL
Palm Beach County Water Utilities, West Palm Beach, FL
South Central Regional Wastewater Treatment Board, Delray Beach, FL
Toho Water Authority, Kissimmee, FL
City of Atlanta Department of Watershed Management, Atlanta, GA
City of Augusta Utilities Department, Augusta, GA
City of Cumming, Cumming, GA
Columbus Water Works, Columbus, GA
DeKalb County Public Works Department, Decatur, GA
Gwinnett County Department of Public Utilities, Lawrenceville, GA
Macon Water Authority, Macon, GA
Peachtree City Water & Sewerage Authority, Peachtree City, GA
City & County of Honolulu Department of Environmental Services, Kapolei, HI
Cedar Rapids Water Pollution Control Facilities, Cedar Rapids, IA
City of Ames Water & Pollution Control Department, Ames, IA
City of Des Moines, Des Moines, IA
City of Boise, Boise, ID
City of Pocatello Water Pollution Control Department, Pocatello, ID
American Bottoms Regional Wastewater Treatment Facility, Sauget, IL
Bloomington & Normal Water Reclamation District, Bloomington, IL
City of Mattoon Wastewater Treatment Plant, Mattoon, IL
Danville Sanitary District, Danville, IL
Downers Grove Sanitary District, Downers Grove, IL
Fox Metro Water Reclamation District, Oswego, IL
Fox River Water Reclamation District, Elgin, IL
Glenbard Wastewater Authority, Glen Ellyn, IL
Greater Peoria Sanitary District, Peoria, IL
Hinsdale Sanitary District, Hinsdale, IL
Kankakee River Metropolitan Agency, Kankakee, IL
North Shore Sanitary District, Gurnee, IL
Sanitary District of Decatur, Decatur, IL
Springfield Metro Sanitary District, Springfield, IL
Thorn Creek Basin Sanitary District, Chicago Heights, IL
Urbana & Champaign Sanitary District, Urbana, IL
Wheaton Sanitary District, Wheaton, IL
City of Fort Wayne, Fort Wayne, IN
City of Valparaiso EKPCF, Valparaiso, IN
City of Indianapolis Department of Public Works, Indianapolis, IN
Gary Sanitary District, Gary, IN
Noblesville Wastewater Utility, Noblesville, IN
Sanitary District of Hammond, Hammond, IN
City of Olathe, Olathe, KS
City of Wichita, Wichita, KS
Johnson County Wastewater, Overland Park, KS
Unified Government of Wyandotte County, Kansas City, KS
Louisville & Jefferson County Metropolitan Sewer District, Louisville, KY
Sanitation District No. 1, Ft. Wright, KY
Sewerage & Water Board of New Orleans, New Orleans, LA
City of New Bedford Department of Public Infrastructure, New Bedford, MA
Fall River Sewer Commission, Fall River, MA
Greater Lawrence Sanitary District, North Andover, MA
Lowell Regional Wastewater Utility, Lowell, MA
Lynn Water and Sewer Commission, Lynn, MA
Massachusetts Water Resources Authority, Boston, MA
South Essex Sewerage District, Salem, MA
Springfield Water & Sewer Commission, Springfield, MA
Upper Blackstone Water Pollution Abatement District, Millbury, MA
Anne Arundel County Department of Public Works, Annapolis, MD
Howard County Department of Public Works, Ellicott City, MD
Washington Suburban Sanitary Commission, Laurel, MD
Augusta Sanitary District, Augusta, ME
City of Bangor, Bangor, ME
City of Kalamazoo Public Services Department, Kalamazoo, MI
City of Saginaw, Saginaw, MI
Detroit Water & Sewerage Department, Detroit, MI
Genesee County Division of Water and Waste Services, Flint, MI
Oakland County Drain Commissioner, Waterford, MI
Wayne County Department of Environment, Detroit, MI
City of Rochester, MN Water Reclamation Plant, Rochester, MN
Metropolitan Council Environmental Services, St. Paul, MN
Western Lake Superior Sanitary District, Duluth, MN
City of Moberly, Moberly, MO
City of Springfield, Springfield, MO
Independence Water Pollution Control Department, Independence, MO
Kansas City Water Department, Kansas City, MO
Little Blue Valley Sewer District, Independence, MO
Metropolitan St. Louis Sewer District, St. Louis, MO
Charlotte Mecklenburg Utilities, Charlotte, NC
City of Greensboro Water Resources Department, Greensboro, NC
City of Raleigh Public Utilities Department, Raleigh, NC
City of Salisbury Salisbury Rowan Utilities, Salisbury, NC
Metropolitan Sewerage District of Buncombe County, Asheville, NC
Orange Water & Sewer Authority, Carrboro, NC
Water and Sewer Authority of Cabarrus County, Concord, NC
City of Omaha Public Works Department, Omaha, NE
City of Nashua Division of Public Works, Nashua, NH
Atlantic County Utilities Authority, Pleasantville, NJ
Bergen County Utilities Authority, Little Ferry, NJ
Edgewater Municipal Utilities Authority, Edgewater, NJ
Ewing-Lawrence Sewerage Authority, Lawrenceville, NJ
Gloucester County Utilities Authority, Thorofare, NJ
Hamilton Township Wastewater Utility, Hamilton, NJ
Hanover Sewerage Authority, Whippany, NJ
Jersey City Municipal Utilities Authority, Jersey City, NJ
Joint Meeting of Essex & Union Counties, Elizabeth, NJ
Kearny Municipal Utilities Authority, Kearny, NJ
Middlesex County Utilities Authority, Sayreville, NJ
North Bergen Municipal Utilities Authority, North Bergen, NJ
Ocean County Utilities Authority, Bayville, NJ
Passaic Valley Sewerage Commissioners, Newark, NJ
Rahway Valley Sewerage Authority, Rahway, NJ
Secaucus Municipal Utilities Authority, Secaucus, NJ
Somerset Raritan Valley Sewerage Authority, Bridgewater, NJ
Stony Brook Regional Sewerage Authority, Princeton, NJ
Albuquerque-Bernalillo County Water Utility Authority-Wastewater Utility Div., Albuquerque, NM
City of Henderson, Henderson, NV
City of Las Vegas Water Pollution Control Facility, Las Vegas, NV
Clark County Water Reclamation District, Las Vegas, NV
City of Ithaca Department of Public Works, Ithaca, NY
County of Monroe Department of Environmental Services, Rochester, NY
Great Neck Water Pollution Control District, Great Neck, NY
Nassau County Department of Public Works, Mineola, NY
Niagara Falls Water Board, Niagara Falls, NY
NYC Department of Environmental Protection, Flushing, NY
Onondaga County Department of Water Environment Protection, Syracuse, NY
Rockland County Sewer District #1, Orangeburg, NY
Suffolk County Department of Public Works, Yaphank, NY
Butler County Department of Environmental Services, Hamilton, OH
City of Akron Public Utilities Bureau, Akron, OH
City of Canton Water Pollution Control Center, Canton, OH
City of Columbus Division of Sewerage & Drainage, Columbus, OH
City of Dayton Department of Water, Dayton, OH
City of Hamilton Department of Public Works, Hamilton, OH
City of Lebanon, OH, Lebanon, OH
City of Lima Utilities Department, Lima, OH
City of Mason, Mason, OH
City of Middletown, Middletown, OH
City of Oregon Wastewater Treatment Plant, Oregon, OH
City of Troy, Troy, OH
Metropolitan Sewer District of Greater Cincinnati, Cincinnati, OH
Northeast Ohio Regional Sewer District, Cleveland, OH
City of Oklahoma City Water & Wastewater Utilities Department, Oklahoma City, OK
City of Stillwater Water Utilities, Stillwater, OK
City of Tulsa Public Works Department, Tulsa, OK
City of Albany, OR, Albany, OR
City of Canby, Canby, OR
City of Corvallis Public Works Department, Corvallis, OR
City of Eugene Wastewater Division, Eugene, OR
City of Gresham Department of Environmental Services, Gresham, OR
City of Klamath Falls Department of Public Works,

Klamath Falls, OR
City of Portland Bureau of Environmental Services, Portland, OR
City of Salem, Salem, OR
City of Wilsonville, Wilsonville, OR
Clean Water Services, Hillsboro, OR
Oak Lodge Sanitary District, Milwaukie, OR
Water Environment Services of Clackamas County, Clackamas, OR
Allegheny County Sanitary Authority, Pittsburgh, PA
Delaware County Regional Water Quality Control Authority, Chester, PA
Derry Township Municipal Authority, Hershey, PA
Harrisburg Authority, Harrisburg, PA
Philadelphia Water Department, Philadelphia, PA
Puerto Rico Aqueduct and Sewer Authority, Santurce, PR
Narragansett Bay Commission, Providence, RI
Warwick Sewer Authority, Warwick, RI
Beaufort Jasper Water & Sewer Authority, Okatie, SC
Charleston Commissioners of Public Works, Charleston, SC
Grand Strand Water & Sewer Authority, Conway, SC
Greenwood Metropolitan District, Greenwood, SC
Mount Pleasant Waterworks, Mount Pleasant, SC
Spartanburg Water System and Sanitary Sewer District, Spartanburg, SC
Summerville Commissioners of Public Works, Summerville, SC
Western Carolina Regional Sewer Authority, Greenville, SC
City of Chattanooga Moccasin Bend Wastewater Treatment Plant, Chattanooga, TN
City of Johnson City, Johnson City, TN
City of Kingsport, Kingsport, TN
City of Memphis Division of Public Works, Memphis, TN
City of Oak Ridge, Oak Ridge, TN
Knoxville Utilities Board, Knoxville, TN
Metropolitan Government of Nashville & Davidson County, Nashville, TN
Austin Water Utility, Austin, TX
City of Amarillo, Amarillo, TX
City of College Station, College Station, TX
City of Corpus Christi Wastewater Department, Corpus Christi, TX
City of Garland, Garland, TX
City of Houston Public Works & Engineering/Public Utilities Div., Houston, TX
Dallas Water Utilities City of Dallas, Dallas, TX
El Paso Water Utilities Public Service Board, El Paso, TX
Fort Worth Water Department, Fort Worth, TX
Gulf Coast Waste Disposal Authority, Houston, TX
North Texas Municipal Water District, Wylie, TX
San Antonio Water System, San Antonio, TX
Trinity River Authority of Texas, Arlington, TX
Upper Trinity Regional Water District, Lewisville, TX
Weatherford Municipal Utilities, Weatherford, TX
Central Davis Sewer District, Kaysville, UT
Salt Lake City Public Utilities, Salt Lake City, UT
Snyderville Basin Water Reclamation District, Park City, UT
Alexandria Sanitation Authority, Alexandria, VA
Arlington County Department of Environmental Services, Arlington, VA
Chesterfield County Utilities, Chesterfield, VA
City of Lynchburg Lynchburg WWTF, Utility Division, Lynchburg, VA
City of Richmond Department of Public Utilities, Richmond, VA
County of Stafford Department of Utilities, Stafford, VA
Fairfax County Wastewater Management Program, Lorton, VA
Hampton Roads Sanitation District, Virginia Beach, VA
Hanover County Department of Public Utilities, Hanover, VA
Henrico County Public Utilities, Richmond, VA
Hopewell Regional Wastewater Treatment Facility, Hopewell, VA
Loudoun County Sanitation Authority, Leesburg, VA
Pepper's Ferry Regional Wastewater Treatment Authority, Radford, VA
Prince William County Service Authority, Woodbridge, VA
Upper Occoquan Sewage Authority, Centreville, VA
City of Everett Public Works Department, Everett, WA
City of Tacoma Public Works Department, Tacoma, WA
King County Department of Natural Resources and Parks, Seattle, WA
Lakehaven Utility District, Federal Way, WA
LOTT Wastewater Alliance, Olympia, WA
City of Fond du Lac, Fond du Lac, WI
City of Superior Wastewater Division of Public Works, Superior, WI
Green Bay Metropolitan Sewerage District, Green Bay, WI
Heart of the Valley Metropolitan Sewerage District, Kaukauna, WI
Madison Metropolitan Sewerage District Nine Springs Wastewater Treatment Plant, Madison, WI
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Public Affiliate Members

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City of Lee's Summit Water Utilities, Lee's Summit,MO
City of Spartanburg, Spartanburg,SC
Greer Commission of Public Works, Greer,SC
Benbrook Water and Sewer Authority, Benbrook,TX
City of Norfolk Department of Utilities, Norfolk,VA
City of Suffolk Department of Public Utilities, Suffolk,VA
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