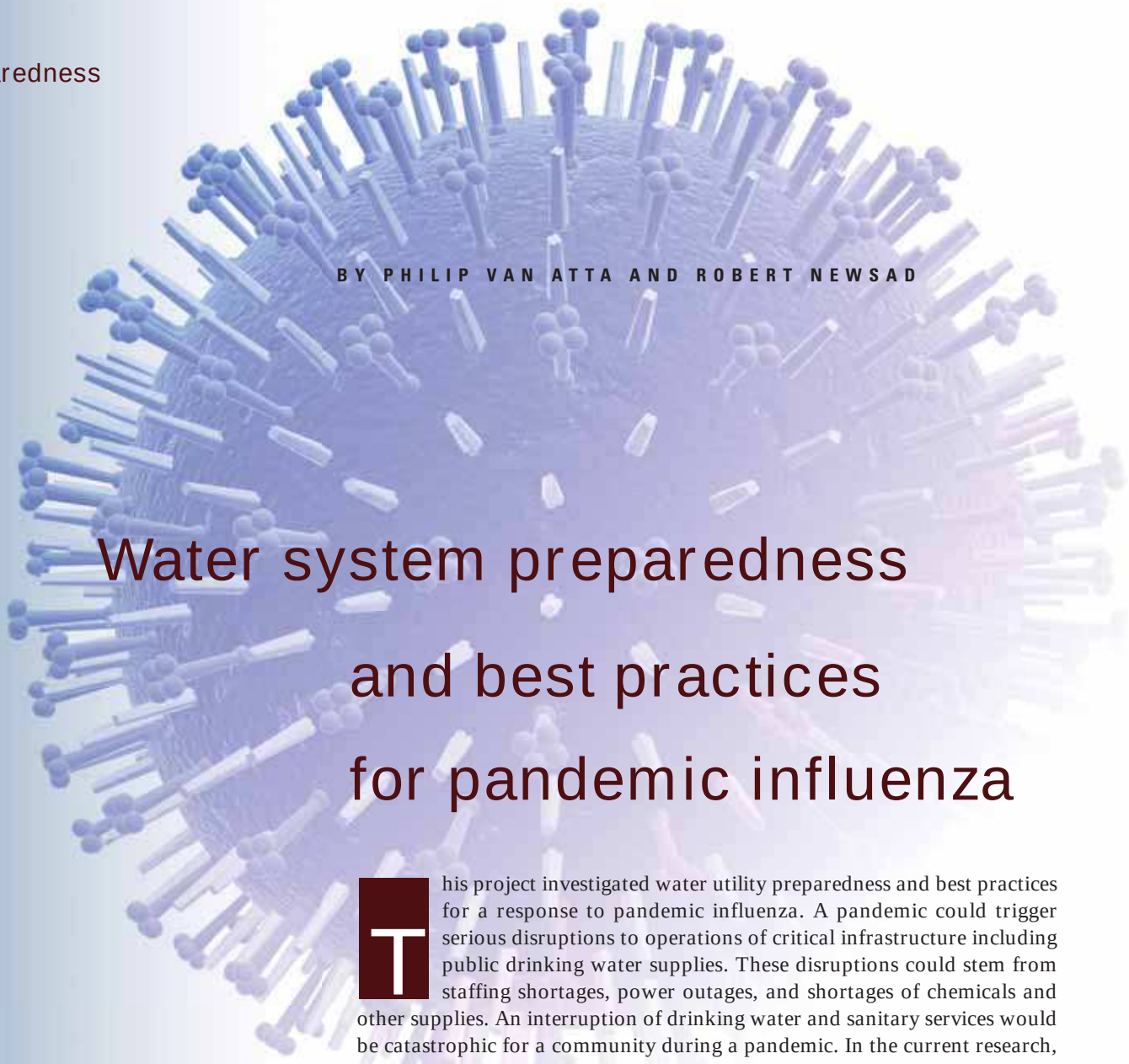


BY PHILIP VAN ATTA AND ROBERT NEWSAD

Water system preparedness and best practices for pandemic influenza

This project investigated water utility preparedness and best practices for a response to pandemic influenza. A pandemic could trigger serious disruptions to operations of critical infrastructure including public drinking water supplies. These disruptions could stem from staffing shortages, power outages, and shortages of chemicals and other supplies. An interruption of drinking water and sanitary services would be catastrophic for a community during a pandemic. In the current research, a literature review, interviews, and a survey of Ohio water systems indicated that water systems across the United States are preparing for pandemic influenza using a variety of methods. Business continuity plans and templates for the development of government agency pandemic influenza plans are readily accessible. This project resulted in the development of a template that can be used by water utilities to prepare for pandemic influenza and other continuity of operations challenges.

Flu pandemics in the 20th century occurred in 1918, 1957, and 1968, and public health and medical experts believe that another flu pandemic could occur at any time (Fauci, 2006). Pandemics occur when a virulent influenza virus undergoes a genetic shift and human-to-human transmission occurs readily. Because of increased global commerce and international travel, today diseases can spread rapidly throughout the world, which would likely make a pandemic in the 21st century much more deadly than in the past. In addition to widespread illness and fatalities, a pandemic flu could create major disruptions to the global economy.

WATER UTILITIES SHOULD ESTABLISH PARTNERSHIPS WITH PUBLIC HEALTH AGENCIES AND EMERGENCY OFFICIALS TO PROVIDE ACCURATE AND EARLY WARNING FOR PANDEMIC INFLUENZA AND OTHER DISEASES.

WHAT ARE THE CONSEQUENCES OF A PANDEMIC FLU?

Drinking water is an unlikely avenue for transmission of avian flu. A review of evidence by the World Health Organization indicated it is unlikely that avian influenza virus can be transmitted through properly treated drinking water or

sewage (WHO, 2006). Although bodies of water could be contaminated by the remains or the feces of infected birds, conventionally treated water should not pose a health risk even if the water source was an open reservoir infected by birds (CRC, 2005). A Netherlands study of avian influenza virus infection via water also concluded that the risk of transmission in treated drinking water is negligible (Schijven et al, 2005).

Water treatment should reduce the avian influenza virus in water to insignificant numbers because the virus has an outer protein envelope that is highly susceptible to damage by oxidants such as chlorine and ozone (WHO, 2006). The US Department of Agriculture and the US Environmental Protection Agency (USEPA) conducted research that indicated that the typical chlorine levels used by public water systems are adequate to inactivate avian influenza virus. Filtration can also be effective for removing the virus (USEPA, 2007). Although drinking water does not appear to be an efficient mode of transmission for influenza, person-to-person transmission could easily spread pandemic influenza to the general population and employees of public water systems.

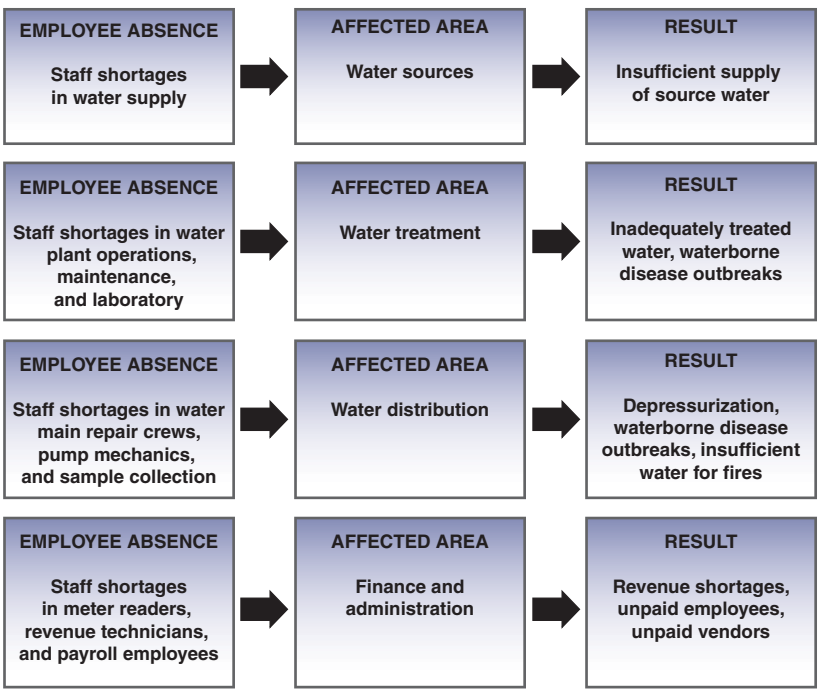
Effects of flu pandemic extend beyond water treatment. The United States has approximately 160,000 public water systems, which serve 84% of the nation through the provision of water for domestic, industrial, and commercial use (USDHS, 2007b). Ensuring continuity of operations for drinking water systems is essential to maintaining the health and economy of all communities. Businesses, factories, and hospitals, clinics, and other public health infrastructure need water to maintain operations. Homes, businesses, and communities are dependent on a continuous supply of water from public water systems to prevent sewage from backing up in sewer lines and to convey sewage to wastewater treatment plants. In the event of a pandemic flu, community water systems could face critical shortages of personnel. Labor shortages would affect production, distribution, water quality testing, vehicle repair, administration, and payroll systems. In addition, labor shortages in transportation, energy, and other sectors caused by an influenza pandemic could lead to insufficient power, parts, supplies, and water treatment chemicals (Figure 1).

Business continuity planning can help ensure that water systems stay up and running. Business continuity planning is a comprehensive, proactive planning process that helps ensure that an entity remains functioning during and following emergencies (SPP, 2007; ASIS International, 2005). Business continuity planning encompasses the strategies, procedures, and resources used by an organization to respond, recover, and resume operations in the event of substantial disruptive incidents. A continuity of operations plan (COOP) specifically describes the preparation, response, and recovery actions necessary to ensure that critical services or products are produced and delivered during and following specified emergencies (USDHS, 2006a). A recent Awwa Research Foundation (AwwaRF) project defined business continuity for water systems as "activities that ensure that the water utility is able to continue its business of providing water services to its customers until business functions assume a state of normalcy" (AwwaRF, 2006).

HOW PREPARED ARE US WATER SYSTEMS FOR PANDEMIC FLU?

Pandemic influenza preparation is a relatively new task for water system emergency planning. As of October 2007, pandemic influenza preparation was not specifically covered in AWWA books and manuals. The Ohio Environmental Protection Agency (OEPA) released its first public document for water system pandemic influenza preparation in late 2006 (OEPA, 2007a). A summary of US preparedness actions related to pandemic influenza is provided in the sidebar on page 47.

FIGURE 1 Employee absence and potential water system disruptions



Water softening basins could go unattended if a pandemic influenza created staffing shortages in the area of treatment and operations.

Government agencies emphasize the need for continuity of operations for critical infrastructure protection. However, few water utilities have addressed continuity of operations in their emergency response plans (AWWA, 2006a). The USEPA and the OEPA encourage water utilities to prepare for supply disruptions and employee shortages in the event of pandemic influenza (OEPA, 2007a). Ensuring that enough employees are available to perform essential services is the most significant factor for maintaining continuity of operations (Hoffbuhr, 2006).

The USEPA has been working with the US Department of Homeland Security (USDHS) and the US Department of Health and Human Services (USDHHS) to assign water system workers a higher priority for access to vaccines and antiviral drugs. In the event of a pandemic influenza outbreak, water and sewer systems would experience decreased staffing levels because of employee illness. Vaccines and antiviral drugs could help ensure that a sufficient number of employees are available to operate water systems.

Study surveyed systems and researched existing utility planning. In the current research, the authors investigated water utility preparation for pandemic influenza in Ohio and the United States and reviewed national, state, and local heath agency and water system pandemic influenza plans. One objective of the project was to determine best practices for water utility continuity of operations during pandemics. The final project objective was to develop a template plan for water utility pandemic influenza continuity of operations planning.

The project included a written survey of 86 medium and large water systems in Ohio to determine the extent of preparations for pandemic flu. Only medium and large water systems were included in the survey because of considerations of data manageability and the belief that small systems were less likely to have pandemic influenza plans. Water system size was determined from OEPA records for the population served (OEPA, 2007b). Data from the survey were compiled for descriptive statistical analysis of the current state of preparedness of water systems in Ohio.

For purposes of this study, the 76 Ohio water systems that served a population in the range of 20,000 to 99,999 were designated as medium-size systems. The 10 Ohio water systems that served a population of at least 100,000 were characterized as large systems. Together these 86 systems serve approximately 7.5 million of the total state population of 10.8 million people served by approximately 5,400 public water systems.

Surveys were sent either by mail or e-mail to the 76 medium and 10 large water systems in Ohio. Surveys were mailed to the majority of the medium-size systems at addresses listed in OEPA website spreadsheets. Surveys were e-mailed to the largest systems and to medium-size systems that had previously been in e-mail contact with this article's primary author.

In addition to the survey, the authors obtained as many existing pandemic response plans as possible from water providers in Ohio and other states. These plans were collected for comparison with utility industry and federal government standards for continuity of operations to determine best practices for a pandemic response. Benchmarks for water system continuity of operations and public health preparedness were established from critical areas identified by the USEPA and AWWA.

Other sources also provided information on pandemic flu preparedness. Information for the project was gathered from presentations delivered at water industry conferences and seminars, including the AWWA Business Continuity Seminar that took place in August 2007. This seminar was attended by 25 utility emergency planners from the United States and Canada (AWWA, 2007). In addition, the authors contacted key water system personnel who had written pandemic influenza COOPs or were currently developing a plan. Other discussions were held with public health officials and emergency preparedness experts to verify critical areas for pandemic influenza preparedness. The relationship between public health preparedness and critical infrastructure, especially drinking water, was one of the areas examined.

From September 2007 to January 2008, an online search was conducted in an attempt to locate existing pandemic influenza template plans for water systems and examine existing public health agency pandemic plans. Search terms used in this online investigation included "pandemic influenza plans," "continuity of operations," and "water system emergency planning." The websites of USEPA, state environmental agencies, various state and provincial health departments, city and county health departments, professional organizations, and other entities were also searched for information on pandemic influenza planning.

Existing pandemic flu plans were reviewed to determine applicability and adaptability for inclusion in a template plan for water utility continuity of operations in the event of a pandemic flu. Some of the essential components for the template were also determined from USEPA and USDHS documents, including Continuity of Operations Planning for Pandemic Influenza Guidance (USDHS, 2006b). Critical infrastructure continuity of operations checklists in business continuity documents from government and professional organizations were used to verify that the template included necessary elements.

RESULTS AND DISCUSSION

Survey results underscored the range of utility preparedness. Of the 86 medium and large Ohio water systems that received surveys, 50 utilities (58%; 46 publicly owned and four privately owned water systems) completed pandemic influenza preparedness surveys (Table 1).

Of the systems returning surveys, 88% stated they either had a plan (in some cases incorporated into their main emergency response plan) or intended to develop a plan (Figure 2). Only 12% of the systems responded that they did not have a plan or any intention to develop a plan. One utility indicated that the local health department would be responsible for pandemic influenza planning. Two systems reported that their existing emergency response plans addressed staffing reductions, but they did not have a plan to address other areas of pandemic influenza planning such as supply shortages.

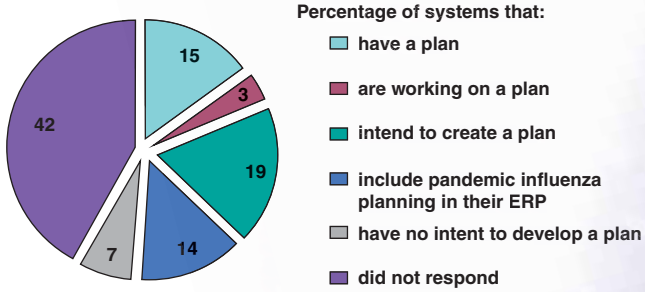
Only four of the 50 Ohio water systems responding (8%) reported having participated in training related to pandemic influenza planning and response. However, 86% of respondents indicated an interest in pandemic training. It is possible that those systems not returning surveys had not developed pandemic influenza plans and were not interested in pandemic training.

TABLE 1 Summary of Ohio water system survey

Planning Status	System Size		Total
	20,000–99,999	≥100,000	
System has a plan.	9	4	13
System is working on a plan.	1	2	3
System intends to develop a plan.	13	3	16
System ERP includes pandemic flu.	11	3	14
Number of surveys returned	38	12	50
Number of systems that did not respond	35	1	36

ERP—emergency response plan

FIGURE 2 Reported pandemic flu preparation status for water systems surveyed in Ohio



n = 50

ERP—emergency response plan, n*—number of water systems responding*

Just 13 of the 50 water systems responding (26%) stated that they had existing pandemic influenza plans. Three of the four privately owned water systems indicated that they had existing pandemic influenza plans. A comparison of planning by system size found that 18 of 38 medium-size systems (47%) and 7 of 12 large systems (58%) reported that they had completed planning for pandemic flu situations.

One Ohio water system provided a copy of its pandemic influenza plan for review. Two systems from outside Ohio allowed review of their pandemic influenza plans. Requests for plans from several dozen other water systems either received no response or were denied because of security concerns.

The US water infrastructure is a key component in pandemic influenza preparedness. Water is one of 17 identified sectors in the USDHS document Pandemic Influenza: Preparedness, Response, and Recovery—Guide for Critical Infrastructure and Key Resources (USDHS, 2006a). There is a strong interdependence between potable water and other critical infrastructure. The water, energy, transportation, and chemical sectors are dependent on one another to maintain operations. Although the guide was officially designed for the private sector (which encompasses 85% of critical infrastructure resources), it offers pandemic planning and background materials that can be used by both public and private critical infrastructure.

The main objective of the guide is to stimulate owner–operators to "develop and integrate effective continuity of operations plans that ensure essential services remain functional and essential goods remain available in the event of a pandemic" (USDHS, 2006a). Continuity of operations would be challenged by reductions in available workers because of illness and disruption in the movement of people and goods. Basic contingency plans are designed for routine challenges such as power outages (Figure 3). The guide categorizes pandemic influenza as an extreme challenge to continuity of operations and promotes development of a continuity of operations plan–essential, or COP–E, as an extension of a COOP to address emergencies such as hurricanes or earthquakes.

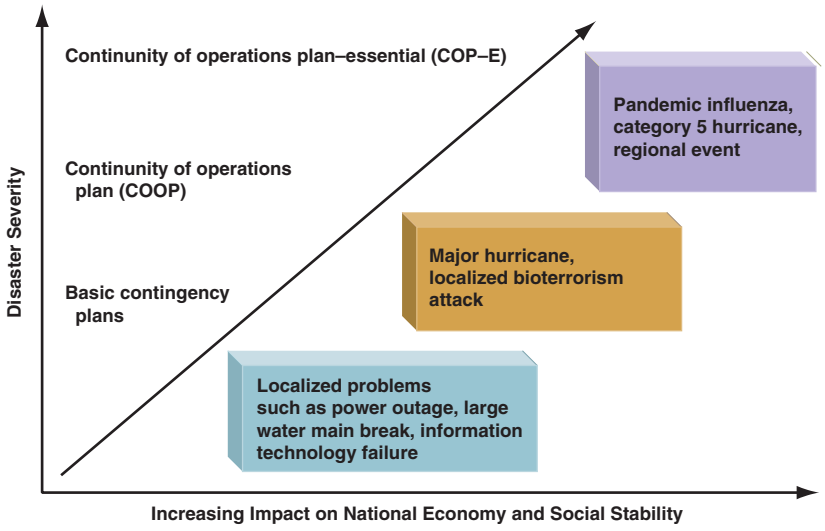
When the Guide for Critical Infrastructure and Key Resources is finalized, information specific to the water sector will constitute one of the guide annexes. This information will identify specific measures that water systems can undertake to maintain continuity of operations in the event of a pandemic influenza (USDHS, 2006a).

The literature review and online search of government documents undertaken in the current investigation did not find pandemic influenza template plans for water systems. The Federal Emergency Management Agency offers a downloadable template document for COOPs and a separate document for pandemic influenza preparation, both designed for government agencies (USDHS, 2006b). In addition, the official government pandemic influenza preparedness website (www.pandemicflu.gov) provides downloadable planning documents and checklists for general business.

Coordination between public health agencies and critical infrastructure sectors is essential. In the United States, state health departments have primacy for public health programs. States delegate control of health programs (including pandemic influenza preparedness) to local health departments. State and local health departments have developed pandemic influenza plans in all 50 states.

Public health agencies have COOPs to ensure that they will be able to provide vaccinations, conduct disease control, and perform other essential public health services in the event of a pandemic. However, these essential services would be greatly affected if water provision or other utilities were disrupted. Major disruptions of water systems caused by pandemics could potentially cause waterborne disease outbreaks that overwhelm healthcare systems and public health departments.

FIGURE 3 Disaster planning continuum



Adapted from USDHS, 2006a

A September 2007 report by the Congressional Research Service provided an analysis of state pandemic influenza preparedness plans written by public health officials (CRS, 2007). According to the report, only 11 state plans mentioned essential services other than public health and healthcare, and only seven plans addressed continuity of essential services, including public utilities. A search of public health department pandemic influenza plans indicated that the only reference to public water supplies usually was found in the section that listed prioritization for vaccination and distribution of antiviral medications. Prioritization of vaccination and distribution of antivirals follows guidance from the USDHHS pandemic influenza plan. Public utility personnel are in tier 2, subtier B (Table 2) for vaccinations and tier 8 (Table 3) for distribution of antivirals (USDHHS, 2005b).

Other references to public water supplies or other critical infrastructure in public health pandemic plans were typically general and brief. Usually the sole reference to drinking water was a mention of the necessity of stockpiling bottled water for staff. The Minnesota Department of Public Health plan called for "work with public water system, local public health, (et al) to assure safety of water supply" (MDPH, 2006). The South Carolina Department of Health and Environmental Control website referred to water and other utilities only in terms of potential labor shortages: "Absenteeism may affect critical supplies such as water and electric . . . " (SCDHEC, 2007).

The scarcity of references points to a need for water systems to contact local public health agencies to discuss pandemic influenza planning. Such discussions should be followed by ongoing pandemic preparedness exercises with participation by both water system employees and public health staff. These efforts would help ensure that public health agencies and water systems understand their interdependencies and lead to significant improvements in all areas of emergency response, including boil water advisories or "do not use water" warnings.

Investigation also finds examples of US water system preparation for pandemic influenza. The USEPA and designated agencies in states with primacy have regulatory responsibility for drinking water systems. As of Feb. 1, 2008, neither USEPA nor OEPA provided pandemic influenza template plans for water systems. The OEPA has created a Drinking Water Supply Emergency Plan guidance document and template that water systems can use for development of system-specific emergency plans. The guidance document lists human-made or natural disasters that water systems should prepare for but does not address pandemic influenza or continuity of operations (OEPA, 2007b).

An unknown number of water systems in other regions of the United States have developed plans or have begun preparing for pandemic influenza. In 2006, the city of Denver (Colo.) water utility, which serves 1.2 million customers, started upgrading its emergency plan to encompass pandemic influenza. Denver's preparations included creating 37 emergency kits to be stored at water treatment plants and key pumping stations. The kits contain food for one or two employees for three days, a sleeping bag, portable stove, cook kit, toilet paper, flashlights and batteries, duct tape, rope, first-aid supplies, masks, gloves, and hand sanitizer. The Denver plan calls for cross-training for key positions and a gradual shutdown of nonessential operations if the utility is alerted of early stages of pandemic influenza (AWWA, 2006b).

The city of Tacoma (Wash.) held a pandemic influenza training exercise in December 2006. This exercise tested the utility's response to a pandemic that would reduce staffing by 40%. After an evaluation of the exer-

TABLE 2 Vaccination prioritization

US Department of Health and Human Services Priority Groups for Vaccination

Tier 1	**Subtier A**	**Subtier B**	**Subtier C**	**Subtier D**
	Health care workers and vaccinators	Infants and elderly with high-risk conditions	Pregnant women; contacts of infants and immunocompromised people	Public health personnel critical to pandemic response; key government positions
Tier 2	**Subtier A**		**Subtier B**	
	Infants and elderly; people age 6 months to 64 years with one high-risk condition		Remainder of public health workforce; public safety personnel (fire, police); transportation personnel; telecommunications personnel; public utility personnel	
Tier 3	Key government health decision-makers; funeral directors/embalmers			
Tier 4	Healthy people age 2 to 64 years not included in tiers 1–3			

Source: USDHHS, 2005b

TABLE 3 Prioritization for distribution of antiviral medications

	US Department of Health and Human Services Priority Groups for Antiviral Medications
Tier	**Group**
1	Patients admitted to hospital with influenza
2	Health care workers with direct patient contact, and emergency medical services personnel directly involved with patient transport
3	Highest-risk outpatients with influenza: Immunocompromised people and pregnant women
4	Public health personnel critical to pandemic response, including vaccinators, public safety, and key government officials
5	Increased-risk outpatients with influenza: Children age 12 to 23 months, people older than 65 years, people with underlying medical conditions
6	Outbreak response in nursing homes and other residential settings
7	Health care workers in emergency department, intensive care unit, dialysis, and emergency medical services settings
8	Critical infrastructure personnel in vaccination priority group tier 2, subtier B, and health care workers without direct patient contact
9	Other outpatients with influenza not included in tiers 1–8
10	Highest-risk outpatients
11	Other health care workers with direct patient contact

Source: USDHHS, 2005b

cise, the city began a cross-training program for water utility employees. The program allows people in different positions to fill in for water plant operators or other positions in an emergency (AWWA, 2006b).

In May 2006, AWWA convened a panel of regulatory, water system, and public health experts to address water utility preparedness for a flu pandemic. The panel's discussions, reported in the June 2006 JOURNAL AWWA, emphasized the importance of water utility preparations for pandemic influenza and the need to partner with public health officials (Hoffbuhr, 2006). Among the topics of discussion was the return to work by employees who had recovered from influenza. Because of their acquired immunity, these employees would be essential to maintaining operations.

The USEPA and USDHS are jointly developing a bird flu preparedness guide for water and wastewater systems. The Association of Metropolitan Water Agencies (AMWA) has developed a pandemic influenza reference guide and checklist for water utilities, which was released to AMWA members and subscribers to the Water Information Sharing and Analysis Center (AMWA, 2007). The Massachusetts Water Resources Authority and the South Florida Water Management District have also developed COOPs for pandemic influenza (Brown and Caldwell, 2006).

Ohio agencies gear up for pandemic influenza preparedness. From Jan. 24 to Feb. 6, 2007, the OEPA participated with public health and other agencies in a pandemic influenza functional exercise. The exercise tested six pandemic influenza target areas: planning, communications, isolation, incident management, medical surge, and public health epidemiology and labora-

Generators used for emergency power help ensure that a water system can stay up and running in case of a power outage.

US Preparedness Actions Related to Pandemic Influenza

This timeline summarizes the actions taken by the US government to prepare the nation for the occurrence of a pandemic influenza.

1998 President Clinton issues Presidential Directive 63 identifying water as one of the nation's critical infrastructure sectors (USDHS, 2006a).

1999 The Centers for Disease Control and Prevention (CDC) assigns states the task of preparing plans for pandemic influenza and provides guidelines (USDHHS, 2007).

2005 The US Department of Health and Human Services issues the Pandemic Influenza Plan and a Business Influenza Planning Checklist (USDHHS, 2005a).

2006 ***MAY:*** The US government's Homeland Security Council releases the National Strategy for Pandemic Influenza Implementation Plan to the public (USHSC, 2006).

SEPTEMBER: The US Department of Homeland Security (USDHS) releases the Pandemic Influenza Preparedness, Response, and Recovery Guide for Critical Infrastructure and Key Resources. This guide lists water as one of 17 critical infrastructure/key resources sectors. Each sector collaborates with the USDHS and sector-specific government agencies (USDHS, 2006a).

2007 ***APRIL:*** The USDHS releases Pandemic Influenza Best Practices and Model Protocols for use by state, local, tribal, and territorial personnel in developing best practices for pandemic plans or training programs (USDHS, 2007a).

MAY: The USDHS releases Water: Critical Infrastructure and Key Resources Sector-Specific Plan as Input to the National Infrastructure Protection Plan (USDHS, 2007b). This federal government plan emphasizes the need for critical infrastructure sectors (including water) to prepare continuity of operations plans in the event of pandemic influenza and other hazards.

JULY: The US Homeland Security Council releases the National Strategy for Pandemic Influenza Implementation Plan One Year Summary (USHSC, 2007). This summary states that the US Environmental Protection Agency (USEPA) is responsible for preparing the water sector for pandemic influenza by "engaging federal, state, and local partners in order to develop and promote the establishment of mutual aid and assistance agreements." In addition, USEPA is assigned the task of assisting the nation's critical drinking water and wastewater infrastructure—collectively known as the water sector—to maintain operations in the event of an influenza pandemic (USHSC, 2007). The USEPA, many state environmental protection agencies, the CDC, and various other agencies issue fact sheets about pandemic influenza and preparedness sheets that discuss business continuity.

2008 ***JANUARY:*** The CDC releases an updated Influenza Pandemic Operations Plan (CDC, 2008).

tory testing. During the exercise, OEPA activated its pandemic influenza plan and called several water systems to determine how those systems would respond to various scenarios. At least one utility was contacted to determine how it would respond to a supply disruption for disinfection chemicals. The OEPA's objective for this exercise was to maintain safe water supplies by performing the agency's essential functions—regulatory, outreach/assistance, and administration (Allen, 2007). In February 2008, the OEPA participated with public health agencies, water systems, and other agencies in another pandemic influenza functional exercise.

In 2007, utilities and agencies in Ohio began developing an Ohio Water/Wastewater Agency Response Network (WARN) mutual aid system. Utilities that register with Ohio WARN assist or receive assistance from other utilities in the event of emergencies, including pandemic influenza. This assistance could come in the form of provid-

In preparation for a pandemic, employees—particularly key personnel—should obtain inoculations at an influenza vaccination clinic.

ing operators, equipment, or supplies (Ohio Section AWWA, 2007).

HOW CAN US WATER SYSTEMS IMPROVE THEIR LEVEL OF PREPAREDNESS?

Effective COOPs are built on best practices. In the event of pandemic influenza, the most critical issue for water utilities is maintaining continuity of operations. A reduced workforce and potential disruption of supplies, chemicals, and energy would create major obstacles to continuity of operations. Other challenges could include inadequate bandwidth for telecommuting, inadequate funding, food shortages, and lack of preparation. The review of the literature, including water industry publications, found that few water utilities addressed continuity of operations in their emergency response plans. A COOP can be developed for different emergency planning scenarios, including pandemic influenza.

Continuity of operations planning for water systems begins with identification of necessary services, key staff positions, critical resources, and essential functions including disinfection, filtration, maintenance, repairs, and pumping. Table 4 provides an example of the criteria used to determine critical services and necessary COOP components. Best practices for water system continuity of operations planning for pandemic influenza were determined by a review of the literature as well as essential areas identified by USEPA and AWWA. Table 5 summarizes the elements that constitute best practices for pandemic influenza COOPs for water systems.

A proactive approach includes improved communications and cooperation. Interagency cooperation and communication are important aspects of a successful COOP. Water utilities must establish partnerships with public health agencies and emergency officials to provide accurate and early warning for pandemic influenza and other diseases. Joint training exercises benefit both water systems and public health agencies. Water utility response can be improved by obtaining advanced information from public health agencies about disease outbreaks and protection measures. Timely, direct communications from public health agencies about illnesses could provide early notice for a response to an influenza pandemic or a bioterrorist attack on a water distribution system. Influenza-type illnesses can have similar symptoms to those of a bioterrorism agent such as anthrax (Gensheimer et al, 2003). It is essential that water system operators work with public health agencies to share accurate and current information and avoid confusion and to use best practices in protecting the public.

TABLE 4 Example of criteria for developing a water utility COOP citing such major considerations as sufficient staff, supplies, energy, and chemicals

Category	Examples
1. Identify essential functions	Provision of potable water
2. Identify critical services	Pumping of water; disinfection of water
3. Identify critical resources	Electricity for pumping; chlorine for disinfection; support and supplies for staff
4. Identify essential personnel	Operators for treatment plant; mechanics for repair of pumps
5. COOP component	Emergency generator plan; alternate disinfectant plan; pandemic influenza plan

COOP—continuity of operations plan

TABLE 5 Best practices for pandemic influenza COOP for water systems

Essential Elements of Pandemic Influenza Preparedness Plans for Water Systems

Planning Step	Description	Action
Identify pandemic coordinator and team.	Identify all planning processes and define roles and responsibilities.	Designate pandemic coordinator; assign members to team.
Identify essential services and products.	Review system services and functions to determine those that are essential.	List essential services.
Identify essential resources.	Determine energy requirements and necessary chemicals and supplies.	Develop alternate energy, supplier, and disinfection plans.
Identify and prioritize services, products, and personnel.	Conduct thorough review of all processes.	List primary, secondary, and nonessential functions and services in plan.
Delegate authorities and lines of succession.	Use existing succession plans or develop succession plans and lines of succession.	Identify authorities and lines of succession in plan.
Determine essential positions for maintaining essential services.	Conduct review of all positions.	Identify essential employees and backups.
Determine current status of pandemic influenza in region on daily basis. Forecast worker absences. Track employees who have influenza and employees who have recovered.	Monitor public health information or establish public health contact. Monitor absences during pandemic. Keep records to track employees who have recovered from influenza.	Meet with public health officials. Monitor official federal, state, and local pandemic information. Develop forms for tracking employees who have recovered from influenza.
Plan for sustaining essential functions, supplies, material, and equipment.	Identify and propose actions to protect and sustain essential functions, supplies, materials, equipment, and systems support.	Cross-train employees. Retrain recently retired employees. Establish mutual aid agreements. Establish contracts for temporary workers. Determine trigger points for prioritizing and ensuring essential services. Propose cost-effective and efficient preparedness actions to stockpile essential supplies, material, and equipment. Propose cost-effective and effective actions to sustain essential functions.
Review or establish emergency communications.	Identify gaps in emergency contacts.	Establish or update emergency communication procedures and maintain equipment. Identify utility public relations officer and structure to release information to local and state emergency management officials.
Sustain essential workers.	Assess needs and requirements to protect and sustain all employees.	Ensure medical resources for employees. Encourage annual influenza vaccinations for employees. Establish telecommuting and flexible work hour policies. Ensure information technology is adequate for telecommuting. Establish hygiene control procedures and train employees. Screen employee health. Establish travel restriction and teleconferencing policies. Establish policies for sequestering critical staff. Store emergency kits at key locations. Practice social distancing (limit contacts with the public by, e.g., ending tours, delaying meter reading). Provide emergency food and other essential items.
Identify and assess worker's family care requirements.	While respecting privacy protections, identify and assess issues for supporting worker family care.	Develop and disseminate pandemic education information for worker families. Assess the number of workers with school-age children or other dependents at home. Identify other special needs for family support.
Identify, document, coordinate, and test trigger points and actions.	Assess and identify triggering events for each action, such as changes in WHO or US government alert matrix	Assess what triggers a change in the federal, state, and local pandemic alert status. Establish authorities, triggers, and procedures for activating and terminating response and recovery plans. Keep records of actions and expenditures.
Assess and develop exercise and training programs.	Involve internal and external partners in training.	Conduct training at least annually. Provide incident command system training for employees.
Finalize, implement, and review pandemic plan periodically.	Finalize and implement the pandemic plan in a practical and timely manner to ensure that the water system is fully prepared to respond and recover from a potentially severe pandemic.	Implement initial appropriate actions for the pandemic phase and external trigger point. Continuously monitor and assess implementation actions to ensure staying on target. Adjust plans as necessary. Review plans periodically (at least every 90 days initially and more frequently as the pandemic evolves).
Identify potential costs associated with pandemic influenza.	Evaluate budget consequences of pandemic influenza.	Develop funding policies and budget for pandemic influenza planning and response.
Investigate mutual aid resources.	Discuss mutual aid with neighboring utilities, AWWA, and regulators.	Develop mutual aid agreements.

COOP—continuity of operations plan, WHO—World Health Organization

System continuity of operations depends on adequate staffing. Ensuring that enough employees are available to perform essential services is the most significant factor in maintaining continuity of operations. Operations of water systems could be disrupted by shortages of essential personnel in such areas as source water conveyance, treatment, distribution, engineering, maintenance, water quality monitoring, and finance and payroll. To prepare for labor shortages, water utilities should plan to use skeleton crews with the diverse skills needed for operations and maintenance. Essential personnel should be identified in advance and protected from illness during a pandemic.

Cross-training of employees can provide a line of succession for management positions as well as backup employees for operational positions. Water systems should encourage and facilitate the delivery of seasonal influenza vaccinations to safeguard the health of their workforce. During pandemics, social distancing, hygiene measures, and access to antivirals and virus-specific vaccinations will also be crucial. Utilities will also need to institute formal procedures for screening employees for illness and isolating healthy employees. Treatment of employees who are infected with influenza will be problematic during a severe pandemic because the healthcare system will be overwhelmed (CDC, 2008).

Developing self-reliance will be a critical component of COOPs. Contingency plans and systems must be developed for alternate sources of chemicals and other supplies as well as emergency power. Water system operators need to identify essential functions and critical resources to prepare for events such as pandemic influenza that can threaten continuity of operations. Water system preparation for pandemic influenza could also include developing the capacity to generate chemicals on site. It may be necessary to acquire equipment and establish onsite procedures to produce sodium hypochlorite so the utility can still function if supply disruptions prevent deliveries of disinfection chemicals. In addition, water providers will need to establish or reinforce procurement systems that enable cash payment for necessary supplies.

Water utilities should stockpile emergency supplies, develop alternate sources or systems for power, and acquire backup communication systems that could include radios with multiple channels, all-in-one wireless communication devices, ham radios, and satellite Internet service. To support telecommuting, water systems could build up information technology systems by increasing bandwidth and adding redundant servers. Preparation for pandemic influenza and establishment of mutual aid agreements can prepare a water utility for natural disasters or other emergencies (such as acts of terrorism) that could threaten continuity of operations.

Template can help water systems create their own pandemic influenza COOP. The current project led to the development of a template that can be downloaded from the Operator Training Committee of Ohio website at www.ohiowater.org/OTCO/pages/downloads.htm or obtained from the authors. The template can be used to develop a stand-alone plan or can be incorporated as an appendix in an existing "all hazards" emergency plan. Because water systems are unique and vary in size, the template is scalable and can be easily modified to fit local circumstances.

Table 6 shows a modified version of a checklist for pandemic influenza planning developed by the USDHHS and the Centers for Disease Control and Prevention. The checklist includes key information from various regulatory, water agency, and critical infrastructure documents and can be used to verify that a system's plan considers essential elements of preparedness, response, and recovery. Utilities can modify the checklist to cover their unique circumstances. Some items on the checklist may be covered by existing all-hazards or emergency response plans. Items can be checked off as "not started," "in progress," or "completed," depending on the status of each action.

Ensuring continuity of operations for drinking water systems is essential to maintaining the health and economy of all communities.

CONCLUSION

Many of the water systems in Ohio serving populations greater than 20,000 and all of the water systems serving populations greater than 100,000 are preparing for the potential of an influenza pandemic. All of the large water systems (those serving more than 100,000 people) responding to the survey indicated that they are preparing for pandemic influenza. The majority of the surveyed water systems (86%) indicated interest in obtaining training related to pandemic influenza preparedness and response. This training could be arranged by professional organizations such as AWWA in partnership with government agencies.

To ensure effectiveness, pandemic influenza COOPs need to be flexible, easy to read, and capable of quick implementation. Half of the utilities surveyed in a AwwaRF study reported that their "all hazards" emergency plans were too cumbersome (AwwaRF, 2006). Utilities could use continuity of operations as a foundation for the development or

TABLE 6 Water utility pandemic influenza planning checklist

Checklist for Pandemic Influenza Planning

Pandemic Response Coordinator:	**Date:**

1 Plan for the impact of a pandemic on the water utility

Completed	In Progress	Not Started	Activity
			Identify a pandemic coordinator and/or team with defined roles and responsibilities for preparedness and response planning. Include input from all management levels and staff that are involved in day-to-day operations.
			Identify critical functions that must be maintained, e.g., disinfection.
			Identify essential personnel functions and critical inputs needed to maintain operations, including locations where staff may be needed during a pandemic. Ensure redundancy of personnel (cross-training), materials (e.g., chemical suppliers, equipment suppliers), communication (e.g., phones, radios), information technology, and power (e.g., electric, gas). Establish contingency agreements with other utilities (gas, electric) where feasible.
			Identify key customers and customers with special needs (such as hospitals and nursing homes), and ensure services can be provided.
			Cross-train employees to provide backups for critical positions. Train and prepare an ancillary workforce (e.g., contractors and retirees). Develop mutual aid contacts with other utilities through a Water Agency Response Network (WARN) or other means.
			Develop and plan for scenarios likely to result in an increase or decrease in demand on facilities during a pandemic (e.g., loss of tourism, consumers at home instead of work).
			Determine the potential effect of a pandemic on utility-related travel (e.g., quarantines, border closures that limit availability of chemicals), including suppliers who make deliveries. Encourage suppliers to develop their own pandemic influenza continuity of operations plans.
			Find up-to-date, reliable pandemic information from the local public health agency and other sources. Make this information available to all personnel.
			Establish an emergency communications plan, and revise it periodically. Plan should include identification of key contacts (with backups), chain of communications (including suppliers and key customers), and processes for tracking and communicating utility operational status and status of employees. Ensure public notification procedures are in place for potential scenarios.
			Implement an exercise/drill to test the plan, and revise it periodically. Ensure that exercises include the participation or cooperation of local health agencies, emergency planning officials, and the state environmental protection agency.

Notes:

2 Plan for the impact of a pandemic on employees and customers

Completed	In Progress	Not Started	Activity
			Forecast and allow for employee absences during a pandemic attributable to factors such as personal illness, family member illness, community containment measures and quarantines, school and/or business closures, and public transportation closures.
			Implement guidelines to limit the frequency and type of face-to-face contact among employees and between employees and customers (e.g., hand-shaking, meetings, office layout, shared workstations). Take into consideration delivery personnel who interact with employees.
			Encourage and track annual influenza vaccination for employees. Consult local public health pandemic coordinators regarding pandemic vaccination and distribution of antiviral medications.
			Evaluate employee access to and availability of health care services during a pandemic, and improve services as needed. Evaluate employee access to and availability of mental health and social services during a pandemic, including corporate, community, and faith-based resources, and improve services as needed.
			Identify employees and key customers with special needs, and incorporate the requirements of such people into the preparedness plan.

Notes:

3 Establish policies to be implemented during a pandemic

Completed	In Progress	Not Started	Activity
			Establish policies for employee attendance, sick-leave absences, and compensation unique to a pandemic (e.g., non-punitive, liberal leave), including policies on when a previously ill person is no longer infectious and can return to work after illness.
			Establish policies for flexible worksite (e.g., telecommuting) and flexible work hours (e.g., staggered shifts). Take into account that longer shifts and onsite sleeping accommodations may reduce potential exposure to key workers. Consider needs and conditions (e.g., food, sleeping accommodations, family arrangements) for sequestering onsite critical staff.
			Establish policies for preventing spread of influenza at the worksite (e.g., promoting respiratory hygiene/cough etiquette, sanitizer stations, disinfection of work areas and break rooms, and prompt exclusion of people with influenza symptoms).
			Establish policies for employees who have been exposed to pandemic influenza, are suspected to be ill, or become ill at the worksite (e.g., infection control response, immediate mandatory sick leave).
			Establish policies for teleconferencing and videoconferencing to limit face-to-face contact.
			Establish policies for travel to affected geographic areas and guidance for employees returning from these areas (refer to Centers for Disease Control travel recommendations).
			Set up authorities, triggers, and procedures for activating and terminating the utility response plan.

TABLE 6 Water utility pandemic influenza planning checklist, *continued*

Checklist for Pandemic Influenza Planning

Notes:

4 Allocate resources to protect employees and customers during a pandemic

Completed	In Progress	Not Started	Activity
			Provide sufficient and accessible infection control supplies (e.g., alcohol sanitizer stations, tissues, N-95 facial masks and receptacles for their disposal) at all work-related locations.
			Enhance communications and information technology infrastructures as needed to support employee telecommuting and remote customer access.
			Ensure availability of medical consultation and advice for emergency response.

Notes:

5 Communicate to and educate employees

Completed	In Progress	Not Started	Activity
			Develop and disseminate programs and materials covering pandemic influenza fundamentals (e.g., signs and symptoms of influenza, modes of transmission), personal and family protection and response strategies (e.g., hand hygiene, use of N-95 masks, coughing/sneezing etiquette, contingency plans).
			Anticipate employee fear and anxiety, rumors, and misinformation, and plan communications accordingly.
			Ensure that communications are culturally and linguistically appropriate.
			Disseminate information to employees about pandemic preparedness and response plan.
			Provide information for the at-home care of ill employees and family members.
			Develop platforms (e.g. ,hotlines, dedicated websites) for communicating pandemic status and actions to employees, vendors, suppliers, and customers inside and outside the worksite in a consistent and timely manner, including redundancies in the emergency contact system.
			Identify community sources for timely and accurate pandemic information (domestic and international) and resources for obtaining countermeasures (e.g., vaccines and antivirals).

Notes:

6 Coordinate with external organizations and help the community

Completed	In Progress	Not Started	Activity
			Collaborate with insurers, health plans, and major local health care facilities to share utility pandemic plans and understand their capabilities and plans.
			Collaborate with local public health officials, environmental officials, and/or emergency responders; participate in their planning and training, share utility pandemic plans, and understand their capabilities (e.g., surveillance) and plans.
			Communicate with local and/or state public health agencies and/or emergency responders about the assets and/or services the utility may be able to contribute to the community.
			Share pandemic continuity of operations best practices with other utilities and professional associations to improve community response efforts.

modification of other response plans, such as those addressing employee strikes or natural disasters.

An informed and prepared public responds better in emergencies and is less likely to make immediate demands for food, water, and emergency supplies. Water systems should provide their customers and community with emergency preparation information. In addition, customers should be assured that influenza is not transmitted by drinking water. This information could be delivered as a water bill insert or in the annual Consumer Confidence Report.

Ensuring that sufficient numbers of employees are available to perform essential services is the most significant factor for maintaining continuity of operations. Cross-training for essential positions, sequestration of critical employees, vaccinations, and other personal protection measures can help maintain an adequate level of water utility staffing. These measures represent multiple barriers to influenza-caused disruptions and reflect the multibarrier concept used to ensure safe drinking water.

ACKNOWLEDGMENT

The authors thank the water and public health professionals who provided information for this project, especially Carel Vandermeyden of the Greater Cincinnati (Ohio) Water Works and Glen Mudd of the Louisville (Ky.) Water Company.

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Date of submission: 03/20/08
Date of acceptance: 09/11/08

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