

Water Sector Interdependencies

Summary Report 2011

Water Environment Federation
Alexandria, VA



Published by the Water Environment Federation of Alexandria, Va., this Water Sector Interdependencies document was authored by James K. Sullivan, who served as project director and served as lead instructor for the WEF/DHS/FEMA training. While the training material was certified by FEMA and contains material for official use only (FOUO), material for this document is from publicly available sources. These sources include the DHS National Infrastructure Protection Plan (NIPP) and various sector specific plans, as well as various publications from the U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey. Other sources are considered “fair use” under the U.S. Copyright Law and are listed in the text following the appropriate reference.

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Executive Summary

Safe drinking water and wastewater treatment and service are essential to the health and economic vitality of any society. Denial of drinking water and wastewater utilities' services — whether the result of a contamination incident, physical attack, or cyber attack — would have cascading public health, economic, psychological, and governance impacts on the nation. Therefore, the water sector is interdependent with every other infrastructure identified by the U.S. government as critical.

From May 2010 to July 2011, the Water Environment Federation® (WEF®), in cooperation with the Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA) conducted 18 workshops to increase the general awareness of water sector interdependencies with other critical infrastructures. Including three pilot sessions, over 1200 individuals representing all 18 critical infrastructure sectors participated in the program. This report summarizes the background of the program, the training methodology, and how the performance measures were met. Additionally, this report provides a summary of every critical infrastructure sector and examples of how that sector is dependent upon water and how the water sector is dependent on that sector. A summary of key points in this report are listed below.

1. While all sectors are interdependent with water, an analysis of the assets of water and the other critical infrastructure sectors revealed nine core sectors with water interdependencies. These sectors include agriculture and food, public health and health care, energy, chemical, dams, information technology, communications, transportation, and emergency services. During implementation of the training, the critical manufacturing sector emerged as a 10th sector with extensive water sector interdependencies.
2. Despite water sector interdependencies with every critical infrastructure, the majority of other critical infrastructure sectors have either not recognized or minimized the importance of their dependencies on water. In fact, throughout the training, water sector utility personnel and representatives from other sectors noted that reliable safe and clean water services are undervalued, taken for granted, or generally disregarded.
3. The water sector has identified five general threat themes for drinking water and wastewater facilities. These include: chemical, biological, or radiological (CBR) contamination attacks; vehicle-borne improvised explosive device (IED) attacks on infrastructure; cyber attacks on instrumentation and control systems; chemical attacks (e.g., combustible contaminant in a wastewater collection system); and natural disasters. During the training, participants concurred that these are substantive threats while identifying natural disasters as the threat of most concern.
4. On a related note, participants also identified actions of water sector personnel, either intentional (disgruntled employee) or accidental (due to lack of personnel or properly trained personnel), as a significant threat to operating a water sector utility. Funding to recruit, train, and retain qualified water and wastewater operator personnel as well as building, repairing, and maintaining water sector infrastructure were seen as the two most pressing priorities facing the sector.
5. The water sector interdependencies program has increased the resilience of the nation. Defined as the ability to resist, absorb, recover from or successfully adapt to adversity or a change in conditions, the water sector, and other key sectors, are more resilient to man-made and natural disasters through the recognition of how threats and hazards to the water sector could have cascading effects to all critical infrastructure sectors.

I. Background

Introduction

Safe drinking water and wastewater treatment and service are essential to the public health and economic vitality of any society. In the United States, drinking water and wastewater utilities, collectively known as the water sector, are charged with implementing programs to provide clean and safe water to their communities every day regardless of external forces that may impede their efforts, including natural disasters or terrorist events. To provide their essential services, water sector utilities do not operate independently. Rather, they are dependent upon other national critical infrastructures such as energy to operate their pumps, transportation to deliver chemicals to properly treat water, and information technology to assist operators who run their utilities. Additionally, many of the nation's other critical infrastructures are dependent upon the water sector to provide clean and safe water for firefighting or irrigation for agriculture. In fact, the water sector is interdependent with every critical infrastructure.

In addition, the denial of drinking water and wastewater utilities' services — whether the result of a contamination incident, physical attack, or cyber attack — would have cascading effects, as many hospitals, schools, and commercial and industrial businesses would be forced to close. It is also clear that advanced preparation to continually provide drinking water and wastewater services during and following an incident will reduce human and economic hardships.

Toward that end, the Water Environment Federation (WEF), in cooperation with the Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA) has provided a series of 18 general awareness trainings on water sector interdependencies from May 2010 to July 2011. The training was funded through a cooperative agreement between DHS/FEMA and WEF via the Competitive Training Grant Program (CTGP), which stresses a cross-disciplinary approach to training, partnerships to maximize program impact, and strong program performance measures. As opposed to a management or performance training, the course was certified as general awareness training with three broad objectives:

1. increase the awareness of water sector utilities of their dependencies on other critical infrastructures;
2. increase the awareness of other critical infrastructure of their dependencies on water; and
3. build partnerships across sectors.

Training Methodology

The DHS/FEMA/WEF water sector interdependencies training program was implemented through the ADDIE

approach: analyze, design, develop, implement, and evaluate. The analysis began with a scan of existing resources, including the National Infrastructure Protection Plan (NIPP), the Water Sector Specific Plan (SSP), and the sector specific plan for every other critical infrastructure. Design of the materials included a blended learning approach of instructor-led presentations, small and large group discussions, and exercises. The primary learning approach was to leverage the expertise of the participants throughout the training in order to identify and analyze water sector interdependencies. The course was developed and refined through a series of three pilot sessions and a review by subject matter experts identified by DHS. FEMA certified the course in October 2009.

Course implementation was originally envisioned as a series of seven regional training sessions throughout the country, but was later expanded to 18 training sessions offered in coordination with state emergency management agencies. At least one training session was offered in every FEMA region.

Training Performance Measures and Course Evaluation

As mandated by the DHS/FEMA, the course included a "Phase 1" evaluation, which allowed participants to rate how the course met its stated objectives, the effectiveness of the instructors, and how relevant the course was to the participant's daily job responsibilities. A "Phase 2" evaluation was designed to assess participants' familiarity with the key concepts of the workshop at the beginning of the course as well as at the end of the course.

Out of a possible top score of 5, the average of the Phase 1 evaluations indicate how participants felt the program content supported the learning objectives (4.3) and that the instructor was prepared (4.67), demonstrated knowledge (4.61), and was skilled and competent (4.65). Finally, by an average score of 4.2 out of 5, the course met the needs of the participants and participants felt the instructor encouraged student participation (4.7).

Regarding the Phase 2 evaluation, all program goals and objectives were met. Out of a range of 1–5 with a high score of 5, participants rated their knowledge skills and abilities (KSAs) prior to the workshop as an average of 2.9. After the workshop, participants rated their KSAs as an average of 3.9. More significantly, the post-test scores increased an average of 105% from the pre-test scores.

As indicated by the measures above, and others, the WEF/DHS/FEMA Water Sector Interdependencies course met the general objective of raising the awareness of all critical infrastructures of their interdependencies with water prior to, during, and following an emergency situation.

II. Setting the Stage: The National Infrastructure Protection Plan (NIPP) and the Water Sector

As mandated by Homeland Security Presidential Directive 7 (HSPD-7), the National Infrastructure Protection Plan (NIPP) provides a unifying structure for the integration of existing and future critical infrastructures and key resources protection efforts into a single national program to achieve an overall goal. This “unifying structure” provided a framework for the water sector interdependencies course, particularly through the NIPP’s identification of 18 critical infrastructures, including the water sector. First released in 2006, the plan was updated in 2009 with its primary goal to “strengthen national preparedness, timely response, and rapid recovery in the event of an attack, natural disaster or other emergency.”

A key component of the NIPP is the fact that it contains no regulatory authority for the federal government prior to, during, or following an incident. Rather, the NIPP promotes a voluntary coordination between the federal government and the “private sector” to implement the Plan’s Risk Management Framework. This voluntary partnership is a key concept in identifying and addressing water sector interdependencies, particularly since DHS estimates that 85% of the nation’s assets are privately owned and operated. As a note regarding public and private sector definitions, even though water sector professionals view themselves as public servants, training participants were surprised to learn DHS considers the water sector a “private sector” because the assets are not owned or operated by the federal government.

The Risk Management Framework of the NIPP is essentially a strategic plan for protection of the nation’s critical infrastructures and key resources (CIKR). The graphic below outlines the six steps of the framework as well as

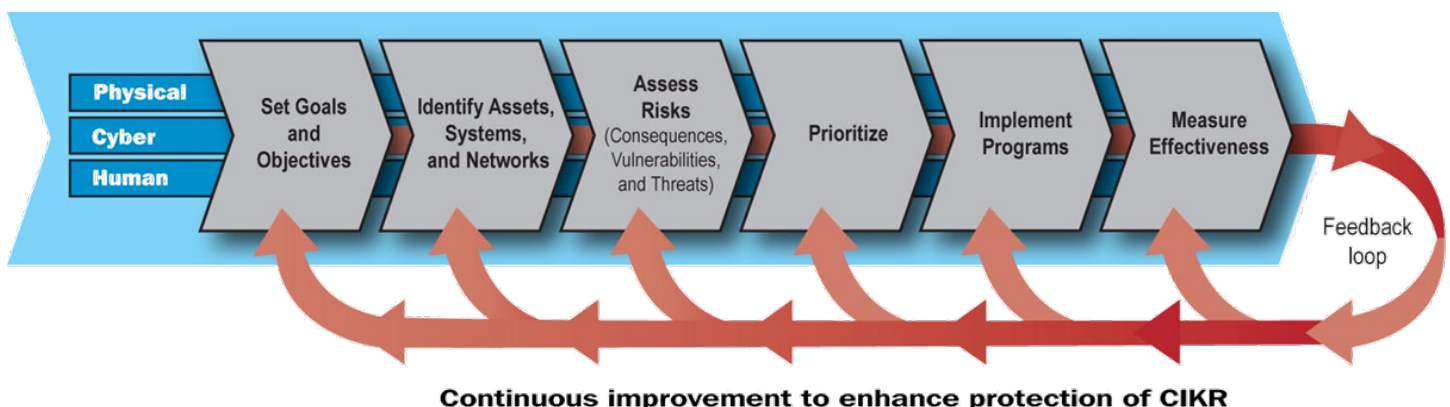
noting it is a continual process. All 18 critical infrastructures, collectively and individually, are in various stages of implementing the framework.

The Risk Management Framework provided the “backbone” of the water sector interdependencies course. Beginning with the water sector, the training materials provided a snapshot of each critical infrastructure and key resource. Through a greater understanding of each sector’s goals and objectives, assets, how the sector assesses risk, how the risks are prioritized through the implementation of protective programs, and how the sector measures its effectiveness, participants were able to identify and appreciate how water is interdependent with every critical infrastructure. As an example, by comparing the assets of the water sector with the energy sector, it is apparent both sectors heavily rely upon instrumentation and control systems in their operations. An overarching threat to the nation’s industrial control systems (e.g., a sophisticated computer virus) will have cascading effects on both sectors as well as on all sectors dependent upon energy and water services, which means all 18 sectors.

Water Sector – Overview

While the NIPP provides an overall structure for all 18 critical infrastructure sectors, each sector produces a sector specific plan (SSP). Each sector plans outlines how the sector adheres to the NIPP’s risk management plan and details specific programs and successes the sector has achieved.

Each sector develops its sector specific plan through a partnership model that includes the sector specific agency (SSA), the government coordinating council, and the sector coordinating council. While DHS is responsible for homeland security across all critical infrastruc-



ture sectors, many sectors have SSAs that take the lead in identifying and implementing protective programs in coordination with the owner and operators of the sector's assets. The U.S. Environmental Protection Agency (EPA) is the SSA for the water sector. In addition, many state and federal government agencies and associations have sector specific security responsibilities. Among others, the Association of State and Interstate Water Pollution Control Administrators (ASIWPCA), Association of State Drinking Water Administrators (ASDWA), and the U.S. departments of State, Interior, Health and Human Services, Defense, and Agriculture constitute the Water Government Coordination Council (GCC).

Finally, the sector coordinating council (SCC) comprises the private sector organizations (typically trade associations and professional societies) that represent the owners and operators of the sector. For water, the SCC is composed of the eight major nonprofit U.S. nonprofit water associations, including WEF, the Water Environment Research Foundation (WERF), the American Water Works Association (AWWA), Water Research Foundation (WRF), National Association of Clean Water Agencies (NACWA), Association of Metropolitan Water Agencies (AMWA), National Association of Water Companies (NAWC), and the National Rural Water Association (NRWA). In addition, the Water Information and Sharing Analysis Center (Water ISAC) is represented on the SCC.

The SSA, GCC, and SCC for each sector draft the sector specific plan for its sector. As such, the SSPs provided the majority of the material for the water sector interdependencies training. Like all sectors, the SSP for the water sector was first drafted in 2007 and updated in 2010. To identify and examine water sector interdependencies, it is critical to begin with a snapshot of what comprises the water sector and how it defines success.

A critical infrastructure sector is defined by DHS as “assets, systems, and networks, whether physical or virtual, so vital to the U.S. that if incapacitated or destroyed would have debilitating impact on security, national economic security, public health or safety, or any combination of those matters.” Water is clearly a critical infrastructure as disruption of water supply or wastewater treatment may lead to loss of life, economic impacts, public health, and/or environmental incidents. The water sector defines itself as comprising drinking water and wastewater systems throughout the country with the following four goals:

1. sustain protection of public health and the environment;
2. recognize and reduce risks;
3. maintain a resilient infrastructure; and
4. increase communication, outreach, and public confidence.

Water Sector — Assets, Risk Assessment, and Prioritization of Assets

As mentioned earlier, a key component in identifying interdependencies between water and other critical infrastructures includes comparing and contrasting infrastructure assets. DHS views a water sector asset as a single drinking water or wastewater utility. According to the water sector's SSP, there are, in the United States, approximately 160,000 public drinking water systems with 2.3 million miles of distribution pipes and over 16,000 wastewater systems with over 600,000 miles of publicly owned collection lines.

Water sector utility sub-assets, or components, are classified as physical, cyber, and human. Physical components include water source (groundwater or surface water) for drinking water utilities and collection systems for wastewater utilities. Cyber components for both drinking water and wastewater facilities include control systems known as Supervisory Control and Data Acquisition (SCADA) systems. Human components consist of employees and contractors charged with managing and operating a utility.

Following the identification of goals and objectives and sector assets, the water SSP outlines how the sector assesses risk. Risk assessment for all sectors is composed of threat, vulnerability, and consequence. For threats, the intelligence community (CIA, FBI, etc.) takes the lead in assessing the intention and capability of an adversary to undertake actions that would be detrimental to a sector. The DHS Homeland Infrastructure Threat and Risk Analysis Center (HITRAC), along with regional intelligence centers, referred to as fusion centers, integrate intelligence reporting and analysis and provide periodic assessments to every sector. For the water sector, five threat themes have been identified and are listed in the water SSP. They include:

1. chemical, biological, or radiological (CBR) contamination attacks;
2. vehicle-borne improvised explosive device (IED) attacks on infrastructure;
3. cyber attacks on control systems;
4. chemical attacks (e.g., a combustible contaminant in a wastewater collection systems); and
5. natural disasters.

During the water sector interdependencies training, participants worked in small groups to discuss whether these identified threats were relevant to the water sector and if there were additional threat themes that deserved attention. In general, participants agreed that the five themes were relevant, but a common addition was the “insider threat.” Operating a water sector utility requires

skilled personnel, and many training participants were concerned with the potential access a disgruntled employee has to critical processes of the facility. However, the greater concern among participants was the perceived lack of training, and the lack of funding for training, to maintain the skills of operators and to train new operators in the profession. In addition, related to infrastructure protection, many participants noted the significant gap in funding needed to maintain the physical infrastructure of water sector utilities. On a national scale, the Government Accountability Office (GAO) and EPA have estimated a \$300–\$500 billion gap in what is currently being spent on water infrastructure and what needs to be invested over the next 20 years.

The second component of risk assessment for all sectors is vulnerability assessment. DHS defines vulnerability in the NIPP as, “the characteristic of an asset’s design, location, security posture, process, and operation that makes it susceptible to destruction, incapacitation, or exploitation by mechanical failures, natural hazards, terrorist attacks, or other malicious acts.” As part of the 2002 bioterrorism act, all drinking water utilities serving more than 3300 individuals were required to conduct a vulnerability assessment of their facility and update their emergency response plan based on that vulnerability assessment. According to EPA, 99% of utilities complied with this mandate. While this was a one-time requirement and currently any compliance to the water sector security program at the federal level remains voluntary, water sector utilities are encouraged to continually conduct vulnerability assessments of their facilities. Currently the sector is offering several tools at no cost to utilities to complete a risk assessment of their facility, including identifying the facility’s greatest vulnerabilities.

The third and final component of risk assessment for all sectors is consequence assessment. According to HSPD-7, categories of consequences include:

1. health impact: effect on human life and physical well-being;
2. economic impact: effect on the local, state, territorial, tribal, regional, or national economy;
3. psychological impact: effect on the public’s morale and confidence in national economic and political institutions; and
4. governance impact: effect on the national government’s ability to maintain order, deliver minimum essential public services, ensure public health and safety, and carry out national security missions.

Based on these themes, the water SSP outlines several consequences of concern unique to drinking water and wastewater utilities.

Drinking Water Consequences of Concern	a) long-term loss of supply, treatment, or distribution of water for drinking, cooking, bathing, flushing toilets, fighting fires, and irrigation
	b) catastrophic release of on-site hazardous chemicals that affects public health
	c) adverse impacts to public health or confidence from actual or threatened intentional contamination of water with biological, chemical, or radiological material
	d) adverse economic and environmental impacts
Wastewater Consequences of Concern	a) collateral damages to buildings, institutions, and icons that could result in loss of life by using sanitary or stormwater collection systems to gain access to facilities
	b) long-term loss of collection or treatment and resulting impacts to drinking water sources
	c) catastrophic release of stored hazardous chemicals
	d) decontamination of wastewater and subsequent residual disposal
	e) adverse economic and environmental impacts

Once a sector sets goals and objectives, identifies assets, and assesses risk, the fourth step in the NIPP Risk Management Framework is the prioritization process. According to the NIPP, this “involves aggregating, combining, and analyzing risk assessment results to determine which assets, systems, networks, sectors, or combinations of these face the highest risk so that risk management priorities can be established.” Like most sectors, the prioritization process for the water sector is continual. The default prioritization of assets for the water sector has been based on service population of a water sector utility, where greater service population equals higher risk. However, much work is being done regarding other factors of prioritization for water sector utilities, including which utilities have critical customers, such as remote hospitals or significant military bases. DHS as a whole, and the water sector specifically, continues to examine the most effective and efficient way to prioritize water sector assets to protect critical infrastructure nationally.

Water Sector — Program Prioritization and Measures of Success

The final two steps of the Risk Management Framework include the implementation of programs and measuring effectiveness. The water sector has been very aggressive in implementing protective programs. EPA has led efforts such as the funding of, and training on, risk assessment tools; the Water Security Initiative (WSI), which addresses the intentional contamination of drinking water distribution systems; and the water laboratory alliance, which provides the water sector with an integrated nationwide network of laboratories to better address intentional or unintentional water supply contamination events involving chemical, biological, and radiological contaminants. EPA, GCC, and SCC have also partnered to create the water and wastewater agency response network (WARN), which provides intrastate mutual aid among water sector utilities. The program allows a disaster-impacted utility to request and receive assistance from a utility that may not be impacted. An agreement is signed in advance between utilities to resolve issues such as liability, insurance, and reimbursement, allowing aid to be received in the quickest, most effective manner.

Finally, the water sector is the first sector to develop a sophisticated metrics program to determine if the programs offered by the sector, for the sector, are effective. The Water ISAC, in coordination with DHS, EPA, GCC, and SCC, sends a survey to all water sector utilities on a periodic basis. A series of questions are asked, including “Do you review your vulnerability assessment annually?” and “If you use hazardous chemicals, does your chemical use include gaseous chlorine?” The answers to these and other questions are then aggregated to produce a snapshot of if, or how, the sector is improving. Again, since the water sector security program is a voluntary public/private partnership, a metrics program is essential in determining how successful certain programs and policies are in preventing and responding to an incident.

III. Water Sector Interdependencies by Critical Infrastructure Sector

The core purpose of the water sector interdependencies training was to introduce participants to all critical infrastructure sectors and examine how the assets of each sector may depend on the water sector or how the water sector may depend on various other sector assets. These interdependencies may be physical, geographic, or cyber. An example of a physical interdependency is the fact that water needs power to operate pumps and power utilities need water for cooling. An example of a geographic interdependency includes infrastructures that share common corridors, e.g., water pipelines, conveyance lines, gas pipelines, and telecommunications cables. Cyber interdependencies will be discussed under the Water Sector Interdependencies With Service Industry Sectors portion of this summary document.

The sector interdependencies with water are divided into four categories of sectors: sustenance and health, production industries, service industries, and federal and state sectors. These categories are used by DHS in their daily open source briefing, which essentially provides news clippings from across the country on issues affecting critical infrastructures. The report is available free of charge by going to www.dhs.gov/files/programs/editorial_0542.shtm. In addition to providing a summary of each critical infrastructure's key asset, a summary of the open source reports was provided to participants to help stimulate discussion during the trainings. In addition, the following definition from the Water SSP regarding interdependencies helps to define the importance of examining the various sectors' assets when discussing interdependencies, "dependency is reliance on another asset or sector for the functioning of certain assets; and interdependency is two or more assets or sectors dependent upon each other for the functioning of certain assets."

Water Sector Interdependencies with Sustenance and Health Sectors

Three sectors compose the sustenance and health sectors: water; agriculture and food; and public health and health care. Having provided a detailed overview of the water sector, this section will provide a snapshot of the other two sectors and give a sampling of water sector interdependencies discussed with those sectors during the workshops and from other material.

The **agriculture and food sector** is almost entirely under private ownership and is composed of an estimated 2.1 million farms, approximately 880,500 firms, and over 1 million facilities. This sector accounts for roughly one-fifth of the nation's economic activity and is overseen at the

federal level by the U.S. Department of Agriculture (USDA) and the Department of Health and Human Services' (HHS) Food and Drug Administration (FDA).

A primary goal of the agriculture and food sector is to provide safe, nutritious, and affordable food by preventing the contamination of the food supply. In its 2007 sector specific plan, the agriculture and food sector admits that, "because of its complexity, the sector has struggled to identify its most critical assets, systems, networks, and functions." Toward that end, the Food and Agriculture Government Coordinating Council has partnered with one of the DHS' Centers of Excellence, the National Center for Food Protection and Defense (NCFPD), to develop an assessment tool to assist states in determining and documenting the most critical elements and systems/subsystems of food and agriculture infrastructure. This tool is called the Food and Agriculture Sector Criticality Assessment Tool (FASCAT).

The water sector and the agriculture and food sector are heavily interdependent. According to the agriculture and food SSP, the sector is dependent upon the water sector, "for clean irrigation and processed water." This is certainly true, although understated. In fact, according to the U.S. Geological Survey (USGS), almost 60% of all the world's freshwater withdrawals go toward irrigation uses. Agriculture is a major user of ground and surface water in the United States and, according to the USDA, accounts for 80% of the nation's consumptive water use and over 90% in many western states.

However, the agriculture and food sector's dependencies on water go well beyond irrigation. Throughout the production, process, and distribution of the nation's food supply, water use and recovery is essential. The agriculture and food sector refers to this cycle as the "farm-to-table continuum" and includes the supply chains for feed, animals, and animal products; crop production; and the supply chains of seed, fertilizer, and other necessary related materials. It also includes the post-harvesting components of the food supply chain, from processing, production, and packaging through storage and distribution to retail sales, institutional food services, and restaurant or home consumption. In addition to irrigation, a major user of water is livestock watering. USGS defines livestock water use as water associated with "livestock watering, feedlots, dairy operations, and other on-farm needs. This includes water for raising cows, chickens, horses, rabbits, fish, and pets, and also water used in the production of meats, poultry, eggs, and milk."

It is also clear that the water sector is significantly dependent upon the agriculture and food sector. In addition to consumption of “safe, nutritious, affordable” food for water sector personnel, the “farm-to-table continuum” shows that the agriculture and food sector is a major customer of the water sector, particularly institutional food services and restaurants.

Similar to the agriculture and food sector, the **health care and public health (HPH)** sector is heavily interdependent on the water sector. Operating in all U.S. states, territories, and tribal areas, the HPH sector plays a significant role in response and recovery across all other sectors in the event of a natural or manmade disaster. The HPH sector constitutes approximately 15% of the gross national product with roughly 85% of the sector’s assets privately owned and operated.

Privately owned and operated HPH assets include manufacturers of critical pharmaceutical products and medical supplies; influenza egg farms; burn care facilities; the medical material supply chain; level 1 trauma centers; mass casualty processing facilities; and private health care reimbursement systems. Government owned and operated HPH assets include health-related networks; federal reimbursement systems; emergency operation centers; critical medical material; health-oriented laboratories; and federal medical shelters.

Based on these assets, it is easy to see how dependent the HPH sector is on the water sector. One example is detailed in a University of North Carolina School of Medicine study concluding that most kidney dialysis patients have not taken the emergency preparedness measures that would enable them to survive a hurricane or any other disaster that disrupts water services. The study was completed following the fact that 5800 Gulf Coast kidney dialysis patients were threatened when Hurricane Katrina forced the closure of 94 dialysis units. Within one month of Katrina, 148 patients died. According to the study, “dialysis machines require both electricity and sterile water, both of which may be unavailable for several days or even weeks in disaster-impacted areas. If dialysis cannot be provided for an end stage kidney disease patient, then toxic molecules and electrolytes will accumulate that can lead to a number of serious health problems, including death.”

Additional HPH sector dependencies on water are outlined in an EPA fact sheet, “Water and Healthcare Sector Interdependencies: Working Together Towards Resiliency.” These dependencies include clean and safe water needed for infection control, heating and air conditioning, manufacturing and storage of pharmaceuticals, sterilization, maintenance of blood and organ banks, and drinking water for patients and staff. A recently released report titled, “Emergency Water Supply Planning Guide for Hospitals and Health Care Facilities” by the Centers for

Disease Control and the American Water Works Association, published by HHS, lists the following HPH sector dependencies on water:

- washing and hygiene;
- drinking at faucets and fountains;
- food preparation;
- flushing toilets and bathing patients;
- laundry and other services provided by central services (e.g., cleaning and sterilization of surgical instruments);
- reprocessing of medical equipment, including those typically performed by special services (e.g., bronchoscopy, gastroenterology);
- patient care (e.g., hemodialysis, hemofiltration, extracorporeal membrane oxygenation, hydrotherapy);
- radiology;
- fire suppression sprinkler systems;
- water-cooled medical gas and suction compressors (a safety issue for patients on ventilation);
- heating, ventilation, and air conditioning (HVAC); and
- decontamination/hazmat response.

While the HPH sector acknowledges needing water for “continuity of operations and service delivery,” the water sector depends on the HPH sector as well. One of two exercises participants engaged in during the water sector interdependencies training involved a fictional pandemic flu outbreak. DHS estimates that organizations should anticipate up to a 40% absentee rate during a pandemic flu outbreak. While opinions varied during the training on what impact this would have on water sector utilities, a consensus did emerge that water sector utility personnel should receive priority status for vaccinations. Considered first responders by DHS and EPA, water sector personnel manage and operate facilities 24 hours a day, 7 days a week, and the result of loss of service could significantly impact public confidence during a pandemic flu outbreak. In addition, many water sector utilities depend on the HPH sector as customers.

Water Sector Interdependencies with Production Industry Sectors

Production industry sectors include energy, chemical, dams, nuclear, critical manufacturing, and defense industrial base. Perhaps the most significant and well-known water sector interdependencies exist with the **energy sector**. According to the energy SSP, energy sector assets and systems are geographically dispersed with thousands of miles of electricity lines and oil and natural gas pipelines and other assets in all 50 states. According to the Energy Information Administration (EIA) the U.S. population is expected to grow by about 70 million in the next 25 years and electricity demand to grow by 50%.

Energy sector assets are divided into three subsectors: electricity; petroleum, and natural gas. The electricity subsector includes the generation of electricity via fossil

fuel power plants (coal, gas, and oil); the transmission of electricity through substations, lines, and control centers; and the distribution of electricity through control systems and electricity markets. Petroleum subsector assets are divided into upstream and downstream components. Upstream petroleum components include exploration and development companies involved in the search for and production of crude oil, natural gas, and oil. Downstream components include crude oil refineries, product distribution terminals and retail sales networks. Finally, the natural gas subsector includes oil and gas fields, gas conditioning process facilities, and local distribution systems.

The energy sector's dependency on water is so important to the nation that the U.S. Congress commissioned a December 2006 Department of Energy study titled, "Energy Demands on Water Resources: Report to Congress on the Interdependency of Energy and Water." The report states, "water is an integral element of energy resource development and utilization ... used in energy-resource extraction, refining and processing, and transportation. Water is also an integral part of electric-power generation ... used directly in hydroelectric generation and is also used extensively for cooling and emissions scrubbing in thermoelectric generation." USGS states thermoelectric-power withdrawals accounted for 49% of total water use, 41% of total freshwater withdrawals for all categories, and 53% of fresh surface-water withdrawals.

According to the training participants, the water sector is more heavily dependent upon the energy sector than any other sector. The EPA and the electric power research institute (EPRI) estimate that approximately 3%–4% of the nation's electricity goes toward moving and treating water and wastewater, the majority of which is paid for by municipal operating budgets. In fact, EPA states drinking water and wastewater plants are typically the largest energy consumers of municipal governments, accounting for 30%–40% of total energy consumed. Also according to EPA, energy as a percent of operating costs for drinking water systems can also reach as high as 40% and is expected to increase 20% in the next 15 years due to population growth and tightening drinking water regulations.

Given the operational dependence and financial commitment water has with the energy sector, many water sector utilities are looking toward alternatives. Toward that end, EPA has released "Ensuring a Sustainable Future: An Energy Management Guidebook for Wastewater and Water Utilities." One option for managing energy costs while improving the reliability of power and thermal energy for wastewater facilities is combined heat and power (CHP), also known as cogeneration. CHP involves electricity generation with the capture of the historically wasted heat energy. A well-designed CHP system has the capacity to produce power at a cost below retail electricity; reduce operating costs by displacing purchased fuels for thermal needs; ensure

the availability of reliable heat and electricity supply; and increase energy efficiency, reduce greenhouse gas emissions, and generate renewable power. Another alternative is capturing energy sources through the wastewater treatment process, specifically anaerobic digestion. Anaerobic digestion decomposes and stabilizes organic material in the absence of oxygen, and produces biogas that consists mainly of methane and carbon dioxide, and which can be used as an energy source. These and other alternatives are steps water sector utilities are taking to move from energy interdependence to energy independence.

The second key sector in the production industry category is the **chemical sector**, which is an integral component of the U.S. economy, employing nearly 1 million people, and earning revenues of more than \$637 billion per year. The chemical sector can be divided into five main segments, based on the end product produced: (1) basic chemicals, (2) specialty chemicals, (3) agricultural chemicals, (4) pharmaceuticals, and (5) consumer products.

Facilities that make up the chemical sector are mostly privately owned and belong to one of three key functional areas, known as the value chain. These include manufacturing plants, transport systems, and distribution systems. Each of these functional areas is dependent on the water sector. Conversely, the water sector is heavily dependent upon chemicals that are used throughout the treatment process. In fact, DHS has identified chemical security as a key element in the protection of the nation's assets and an overarching concern for all critical infrastructure sectors.

As a result, DHS has established a risk-based set of performance standards for chemical facilities that can apply to facilities from other sectors that use, store, or deliver chemicals. Certain water sector utilities would be subject to this set of regulations, known as the Chemical Facility Anti-Terrorism Standards (CFATS). CFATS authorizes DHS to require high-risk chemical facilities to complete Security Vulnerability Assessments (SVAs), develop SSPs, and implement protective measures necessary to meet risk-based performance standards established by DHS. The CFATS Appendix A, published in the *Federal Register* on November 20, 2007, contains a list of chemicals and their Screening Threshold Quantities (STQ). Possession of one or more of these chemicals of interest, including many used by water sector utilities, at or above the applicable threshold quantity triggers a risk assessment process to determine if the facility must comply with CFATS regulations. Currently Congress has exempted the water sector from the CFATS rule. However, the debate continues on whether water sector utilities are public health facilities that use chemicals, or chemical facilities that should be subject to CFATS.

A third major sector classified as a production industry, is the **dams sector**. The dams sector comprises the

assets, systems, networks, and functions related to dam projects, navigation locks, levees, hurricane barriers, mine tailings impoundments, or other similar water retention and/or control facilities.

A simple listing of assets for the dams sector shows the multiple interdependencies with the water sector. These include: water impounding structures; reservoirs; spillways; outlet works; powerhouses that produce hydroelectricity; penstocks used to convey water under pressure to turbines or pump units; and canals/aqueducts to convey water by gravity. In fact, a good portion of the discussions during the training sessions revolved around whether the water and dams sectors should be combined.

Of the remaining production industry sectors, the critical manufacturing sector has the most significant interdependencies with water according to the training participants. Not included in the original list of 17 critical infrastructures, the critical manufacturing sector was later included as the 18th sector through a notice in the Federal Register. Composed of four broad industries, the critical manufacturing sector employs 1.1 million workers and manufactures \$676 billion in products. The industries include: primary metal (iron and steel mills); machinery (engine, turbine, and power transmission equipment); electrical equipment, appliances, and components; and transportation equipment (motor vehicles). Each industry is heavily dependent upon water for cooling, cleaning, and production. Conversely, the water sector depends on the critical manufacturing for the vast amount of equipment in water sector utilities and the equipment needed to service water sector utilities.

The **defense industrial base sector** includes the hundreds of thousands of domestic and foreign entities and subcontractors performing work for the Department of Defense. Although this sector does not highlight any interdependencies in its sector specific plan, the sector does rely upon the water sector for basic drinking water and wastewater services.

The final production industry sector is the **nuclear sector**, which includes nuclear power plants; non-power nuclear reactors used for research, testing, and training; nuclear materials used in medical, industrial, and academic settings; nuclear fuel fabrication facilities; decommissioning reactors; and the transportation, storage, and disposal of nuclear material and waste. Since nuclear power accounts for approximately 20% of the nation's electrical use, much discussion surrounding the nuclear sector at the training centered on why the nuclear sector is separate from the energy sector. The primary reason, according to DHS officials who attended the training, is that the nuclear sector already had a sophisticated security program prior to September 11, 2001, and therefore was kept separate to allow the sector to continue security measures

through the Nuclear Regulatory Commission (NRC). While not discussed during the water sector interdependencies training, the Fukushima Daiichi nuclear disaster in Japan during March 2011 demonstrates the interdependencies between the two sectors during daily operations and, particularly, during disaster recovery. Cooling water for nuclear reactors and decontamination of radioactive water are two examples of water/nuclear interdependencies identified by participants during the training.

Water Sector Interdependencies with Service Industry Sectors

The following sectors compose the service industry sectors: information technology; communications; transportation; banking and finance; commercial facilities; and postal and shipping. The **information technology (IT) sector** is central to the nation's security, economy, and public health and safety. The IT sector is an aggregate of primary virtual and distributed functions supported by various assets, systems, and networks. Rather than listing assets, the IT sector lists their critical functions, which include: IT products and services (hardware and software); provision of incident management capabilities; domain name resolution services; identity and management associated trust support services; Internet-based content, information, and communication services; and Internet routing, access, and connection services.

Like the chemical sector, protection of the IT sector is a priority at DHS as evidenced by the development of several cross-sector initiatives related to IT. President Obama has declared that the "cyber threat is one of the most serious economic and national security challenges we face as a nation" and that "America's economic prosperity in the 21st century will depend on cybersecurity." A cybersecurity office is now part of the White House National Security staff.

Water sector utilities are dependent upon the IT sector for all the functions described above. A significant water dependency on IT is through the water sector SCADA systems. SCADA systems are designed to integrate the monitoring of various system operations into a central data display and processing center so that operators can monitor and evaluate the system in real time. Vulnerabilities to SCADA systems, like all automation and industrial control systems, include computer viruses, transmitted either intentionally or by accident.

While all training participants agreed the IT sector was vital to operating a water sector utility, many water sector representatives felt reliance on IT was primarily a personnel issue. Acknowledging many water sector operators no longer know how to manually operate a water sector utility, participants felt that increased personnel and training on manual operation would significantly reduce the water sector's dependency on information technology.

Related to, but distinct from, the IT sector is the **com-**

munications sector. Over 25 years, the communications sector has evolved from being predominantly a provider of voice services into a diverse, competitive, and interconnected industry using terrestrial, satellite, and wireless transmission systems. The transmission of these services has become interconnected; satellite, wireless, and wireline providers depend on each other to carry and terminate their traffic, and companies routinely share facilities and technology to ensure interoperability. A primary goal of the communications sector is to rapidly reconstitute critical communication services after national and regional emergencies. To accomplish this goal, the federal government has three programs designed to provide emergency access. For access to wireline or public switched telephone network (PSTN), the National Communication System (NCS) provides the government emergency telecommunications service (GETS). For wireless service, NCS provides wireless priority service (WPS). And for all telecommunication service, Telecommunications Service Priority (TSP) is available. All three programs are designed to provide first responders, such as personnel from water sector utilities, priority service to communicate during an emergency or crisis situation.

In both day-to-day and emergency situations, the water sector is heavily dependent upon the communications sector. In fact, the majority of participants in the water sector interdependencies training stated that they rely more on communications than IT during an emergency situation. The communications sector is also dependent upon the water sector. The Geospatial Information and Technology Association (GITA) published a white paper on water sector infrastructure interdependencies. Communications dependencies on water during a disruption of water supply are listed as, “first order effects (capacity saturation due to public calls), second order effects (operation limitations due to limited cooling), and third order effects (interruption of emergency communication)”.

A third, and vital, service industry sector is the **transportation sector**. Due to its vast, open, interdependent nature, the transportation sector consists of six subsectors, known as modes: aviation, maritime, mass transit, highway, freight rail, and pipeline. Examples cited during the training of how dependent the water sector is with these modes included:

- rapid transport of laboratory samples (aviation);
- transporting water sector personnel, light equipment, and chemicals (mass transit and highway);
- transporting water sector heavy equipment and chemicals (freight rail); and
- water conveyance lines (pipeline assets).

Regarding transportation of personnel, equipment, and chemicals to water sector utilities, many training participants noted the unique nature of transportation creden-

tialing during an emergency. A wide disparity of programs exist from state to state regarding what credentials, other than a commercial driver’s license, contractors or employees may need when transporting personnel, equipment, or chemicals to a drinking water or wastewater facility, particularly immediately following an incident.

Examples of ways in which the transportation sector is dependent upon the water sector include cleaning of equipment and de-icing airplanes (aviation); water for cooling of equipment (mass transit, highway, and freight rail); and common rights of way (pipeline).

The banking and finance sector, commercial facilities sector, and postal and shipping sector round out the service industries. Accounting for 8% of the U.S. gross domestic product, the **banking and finance sector** lists its assets as “critical processes and institutions.” These include deposit and payment systems (banks); credit and liquidity products (home mortgage, business line of credit); investment products (bonds and mutual funds); and risk-transfer products (insurance companies). A major interdependency between the banking and water sector (as well as the IT sector) includes online payments by customers of drinking water and wastewater utilities. Even though most water sector utilities are municipally owned and operated, they are still subject to the red flags rule of the Federal Trade Commission (FTC). The rule requires implementation of a written Identity Theft Prevention Program designed to detect the warning signs — or “red flags” — of identity theft in their day-to-day operations.

Commercial facilities sector consists of eight subsectors: entertainment and media, lodging, outdoor events, public assembly, real estate, resorts, retail, and sports leagues. While water sector utilities depend on many commercial facilities as customers, commercial facilities are far more dependent upon water than water is dependent upon commercial facilities. Perhaps no other sector illustrates the economic importance of clean and safe water service than the commercial facilities sector. However, in its sector specific plan, the commercial facilities sector notes only its interdependencies with the energy sector. In fact, with a few notable exceptions, all 17 other critical infrastructure sectors either are not aware of their dependencies on water, or minimize the importance of their dependencies on water. This was a major topic of discussion during the water sector interdependencies training. Water sector utility personnel, as well as representatives from other sectors, noted reliable safe and clean water services are undervalued, taken for granted, or generally disregarded.

The final service industry is the **postal and shipping sector**. Consisting of the U.S. Postal Service as well as the private companies such as Federal Express and United Parcel Service (UPS), the sector receives, pro-

cesses, transports, and distributes billions of letters and parcels annually. Primarily relied upon by the water sector to deliver laboratory samples and business documents, the postal and shipping sector is also dependent upon water for cooling and cleaning of equipment.

Water Sector Interdependencies with Federal and State Sectors

The final category of sectors is the federal and state sectors. Consisting of the emergency services, government facilities, and national monuments and icons sectors, the majority of time during the training focused on the **emergency services sector (ESS)**. The sector lists “understanding dependencies and interdependencies with other sectors” as a primary goal. It is no coincidence then that other than the water sector, the ESS was the most represented sector at each water sector interdependencies training or that the ESS is one of the few sectors that details the importance of clean and safe water service during and following an emergency.

Consisting of several disciplines and specialized capabilities, the ESS acknowledges that it is a complex and dispersed sector presenting challenges in coordinating emergency responses across levels of government. ESS disciplines include: law enforcement; fire and emergency services; emergency management; emergency medical services; and public works. ESS specialized capabilities include: hazardous materials (HAZMAT); search and rescue (SAR); explosive ordnance disposal (EOD); special weapons and tactics and tactical operations (SWAT); aviation units; and public safety answering points (PSAPs). Simply put, the ESS is organized and performs at the state, local, tribal, and territorial level and represents the nation’s “first line of defense” against terrorist activity and natural disasters.

Recognizing the importance of the ESS to the water sector, EPA has published, “Water and Emergency Services, A Critical Community Interdependency.” The document lists ESS dependencies with the water sector by discipline and specialized capabilities, including: fire and rescue (water for firefighting); emergency medical services (sterilize on-scene medical equipment and hydrate emergency medical technicians [EMTs], paramedics, and accident victims); emergency management (drinking water and wastewater services for emergency shelter operations). The document also lists water sector dependencies with ESS, including: law enforcement (protect water infrastructure; investigate criminal acts at water utilities sites); emergency medical services (respond to public health impacts of water service interruptions, particularly for consumption of contaminated drinking water); HAZMAT response (handle and dispose of contaminated surface, ground, or drinking water); and emergency management (coordinate water emergency response and recovery efforts).

A major discussion topic and general consensus during the water sector interdependencies training program was how ESS personnel are more valued than personnel of the water sector or other sectors within and external to the ESS sector. One example is the fact that emergency services personnel are listed in the ESS SSP as the most important asset of the sector. One program, sponsored by WEF and AWWA titled, “Work for Water,” is intended to raise awareness of the value of the water profession and provide water sector utilities a tool to recruit, train, and retain the next generation of water professionals.

The **government facilities sector** consists of a wide variety of facilities owned or leased by federal, state, local, or tribal governments, located both domestically and overseas. Assets are distinguished by whether or the facility is open to the public.

Many government facilities are open to the public for business activities, commercial transactions, or recreational activities. Others not open to the public contain highly sensitive information, materials, processes, and equipment. This includes general-use office buildings and special-use military installations, embassies, courthouses, national laboratories, and structures that may house critical equipment and systems, networks, and functions. In addition to physical structures, the sector considers cyber elements that contribute to the protection of sector assets (e.g., access control systems and closed-circuit television systems) as well as the protection of individuals who possess tactical, operational, or strategic knowledge or perform essential functions.

Training participants acknowledged a dependency on the government facilities sector by the water sector, primarily because many water sector personnel and other assets are housed within buildings owned and operated by local or state governments.

The final sector under the federal and state category is the **national monuments and icons (NMI) sector**. NMI assets are located throughout the United States and its territories and many are listed on the National Register of Historic Places. All assets are owned by the federal government and the priority ranking criteria are developed based on uniqueness of the asset and significance as a national symbol.

Interestingly, the NMI SSP states, “unlike other assets that have numerous interdependencies, NMI assets are basically stand-alone assets, and the loss of or damage to an NMI asset generally will not have a cascading effect on other assets within the NMI sector, or other sectors.” This statement was debated during the training and the general consensus was that no sector “stands alone.” In fact, many participants questioned the reason why NMI is considered a critical infrastructure. This was addressed in the training through the concept of resilience and is applicable across all critical infrastructure sectors.

A key component to the nation's public health, economic, psychological, and governance security is resilience. The Community Resilience Task Force of the Homeland Security Advisory Council within DHS defines resilience as the "ability to resist, absorb, recover from or successfully adapt to adversity or a change in conditions." Relating to critical infrastructure protection, resilience is further defined by DHS as the "ability of systems, infrastructures, government, business and citizenry to resist, absorb, recover from, or adapt to an adverse occurrence that may cause harm, destruction, or loss of national significance." Still further, DHS defines resilience as the "capacity of an organization to recognize threats and hazards and make adjustments that will improve future protection efforts and risk reduction measures."

Relating to the NMI sector, the concept of why it is considered one of the 18 critical infrastructure sectors is that it would be extremely difficult, or impossible, to recover from the destruction of a national monument or icon, such as the White House or U.S. Capitol Building. The monuments could be rebuilt, but the history associated with the building, including artwork, statutes, etc., are irreplaceable due to their unique nature.

IV. Water Sector Interdependencies Training Conclusions and Lessons Learned

Since increased resilience is a major objective of all critical infrastructures, understanding and appreciating water sector interdependencies is essential. Although not universally recognized by other critical infrastructure sectors, the nation needs to address the cascading effects associated with water sector interdependencies, particularly with infrastructure sectors such as agriculture and food, health care and public health, energy, chemical, dams, information technology, communications, transportation, and critical manufacturing. All sectors are vulnerable if water sector service is compromised and the consequences are not just related to public health and economics, but to the nation's psychological well-being and confidence in governance.

While the water sector interdependencies training is the first of its kind and additional national training programs are needed to raise awareness of all critical infrastructure interdependencies, perhaps a lesson learned from this training is that state and local officials need to continue to convene multi-sector meeting and trainings within their community.

EPA has developed two tools to assist in this endeavor: the community based-resiliency tool and the table-top exercise CD for water and wastewater utilities. By taking a lead in their community, water sector operators, manag-

ers, and staff could use these tools to host multi-sector meetings with representatives from all 18 critical infrastructure sectors. The result may be a more comprehensive and relevant community emergency response plans and a greater appreciation for how to increase resilience at the local level.

On March 30, 2011, a Presidential Policy Directive was issued on overall national preparedness (PPD-8). PPD-8 is aimed at "strengthening the security and resilience" of the United States through "systematic preparation for the threats that pose the greatest risk to the security of the Nation." A part of the implementation of this initiative is to "employ an all-of-Nation/whole community approach, integrating efforts across federal, state, local, tribal, and territorial governments and with private sector, community, nongovernmental, and individual partners."

Water sector dependence on other critical infrastructures and those sectors' dependence on water pose a significant risk to the security of the nation. In its most basic form, the water sector interdependencies project began to address this risk by convening a total of 21 trainings in every FEMA region with the hope that individual communities would continue the effort.

Attachment A – Water Sector Interdependencies Training Agenda

DAY 1

8:00 a.m. - 8:30 a.m. Registration

8:30 a.m. - 10:00 a.m. Module 1: Workshop Learning Objectives and Interdependency Exercise

This module is designed to provide an overview of workshop goals, objectives, and expected learning outcomes. By the end of Module 1, participants will be able to understand the background and learning objectives of the workshop and identify the goals and objectives of the National Infrastructure Protection Plan (NIPP).

10:00 a.m. - 10:15 a.m. Networking Break

10:15 a.m. - 12:00 p.m. Module 2: Sustenance and Health Sector Overviews and Group Discussion

This module provides an overview of the Sustenance and Health Sectors, including sector profile, goals, assets, and sector interdependencies. Participants will be able to identify and describe the assets of the Water, Agriculture and Food, and Public Health and Health Care Sectors as well as assess and relate how the Water Sector adheres to the NIPP risk management framework.

12:00 p.m. - 1:00 p.m. Working Lunch: Water Sector Interdependency Case Study

1:00 p.m. - 2:30 p.m. Module 3: Service Industry Sector Overviews and Group Discussion

This module provides an overview of the Service Industry Sectors, including sector profile, goals, assets, and sector interdependencies. Participants will be able to identify and describe the assets of the Information Technology, Communications, Transportation, and other Service Industry Sectors.

2:30 p.m. - 2:45 p.m. Networking Break

2:45 p.m. - 4:00 p.m. Module 4: Federal and State Sector Overviews and Group Discussion

This module provides an overview of the Federal and State Sectors, including sector profile, goals, assets, and sector interdependencies. Participants will be able to apply concepts learned by engaging in a group discussion on federal and state sector interdependencies with the water sector.

DAY 2

8:30 a.m. - 10:00 a.m. Module 5: Production Industry Sector Overviews and Group Discussion

This module provides an overview of the Production Industry Sectors, including sector profile, goals, assets, and sector interdependencies. Participants will be able to apply concepts learned by engaging in a group discussion on production industry sector interdependencies with the water sector.

10:00 a.m. - 10:15 a.m. Networking Break

10:15 a.m. - 11:30 a.m. Module 6: Water Sector Interdependency Exercise and Hotwash Pandemic Flu

This module of the Water Sector Interdependency General Awareness Workshop involves an exercise for participants as an exploration of water sector interdependencies. The exercise involves a pandemic flu outbreak scenario, and challenges participants to discuss options and impacts from a series of directed injects that describe conditions and events in a theoretical situation.

11:30 a.m. - 12:00 p.m. Workshop Evaluative Summary and Next Steps

ATTACHMENT B – Water Sector Interdependencies Training Participation by Sector

