A Clear Commitment to America's Waters

Chemical Security Legislation:

Economic, Environmental, and Public Safety Implications from a POTW Perspective

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Congress authorized the Chemical Facilities Anti-Terrorism Standards ("CFATS") when it enacted the *Department of Homeland Security Appropriations Act of 2007* (PL 109-295) in October 2006. Section 550 of the Act authorizes the Department of Homeland Security (DHS) to require high-risk chemical facilities to complete security vulnerability assessments, develop site security plans, and implement risk-based measures designed to satisfy DHS-defined risk-based performance standards. The Act also granted an exemption to wastewater treatment utilities (collectively referenced herein as "Publicly-Owned Treatment Works" or "POTWs")[1] from the Act's requirements. In April 2007, DHS promulgated the CFATS rule. The rule includes an Appendix which lists certain chemicals of interest ("COIs") and threshold quantities of these chemicals that trigger initial reporting and screening requirements under CFATS. Gaseous chlorine, a disinfectant used by many POTWs as part of the wastewater treatment process, is a listed COI.

The CFATS program is slated to sunset on September 30, 2009, and Congress is currently considering legislation that would make the CFATS program permanent and remove the statutory exemption for POTWs. Without the existing exemption, POTWs that possess gaseous chlorine in quantities above specified threshold levels would be required to comply with CFATS evaluation and security implementation requirements.[2] A legislative proposal from the 110th Congress, *The Chemical Facility Anti-Terrorism Act of 2008* (H.R. 5577), which would likely form the basis for legislative action in the current 111th Congress, would revise the CFATS regime to mandate that all CFATS-regulated facilities consider and implement inherently safer technologies ("IST") as part of their site security plans.[3]

The extension of CFATS to POTWs and the proposal to mandate IST raise a series of public safety, public health, environmental, and economic concerns for the wastewater treatment community. While wastewater treatment utilities understand the need to secure their facilities against potential terrorist threats, any provision requiring POTWs to incorporate IST approaches must account for the unique functions of POTWs and give utilities the ultimate authority to determine the most appropriate disinfection technology for a particular facility. As the preeminent national voice advocating on behalf of POTWs, the National Association of Clean Water Agencies (NACWA) is concerned with the potential ramifications of applying IST to wastewater utilities in terms of disinfection methods, and encourages Congress to provide POTWs with the necessary flexibility regarding disinfection in any future CFATS legislation.

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[1] The water industry exemption extends to both wastewater treatment and drinking water facilities; however, this paper focuses primarily on the implication of CFATS for the wastewater treatment sector.

[2] The Screening Threshold Quantity for Chlorine present onsite is 2,500 pounds or greater in a concentration of 1% or more as a "release" chemical, and 500 pounds or greater in a concentration of 9.77% or more as a "theft" chemical.

[3] Inherent safety is a well-recognized process safety concept. It is a collection of four basic strategies – substitution, minimization, moderation, and simplification – all of which focus on process safety improvement through the reduction of hazards. The concept is based upon the belief that if one can eliminate or moderate the hazard, not only is the risk reduced, but it may be possible to remove the risk altogether. IST is referred to in H.R. 5577 as "consequence reduction," and the proposal requires consideration of substitution, minimization, and other IST strategies.

Publicly Owned Treatment Works Provide Critical Public Health, Safety, and Environmental Functions

Congress correctly recognized when it granted the CFATS exemption to POTWs in 2006 that wastewater treatment plants differ from private chemical companies in several key respects. POTWs are publicly-owned entities that provide an essential service to the public at-large and the communities they serve. The processes and technologies employed by POTWs are carefully designed to maximize public health, environmental benefits, and ratepayer value. Because POTWs have fiduciary responsibilities to the public, many facilities have already adopted security measures to ensure against possible terrorist attacks. Further, POTWs must comply with strict federal permit standards under the Clean Water Act ("CWA") and with other federal laws including the Clean Air Act. Finally, POTWs must carefully evaluate any proposed increases in rates to the communities they serve as a result of increased operating or capital costs. Rate increases often involve contentious local political battles. As such, rate increases by POTWs due to increased federal regulation for technology upgrades is much more complicated than private chemical companies increasing the price of the products they sell in the private marketplace.

POTWs are also heavily regulated in ways that private chemical facilities are not. They were created to meet the rigorous requirements of the CWA, which establishes effluent guidelines for POTWs to ensure public health and environmental safety. In addition, the Clean Air Act Risk Management Plan program requires POTWs that store a threshold quantity of gaseous chlorine on site to develop emergency response plans to mitigate the consequences of an attack or an accidental release, including extensive risk management planning and assessments.

Wastewater treatment involves complex chemical and biological treatment processes that rely on effective disinfection methods to destroy pathogens and other compounds that can cause illness if human exposure occurs. Additionally, each POTW is a distinctive facility with a treatment process designed specifically for the needs of that facility's surrounding environment, community, and receiving water body. POTWs that employ gaseous chlorine do so after evaluating its effectiveness and determining that its use is the most efficacious method available to them to protect public health and achieve water quality standards required under the CWA. The use of gaseous chlorine or any disinfection method is a critical design component for a POTW and is integral to the overall engineered design of the treatment process. Approximately 50 percent of POTWs use gaseous chlorine for disinfection.

POTWs have expended significant resources to secure their facilities because they understand their responsibility to their communities to operate effectively, safely, and efficiently 24 hours a day, seven days a week. The majority of POTWs have conducted an initial, voluntary vulnerability assessment, and then updated these vulnerability assessments as determined necessary by the utility. Vulnerability Assessments allow utilities to define and focus on appropriate risk management and security improvements for their facilities. A 2007 survey of the water sector found that an overwhelming number of respondents, regardless of their disinfection strategies, use a combination of security methods to safeguard their utility perimeters.[4] These methods

[4] This survey was conducted jointly by NACWA, the Association of Metropolitan Water Agencies, the American Water Works Association, the National Association of Water Companies, the Water Environment Federation, and the National Rural Water Association.

include fences (88% of all responses), gates (65% of all responses), and warning signage (64% of all responses). Access into the utility is controlled for 85% of all utilities, using methods such as manual locks, electronic access controls, and visitor restrictions. For utilities that use chlorine gas, approximately 80% store the chlorine and other hazardous chemicals in a hardened building, and nearly all of these are concrete/block construction. Other measures taken to secure the building are doors with exterior locks, interior locks, sensor alarms, video surveillance and remote sensors, and additional fencing and restricted viewing from off-site. Inventories of hazardous chemicals are routinely reconciled and/or audited for 86% of these utilities, and 95% of these utilities limit access to hazardous materials to authorized personnel.

Most utilities have also taken steps to prepare for emergency situations, with 94% of all responding utilities having an emergency response plan, most of which address chemical theft or release. Eighty-five percent of all utilities have established protocols with first responders, such as law enforcement, fire departments, and hazmat responders, to address hazardous chemical theft or release, and the majority of utilities would also report to their state primacy agency. Over 60% of all utilities also communicate regularly with law enforcement to report and receive information on suspicious incidents and activities. These security measures have been undertaken voluntarily by POTWs, and further improvement in security measures at POTWs can also be achieved through voluntary programs.

Current CFATS Approach Providing Flexible IST Implementation Should Be Continued

Under the existing CFATS regime, regulated facilities have the flexibility to consider IST options to meet performance standards. The existing, flexible scheme makes good sense in that it ensures consideration and appropriate implementation of risk-based standards to address consequences of a terrorist attack, while at the same time allowing a facility to switch to a non-listed COI. Just as importantly, this approach provides regulated facilities the ability to consider and assess their unique site-specific concerns in developing an appropriate security program. Any future application of CFATS requirements to POTWs should include flexible IST implementation with regard to the choice of disinfection technology.

In most cases, the factors that make POTWs distinct from private chemical facilities also make them poorly suited for inflexible IST requirements regarding disinfection techniques. Unlike private chemical facilities, the communities served by POTWs rely on the safe, effective functioning of the utility, and POTWs work well, in part, because they are responsive to the needs of their communities. This is particularly true when wastewater treatment plants choose specific methods of disinfection. Most POTWs that are currently using gaseous chlorine for disinfection are doing so after careful consideration of other treatment methods and a deliberate decision that chlorine best meets the needs of that particular facility. Various tools are available for evaluating the treatment methods, such as the *Chlorine Gas Decision Tool for Water and Wastewater Utilities* that was developed in 2006 by NACWA for the DHS Advanced Research Projects Agency. This tool has led some utilities to switch from chlorine gas to another disinfection method, while other utilities have continued their chlorine gas use after evaluating alternatives. The reasons for a utility's decision to continue chlorine gas use can be many and varied, including specific discharge limits under a CWA permit, environmental and public health requirements of the receiving water body, lack of availability or transportation of

sufficient alternative treatment chemicals, local community considerations regarding transport and storage of chemicals in and around the facility, economic factors associated with plant operation costs, and specific plant design of a POTW's treatment process. A mandatory switch from chlorine to another disinfection method could adversely affect any one of these considerations.

If Congress were to require POTWs to switch disinfection technologies from gaseous chlorine to an alternative method, negative environmental and public health consequences could ensue. POTWs must comply with strict CWA permits that establish fecal coliform effluent limits to protect human health and the environment from pathogens entering the receiving water. Failure to meet such limits, in addition to the potentially serious health and safety risks for humans and wildlife, subjects the POTW to possible civil and criminal enforcement under the CWA, exposing the POTW to potentially significant financial liability. Additionally, many POTWs discharge to water bodies that serve as primary contact (bathing or swimming) recreation for the public and must be sure their effluent is properly disinfected to avoid potential illnesses among downstream recreational users. If a POTW has determined that chlorine is the best disinfection technology to prevent such illness, mandating a switch to less reliable and effective techniques unnecessarily and irresponsibly places public health at risk.

A mandate to switch disinfection methods under an inflexible IST approach also conflicts with other competing health and safety priorities and concerns. For example, to ensure continued operation in the event of a natural disaster, terrorist attack or other event that disrupts delivery of supplies, many wastewater facilities store a reserve supply of the chemicals needed for disinfection treatment, recognizing the vital public health service they provide and the need for seamless operation. An inflexible IST mandate to reduce such inventories would impair the ability of the utility to function effectively and provide critical service during a period of local or national emergency.

Furthermore, "inherently safer" does not necessarily mean zero risk. Instead, it may be that the hazard is simply shifted to different locations. IST regulations encourage individual facilities to take the most inherently safe position relative to their operations, not necessarily the most inherently safe (or secure) position for the community in which they operate, thereby potentially increasing the societal risks. DHS has already recognized this, stating that "[DHS] also believes that IST is often not appropriate in the security arena, because many IST solutions do not eliminate or reduce risk, but only move risk to another location."[5]

A common example is that of transportation risk, where an IST mandate to switch from gaseous chlorine could increase the number of trips needed to transport other dangerous chemicals through the community serviced by a POTW. As an example of this, one water utility recently did an evaluation of the impact of switching from gaseous chlorine, the utility's current disinfection method, to sodium hypochlorite, the most common alternative to chlorine. The utility currently uses one railcar of chlorine per week to meet its disinfection needs. However, switching to sodium hypochlorite would require approximately 70 five-thousand gallon tanker truck deliveries per week to

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[5] DHS on-line response to Frequently Asked Question No. 43. *http://csat-help.dhs.gov/pls/apex/f?p=100:1:3314148706186753::NO:::#43.*

meet the same need.[6] The utility determined that the increased traffic, air pollution, and safety risks of 70 tractor trailers per week traveling through local neighborhood roads around its plant with a potent chemical was not "inherently safer" than one railcar delivery per week of chlorine, and chose not to switch disinfection methods. Instead, the utility choose to harden and expand its existing containment and security measures surrounding the storage of gaseous chlorine. This decision was made based on local needs and circumstances after careful evaluation of all factors, including transportation, and represented the best choice for the utility.

Alternatively, some POTWs have conducted similar evaluations of their operations and needs and decided to make the switch from chlorine to sodium hypochlorite. This does not necessarily reduce or eliminate the risks, however, because the manufacturing of sodium hypochlorite still depends upon the use of gaseous chlorine as a key ingredient. An increase in the manufacture of sodium hypochlorite could therefore shift the risk of an increase in the frequency of transits and quantity of gaseous chlorine from the POTW and neighboring community to the community near to the manufacturing plant and the workers involved.[7] As a result, while some POTWs have already voluntarily switched to alternative disinfection methods, others have decided it more prudent to harden their facilities. POTWs that made the switch did so only after careful consideration of the ability to provide continuous, effective services at an affordable cost to the consumer.

Other disinfection methods that have been mentioned as "safer" alternatives to gaseous chlorine for disinfection include production of sodium hypochlorite onsite (as opposed to shipping it in from offsite), ozone, and ultraviolet light. However, while these alternatives do have advantages for some POTWs, each of these approaches presents its own set of hazards and drawbacks. Production of sodium hypochlorite on-site still involves additional transportation risks, as significant amounts of salt must be trucked to the plant.[8] The production process also creates hydrogen as a byproduct, a combustible gas that must be processed and disposed of in a safe manner. Ozone is extremely toxic in nature and must be constantly monitored with expensive, high-tech monitoring systems. It is also extremely flammable.[9] For ultraviolet (UV) disinfection, the presence of color or suspended or dissolved materials in the flow can impede the disinfection

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[6] See testimony of Association of Metropolitan Water Agencies before U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Environment and Hazardous Materials, June 12, 2008. Although this particular example involves a drinking water facility, the technical and transportation challenges presented by changing disinfection techniques are very similar between drinking water and wastewater facilities and require similar consideration of impacts on the surrounding community.

[7] Notably, sodium hypochlorite is not without hazards. Serious injury can occur as a result of chlorine released when sodium hypochlorite solutions are accidentally mixed with acids or acidic materials. Sodium hypochlorite is incompatible with many acids, ethylene glycol, propane, metals such as copper and nickel, reducing agents such as sodium sulfite, and hydrogen peroxide to name a few.

[8] See testimony of Association of Metropolitan Water Agencies before U.S. House of Representatives Committee on Energy and Commerce, Subcommittee on Environment and Hazardous Materials, June 12, 2008.

[9] See Disinfection Technologies for Potable Water and Wastewater Treatment: Alternatives to Chlorine Gas, U.S Army Forces Command, Air Quality Division, July 1998, pp. 28-29.

performance of the UV light.[10] And onsite sodium hypochlorite production, ozone, and UV all use significant amounts of additional electricity, increasing a POTW's electric costs and associated greenhouse gas emissions at a time when many utilities are striving to reduce costs and their carbon footprints. Attached to this document (Attachment A) is a table of some the disinfection methods most commonly mentioned as alternatives to gaseous chlorine, as well as comparison of evaluation factors for each method. Given the significant challenges each of these alternatives present, it is important that each utility and facility have the ability to choose a method that works best based on their unique needs and circumstances.

What must not be overlooked, especially in the context of the POTW community that is so directly tied to public safety, is the potential that a shift to mandatory IST and away from local choice over disinfection methods could simply lead to a redistribution of risk across the community or the country. Any future action by Congress to include POTWs within the CFATS framework must include flexibility regarding IST and the continued ability of POTWs to make appropriate, local, site-specific decisions regarding disinfection techniques.

Mandatory IST Will Pose Serious Economic Challenges to POTWs

Most POTWs operate in small communities with limited resources, which already struggle to meet increasing federal regulatory requirements aimed at public health and environmental protection. POTWs already face an EPA-estimated $300-500 billion gap nationally in funding needs due to these increasing requirements, aging infrastructure, and growing population demands.[11] And unlike private chemical faculties, they cannot easily pass additional costs on to the consumer without extensive political and public involvement regarding rate increases. Increasing the economic burden may also interfere with a POTW's ability to maintain a sufficient chemical inventory, thus exposing the POTW and the community to the risk of non-compliance with the CWA. In determining the future of the CFATS regime, these considerations must be balanced from a risk perspective with other hazard reduction goals.

<u>IST Must Be Supported By Direct Funding to POTWs</u>

IST will only increase the economic burden on POTWs, so any shifts to IST, whether mandatory or voluntary, should be funded. The exact cost to switch from chlorine to another disinfection technique will vary from utility to utility, but can range anywhere from $650,000 to over $13 million.[12] This is a steep price for any utility to bear, but would be especially painful for smaller or economically disadvantaged communities with limited funding and a ratepayer base unable to absorb the additional costs. Conversion to other disinfection methods can also result in higher annual operating and maintenance costs. Attached to this document (Attachment B) is a chart

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[10] Id., p. 32. The inability of large POTWs to adequately disinfect their effluent with UV could pose serious public health threats to the receiving water bodies, not to mention potential liability for the POTW in failing to meet its discharge permit limits.

[11] See EPA's Clean Water and Drinking Water Infrastructure Gap Analysis, September 2002, available at *www.epa.gov/OGWDW/gapreport.pdf*.

[12] See U.S. Government Accountability Office Report GAO-07-480, March 2007, available at *http://www.gao.gov/htext/d07480.html*.

showing the increased cost over a range of POTW sizes for alternative disinfection techniques such as UV or sodium hypochlorite over chlorine. These costs can be quite significant, particularly as the amount of wastewater treated increases.

Section 2110(f) of H.R. 5577 contemplates IST funding for POTWs and provides that "the Secretary may not require a publicly-owned facility regulated under . . . the Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.) to implement methods to reduce the consequences of a terrorist attack under subsection (b) unless that facility receives funding under subsection (e)." Although NACWA believes mandatory IST should not apply to POTWs, if Congress determines otherwise, federal funding to meet the IST requirements must be provided. Mandating IST carries significant risks and challenges to POTWs and the communities they serve. Increased federal funding to meet those challenges must go hand-in-hand with increased federal requirements.

POTWs Should Receive Increased Federal Funding To Comply With CFATS

Looking beyond IST to the upcoming CFATS reauthorization more generally, removing the POTW exemption from the CFATS rule would force wastewater utilities to undertake many expensive security and administrative changes. These economic burdens are substantial, particularly in the current economic climate. Given the unique nature of POTWs and the limited resources available to them, POTWs should receive additional federal funds if forced to comply with CFATS.

At a minimum, inclusion under CFATS would require POTWs to review and regularly assess their chemical inventories, hire and train safety and security personnel, establish processes to protect newly developed information from unauthorized release, and meet annual auditing responsibilities, among other requirements. To complete these administrative evaluation efforts, a POTW will likely need to invest 30.3 - 150 hours to prepare the chemical inventory Top Screen, 250 -1,000 hours to prepare the Security Vulnerability Assessment ("SVA"), 500 -1,000 hours to prepare the Site Security Plan ("SSP"), and 1,200 - 2,400 hours to undertake self audits, inspections and finalization of the SSP. In sum, a typical facility that is determined by DHS to be a CFATS "high risk" facility will likely spend between 1,600 and 4,550 hours for the initial rollout of the evaluation process. There would also be significant cost for the POTW to hire a consultant for assistance with the evaluation process.

In addition to these administrative evaluation costs, which would potentially be imposed every two to three years, POTWs would most likely be required to undertake security upgrades and shoulder ongoing costs for security implementation. Although many POTWs have already invested significant money and time improving security at their facilities, incorporation under CFATS would bring a host of new federal requirements. Specifically, covered POTWs would be obligated to meet and implement the mandatory risk-based performance standards ("RBPS") developed by DHS as part of the CFATS program. *See* 6 CFR § 27.230(a). These RBPS include extensive and complex requirements to, among other things:

- secure and monitor the perimeter of the facility and restricted areas or potentially critical targets within the facility,
- screen and control access to the facility and to restricted areas within the facility by screening and/or inspecting individuals and vehicles as they enter,

- deter, detect, and delay an attack, creating sufficient time between detection of an attack and the point at which the attack becomes successful,
- deter theft or diversion of potentially dangerous chemicals,
- maintain effective monitoring, communications, and warning systems.

In addition to the RBPS enumerated in the CFATS rule, regulated facilities are required to comply with "any additional performance standards [DHS] may specify." 6 CFR § 27.230(a)(19). Thus, the RBPS requirements are part of an evolving, enforceable, and expensive regulatory program. Facilities not in compliance with the standards may be fined or face other sanctions.

Compliance with these CFATS evaluation and security requirements would impose significant burdens on POTWs. The imposition of an additional obligation – to evaluate and shift to IST – would substantially increase these burdens and may, as a consequence, adversely affect the ability of POTWs to effectively and safely treat the public's wastewater. It is imperative that Congress recognize both the cost of these burdens on POTWs and the unique role POTWs play in their local communities, and include additional federal funding to help wastewater utilities meet any new federal requirements under any future CFATS legislation.

Conclusion

Public safety and environmental protection is the number one priority for the municipal wastewater treatment community, including the safety of all chemicals used and stored at treatment facilities. POTWs continue to evaluate the security needs of their plants and make needed changes. However, given the unique and critical role POTWs play in protecting public health and the environment, any future application by Congress of CFATS and IST regulation to POTWs must be flexible enough to allow utilities to make informed, deliberate choices about what form of disinfection technology is right for local facilities and local communities. NACWA and its public utility members look forward to continued work with Congress on this important issue and to providing their local communities with continued safe and reliable service.

The National Association of Clean Water Agencies ("NACWA") is a nationally-recognized leader in environmental policy and a sought-after technical resource on water quality and

ecosystem protection issues. NACWA was established in 1970 by a group of individuals representing municipal sewerage agencies. Today, NACWA represents the interests of nearly 300 of the nation's publicly owned wastewater treatment facilities which serve the majority of the sewered population in the United States, collectively treating and reclaiming over 18 billion gallons of wastewater every day. Please visit us on the web at *www.nacwa.org*.

Attachment A

Comparison of Wastewater Disinfection Technologies

Chlorine Gas	
Description	Liquefied chlorine gas is transported to the treatment works in high pressure cylinders on tractor trailers or tank cars by rail, and then applied to the wastewater in solution using equipment called a chlorinator. Dechlorination using the chemical sulfur dioxide is another chemical process required to remove chlorine residual before the effluent is discharged to the receiving water body at most POTWs.
Applicability	• Well-established and most commonly used technology for any size of wastewater disinfection system. • Can also control odor and filamentous bacteria.
Cost Implications	• Generally more cost-effective than sodium hypochlorite solution and other disinfection alternatives. (Cost should also include dechlorination system, fire code requirements, and maintaining a Risk Management Plan and Emergency Response Plan. In some cases, an emergency chlorine gas scrubber needs to be installed.)
Process Reliability	• Proven, reliable technology for wastewater disinfection. Effective for most pathogens. • Presence of chlorine consuming compounds (such as nitrite) may affect the chlorine dose, and thus disinfection reliability. • Control of chlorine dose and dechlorination is challenging for intermittent wet weather flows with widely ranging flow rates and water qualities, such as combined sewer overflows.

Community Safety and Security	• Highly toxic and corrosive. Stringent regulations must be followed during handling, transporting, storing, and application. • Accidental leakage may have a large scale impact on operator and community safety. • Dechlorination chemicals (sodium bisulfite or sulfur dioxide) also have safety concerns.
Impact on Receiving Water	• Produces carcinogenic disinfection by-products (haloacetic acids and trihalomethanes). • Chlorine residual, if not completely removed through dechlorination, is toxic to aquatic life. • Excessive dechlorination may reduce dissolved oxygen in the water.
Purchased Sodium Hypochlorite	
Description	Sodium hypochlorite solution is purchased and transported to the treatment works in tractor trailers with 3-15 percent available chlorine. It is applied to the wastewater through chemical feeding pumps. Dechlorination using the chemical sodium bisulfite is another chemical process required to remove chlorine residual before the effluent is discharged to the receiving water body at most POTWs.
Applicability	• Same as chlorine gas.
Cost Implications	• Chemical costs are usually higher than gas chlorine and vary based on geographical location and other factors. • Liquid solution requires significantly more space for storage due to less strength of free chlorine. • Capital costs are higher than chlorine gas for large facilities.
Process Reliability	• Proven, reliable technology for wastewater disinfection. • Degradation of bulk chemical strength can occur over time. Degradation occurs more rapidly at higher temperature, higher concentration, and exposure to UV light or contaminants. In warm climates the chemical may need to be stored in an air- conditioned building. Normally stored at a diluted concentration which requires larger storage facility or more frequent deliveries. Periodic monitoring of strength is required to ensure adequate dose for disinfection. • Pumping and feed systems can clog because of crystallization and improper venting. • Dose and dechlorination control present challenges for satellite combined sewer overflow (CSO) disinfection.

Community Safety and Security	• Fewer regulations exist than for chlorine gas. Risk Management Plan and Emergency Response Plan are not required. • Risk of large-scale accident is lower. • Highly corrosive – proper personal protective equipment (PPE) must be used and safety precautions must be taken when handling. • Requires more delivery trucks than chlorine gas. These delivery trucks create additional risk of traffic accidents and emit additional greenhouse gases.
Impact on Receiving Water	• Produces the same disinfection by-products as chlorine gas, as well as additional by-products such as bromate and chlorate. • Dechlorination requirements are the same as for chlorine gas.
Onsite Generation of Sodium Hypochlorite	
Description	On-site generation systems operate by feeding softened water into a brine dissolver. The salt dissolves to form a brine solution, which is further diluted to the desired salt solution. The salt solution is then passed through the electrolytic cell(s), which apply a low voltage DC current to the brine to produce sodium hypochlorite. Generated sodium hypochlorite is stored in a day tank and applied to the wastewater.
Applicability	• Not commonly used due to high cost.
Cost Implications	• No bulk chemical storage is required. • Capital and operations and maintenance requirements are higher because of system complexity. • Electric power consumption is higher than for other chlorination methods.
Process Reliability	• Systems have several mechanical subsystems components that are relatively complex to operate and maintain. In many cases, this requires that vendor service contracts be utilized to keep systems functional. • Backup power supply or disinfection system may be needed.
Community Safety and Security	• No safety issues exist related to transporting toxic/hazardous or corrosive chemicals. • Potentially explosive hydrogen gas must be vented to the outdoors.
Impact on Receiving Water	• Same as purchased sodium hypochlorite.

Ozone	
Description	Ozone is generated on site by exposing extremely dry air or pure oxygen to a controlled, uniform, high-voltage discharge at a high or low frequency. Ozone is applied to the wastewater by diffused bubbles.
Applicability	• Generally used at medium to large size plants after at least secondary treatment. • Provides more effective disinfection than chlorine or ultraviolet irradiation. • Also used for odor control.
Cost Implications	• Capital cost may be higher than other disinfection options. • Power cost can also be high.
Process Reliability	• Proven technology. More effective than chlorine in destroying virus and bacteria. • In some cases, it may be necessary to install a tertiary treatment system to further remove suspended solids and oxygen demand compounds for ozone to be effective and reliable. • More complex to operate and requires complicated equipment and efficient contacting system.
Community Safety and Security	• Generated on site. No safety issues exist related to transporting toxic/hazardous or corrosive chemicals. • Highly reactive and corrosive. Off-gas containing ozone is a safety hazard and must be destroyed before release to the atmosphere. • Storing hazardous compressed oxygen onsite may be required.
Impact on Receiving Water	• No harmful residuals to be removed. • Elevates the dissolved oxygen concentration in the effluent, which may eliminate post-aeration processes. • Reacts with bromide, if present, in the wastewater to form the disinfection by-product bromate.

Ultraviolet (UV) Irradiation	
Description	Wastewater passes through the UV reactors and microorganisms are deactivated by the UV irradiation emitted from UV lamps enclosed in quartz sleeves. It is a physical disinfection technology and no chemical is required. UV systems are equipped with low or medium pressure lamps.
Applicability	Generally for secondary or tertiary treatment effluent. Cannot be used for ancillary wastewater treatment plant uses such as filament or odor control. A different form of chlorine is required for these ancillary purposes.
Cost Implications	• Capital cost for UV disinfection is generally higher than for chlorine. • UV equipment must fit into a plant's hydraulic profile. If it does not, a costly pump station needs to be installed. • High electrical power use for UV disinfection may require costly modifications to plant power service.
Process Reliability	• Effective at inactivating most viruses, spores, and cysts. • Provides easier control for wastewater with variable flow rates and water qualities (e.g., for CSOs). • Higher suspended solids or UV absorbing compounds in the effluent may require a higher UV dose. Low-quality wastewater may require additional or higher degree treatment to remove solids prior to UV. • System design requirements vary widely between vendors. Pilot scale validation testing is generally required for each specific UV system. • A preventive maintenance program is necessary to keep UV lamp sleeves clean to ensure effectiveness of disinfection and to save operating power cost. • An uninterruptible power supply system or backup disinfection system may be required.
Community Safety and Security	• UV is user-friendly for operators. Eye protection must be worn when near operating UV bulbs. • No safety issues exist related to generating, handling, transporting, or storing toxic/hazardous or corrosive chemicals. • UV lamps contain mercury, so provisions for lamp recycling and emergency response are necessary.
Impact on Receiving Water	• No harmful residuals need to be removed, and no disinfection by-products are formed.

Attachment B

Wastewater Disinfection 20-Year Present Worth
(Assumes average chlorine dose is one third of peak capacity)