



Solutions for Critical Infrastructure Protection

XYLEM'S CONTRIBUTION TO URBAN RESILIENCE

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xylem
Let's Solve Water



Letter from Xylem's President and CEO

Urban infrastructure relies on a number of distinct networks to supply city dwellers with food, water, energy, transportation, and other services. These infrastructure networks are vital to the life of modern cities, and when they are damaged, human health and welfare, and the economy are put in jeopardy. Unfortunately, many cities are confronting a “new normal” of increased natural hazards and weather volatility that threaten to impair and even overwhelm the critical infrastructure on which human lives depend.

This paper is the third in our series exploring Xylem's contributions to urban resilience. The first two papers outlined our work addressing flooding and water scarcity. This paper explores urban resilience from another perspective: critical infrastructure protection. Increasing the resilience of critical infrastructure is a multi-dimensional problem, but at its root involves protecting a city's most vital infrastructure networks from harm and cultivating the capacity to bounce back quickly when they are impaired. Effective water management plays an important role in urban resilience, as floods and contaminated water can significantly impair the performance of essential networks, such as those that support transportation, energy and wastewater services.

While technology alone cannot solve the challenge of urban resilience, we at Xylem believe that innovative solutions have a vital role to play. We are proud of the work we do to increase the resilience of critical infrastructure and are committed to developing new solutions that can help to protect lives and livelihoods.



Patrick Decker
President and Chief Executive Officer
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Introduction

Recent years have spawned a large number of unpredictable and sometimes devastating natural disasters around the world. Typhoons in the Philippines and China, wildfires in Australia and Portugal, earthquakes in Pakistan, China and Chile, floods in Canada, Central Europe, India, and Mexico and droughts in Brazil, China, and the U.S. contributed to losses of \$45 billion in 2013, all on the heels of \$72 billion in losses in 2012.

Around the world, cities face new and unprecedented pressures. Populations are booming, urban density is increasing, infrastructure is either underdeveloped or in need of upgrade, and a new set of disasters – both natural and man-made – is putting these vital centers at greater risk. As the effects of natural disasters grow, urban resilience must become a priority list for cities that want to be viable over the long term.

Investments in the resilience of critical infrastructure can help cities reduce losses, ensure operational continuity, and save lives. In the United States, the U.S. Department of Homeland Security (DHS) defines critical infrastructure as “assets, systems, and networks, whether physical or virtual, so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof.” Other countries have articulated similar concepts. We focus on three infrastructure sectors that have immediate implications for the health and safety of urban areas during natural disasters: transportation, water and wastewater, and energy networks.

Cultivating resilience requires investments in both preparation and response. Preparation involves hardening infrastructure to increase resistance to the most common challenges facing a region – such as floods, storm surges, high winds, wildfires, earthquakes, or hurricanes. It also involves building in redundancies and backup systems to contain the impact of any failures. Recovery is equally vital; given the critical importance of basic infrastructure services, every hour gained in restoring services can prevent millions of dollars or more in losses. Investments include technologies, systems and services that accelerate infrastructure repair or restoration to minimize downtime before services resume. Finally, resilience requires translating the lessons of recovery into a new round of preparation by identifying and addressing potential failure modes to prevent future impacts.

Effective water management stands at the heart of urban resilience, as floods and contaminated water can impair the performance of essential networks, such as those that support transportation, energy and wastewater services. In the following sections of this document, you will read about how Xylem works with partners to build “water resilience” in urban transportation, water, and power infrastructure.

Xylem's Contributions to Resilient Transportation Infrastructure

If people are the lifeblood of a city, airports, roads, railways, subways, and seaports are its circulatory system. Disruptions to the urban transport network can be catastrophic. Emergency services are halted, as law enforcement, fire fighters, and ambulances are unable to respond to calls for help. Every minute of delays from closed roads, stalled trains, and grounded flights adds to the cost in person-hours of lost productivity. Failed deliveries, delayed services, and deferred plans lead to mounting economic costs. The human cost of time stolen from families stuck with stranded flights, longer commutes, or even worse, lost lives, is far greater.

Of all the hazards that threaten transportation systems, water risks, in the form of debilitating storm surges or flooding, are perhaps the most pervasive and persistent. The cases below highlight Xylem's contribution to major urban transportation resilience. From airports to subways to roads and tunnels to railroads, Xylem has experience around the world in developing water technologies that support operational continuity of infrastructure services.

Airports

In air travel, there is no room for error. Getting millions of passengers ticketed, seated, into the air, and back down safely requires strict adherence to industry procedures and systems. This consistency requires every piece of supporting infrastructure and technology to work reliably and through any challenge. That is why so many airports around the world have turned to Xylem technologies to support their runway and ground infrastructure to make sure take-offs, landings, and taxiing occur without interruption or downtime. The following section illustrates how Xylem's water management technologies support operations at three of the world's most important air travel hubs.

Submersible Pumps Help LaGuardia Airport Recover from 2012 Superstorm Sandy

Hurricane Sandy paralyzed LaGuardia Airport in New York as it rolled through the Northeast in October 2012. After the airport's five storm water pump stations lost power, an estimated 100 million gallons of water pooled around the airport. The water was up to four feet deep at some points, including along the shuttle ramps at this vital New York City travel hub. Operations came to a halt, planes piled up, passengers were stranded, and cancellations rippled across nationwide flight plans.

In the aftermath of the storm, the Port Authority of New York & New Jersey accelerated the planned replacement of the hydraulic and electrical muscle of Pump Stations 4 and 6, which drain LaGuardia's two runways. The airport's engineers chose to do so by installing Xylem's market-leading submersible Flygt pumps.

The Port Authority decided to replace these pump stations' extended shaft propeller pumps with submersible pumps. The old pumps could move water so long as the water stayed below the pumps' critical components. But in the flood conditions created by Superstorm Sandy, the pumps ground to a halt, putting operations at risk. As a result, the Port Authority made the transition to a tougher, more resilient technology: heavy-duty submersible pumps. Submersible pumps have motors that can be placed underwater, unlike traditional dry-mounted pumps that are easily damaged and put out of service when water levels rise.

To replace the existing pumping units, G. A. Fleet Associates, a full-service Xylem Flygt representative located in suburban

New York City, supplied Flygt electric submersible propeller pumps, each with a capacity of 33,000 gallons per minute. These pumps also feature explosion-proof motors approved for use in hazardous locations - critical in this application due to the possibility of petroleum products, like jet fuel, entering the wet wells.

With Flygt submersible pumps and updated controls in place, LaGuardia is ready for the next challenge that might reach New York Harbor. In 2013, LaGuardia Airport served as the launch or landing point for more than 370,000 domestic and international passengers traveling to or from New York. These travelers were kept dry and safe as a result of cooperation between the Port Authority, Xylem and G.A. Fleet, who came together with a shared purpose: to make New York City more resilient.



Xylem keeps Dubai International Airport Safe and Dry

If just two millimeters of rain fall on a single airport runway measuring one mile long and thirty yards wide, the result is around 24,000 gallons of water that can cause major headaches for airport operators. Despite the generally low rainfall in the United Arab Emirates, Dubai Airport, one of the fastest-growing airports in the world, can experience enough rain and stormwater run-off to cause safety and operational concerns.

The Dubai Department of Civil Aviation turned to Xylem technologies to provide a solution to water challenges in connection with a major expansion to the airport. Design consultants Dar Al Handasah Shair & Partners prepared a storm water master plan to address the challenge of disposing of the extra water that would accumulate on site as a result of the proposed extensions to the airport. To meet regulations, a new pumping station would be needed to collect storm water and pump it to a dedicated creek for collection and storage. Flygt pumps, supplied by local agent Inma-Gulf Development & Construction, had been used at the airport for a number of years and were selected for the upgrade of existing pump stations.

Mustafa Bawab, General Manager of Inma-Gulf Development & Construction explained the choice, "Flygt pumps were chosen for their consistent design and performance based on the experience of other projects and installations at the airport," said Bawab. "Flygt pumps have been an important part of the airport's growth since the earliest stages."

In early 2014, five large submersible centrifugal pumps with 400 kilowatt motors, rated to deliver approximately 1600 gallons per second at a twenty one meter head, were supplied by Xylem Flygt agent Inma-Dubai to the main contractor, Al Naboodah Engineering Services. According to Bawab, the pumps supplied for this upgrade have been a great success, and "have been able to demonstrate more efficiency in their performance than those offered by our competitors." Given Dubai's global prominence as a transport hub, even small improvements in operational reliability create global benefits.

Xylem's Flygt Exporior at London's Heathrow Airport

Ian Jolly of Heathrow Airport's Water Services Department knows how important it is to minimize downtime and maintain efficiency at one of the world's busiest airports.

"With almost 70 million people travelling through our terminals during 2012, it is critical to ensure that systems are run in the most efficient way possible," said Jolly. "Heathrow Airport is committed to working with innovative, reliable technology to cater for this consistently high footfall of passengers."

Heathrow Airport Water Services Department recently commissioned Xylem to evaluate the airport's wastewater pumping system in the cargo center area of the airport, which handles non-stop traffic every day. Tony Price, Market Development Manager for Xylem in the U.K., commented, "Heathrow Airport is globally renowned as a gateway for millions of people each year. To cater to the system demands associated with dealing with such a high volume of traffic, its pump facilities are constantly under pressure to deliver day in, day out." Following an evaluation, the Xylem team was charged with developing and implementing a reliable and energy-saving wastewater pumping solution to prevent costly and potentially disastrous sewage back-ups or failures.

Xylem installed two Flygt Exporior pumping systems featuring Adaptive N-Pump non-clog technology and two SmartRun intelligent pump controllers in the sewage wet well of the cargo area. Three complementary functions - hydraulics, motors and controls - distinguish the fully integrated Exporior system from traditional pump systems. Xylem's Flygt Adaptive N-Pump, recognized as "Most Innovative Product of 2011" by the Water Environment Federation, improves upon the proven clog-free

impeller of the original Flygt N-pump by allowing the impeller to move axially upward long enough for bulky materials or other debris to pass through even more smoothly. This innovation significantly reduces stress on the shaft, seals, and bearings during these intrusions. Finally, the two SmartRun intelligent pump controllers monitor the specific energy use of the pumps and continually adjust the pump speed to ensure that the minimum amount of energy is being used for all pump cycles without the need for a site visit and recalibration of the system.

"Our aim was to provide Heathrow with a superior pumping system that would not only help reduce energy bills through eliminating any unnecessary energy consumption, but also by providing a highly reliable solution which would decrease maintenance calls required to ensure the smooth running of the pump system," said Price. "We were able to quickly identify the key solutions and complete installation within the cargo center loading area in just under a day."

According to a comparison study conducted by Heathrow Airport's Water Services Department, Xylem's Flygt Exporior wastewater pumping system, including Flygt's Adaptive N-Pump technology and SmartRun intelligent pump controllers has eliminated the need for maintenance call-outs to the pump station since being installed in January 2013. Moreover, Xylem's installation has reduced energy consumption at Heathrow Airport's cargo center pump station by fifty percent.

The benefits of reliable, efficient, and labor-saving solutions extend far beyond the energy expenses saved. With smart monitoring, energy efficiency, and fewer call-outs, Heathrow's cargo center is more durable, flexible, and resilient than ever before.

Roads & Tunnels

Coastline Protection Along the New Jersey Shore

Route 35 isn't just a road winding down the New Jersey shore. Along one stretch, it's the transportation lifeline for island towns like Bay Head and Mantoloking, towns that sit on a sliver of land between the ocean and bay.

Superstorm Sandy tore through these towns and ripped up Route 35. The New Jersey Department of Transportation made immediate stopgap repairs to reopen the road, and is using Xylem's technology so that the rebuilt roadway will be able to stand up to the most intense storms. Xylem pumps and controllers are a key element in creating a safer and stronger highway. "When it's complete, this road will be ready to withstand even the worst of the worst-case scenarios," says Chuck Narod, a Xylem sales representative in the U.S.

The road redesign includes improvements to the pavement, utilities and landscaping, but a new drainage system featuring Xylem's products is the key to storm-proofing this vulnerable stretch of Route 35. As part of the \$265 million reconstruction project, Xylem will supply nearly 50 powerful Flygt Slimline submersible propeller pumps and another 27 smaller submersible pumps in nine pump stations along the 12-mile section of the road that was hardest hit during Superstorm Sandy. The Xylem pumps - located in concrete-encased pump stations underneath the road - are capable of working underwater, and each Slimline propeller pump can move 9,000 gallons of water a minute. If a storm overwhelms the regular drainage sewers, Xylem's pumps will kick in and push the excess water back into the bay.

"There's not a lot of room for these pump stations under the road, so the unique small-footprint design of our Flygt Slimline pumps was a big plus for the contractors working on this project," says Mark Umile, Manager of the Xylem sales branch located in Malvern, Pennsylvania, about 100 miles from the

New Jersey coast. "It allowed them to design smaller concrete vaults for the pump stations" - thereby reducing capital costs even further.

Each pump station is connected to a control panel - located 12 feet above the ground level to protect it from storm surges. The role of the control panel is to coordinate the operation of the multiple pumps inside each station. Again, Xylem had the right product for this part of the job: Xylem's MultiSmart controller. The MultiSmart is a pre-programmed controller that can run multiple pumps without complication.

"You don't need to hire someone to control the pumps or create a custom control system for each pump station," says Narod. "For this job, one MultiSmart controller can be programmed quite easily to run the multiple Xylem pumps down in the pump station to ensure we're getting out as much water as possible, as fast and efficiently as possible."

For Narod and Umile, both long-time industry veterans, this project has a little more meaning than most. It's not just that they are helping New Jersey recover from Superstorm Sandy, it's that they are helping the state in ways that will be fully realized for years to come.

"Our company doesn't just sell products and walk away from the job," says Umile. "We're an industry leader with a large service department that's going to be here when we're needed. So while we're solving a problem for the state today, New Jersey is also going to find out years from now that we are still here to help them out. They might not know it today, but they'll find out tomorrow when another huge storm hits and they need somebody they can depend on to help them get through it. That's where we come in. And that feels good."



Route 35 after Superstorm Sandy made landfall.



Destruction from Superstorm Sandy in Mantoloking, NJ.

Keeping Beijing from Going Underwater

In July 2012, for days on end, heavy rains soaked the city of Beijing, China. The tipping point came on July 21 when the skies opened and up to 18 inches of rain fell on some parts of the city in a 24-hour span.

Rivers overflowed and the city's storm drainage system was quickly and totally overwhelmed. The resulting floods caused billions of dollars of damage, displaced thousands of homeowners and killed nearly 80 people. After the flash floods, residents looked to city leaders for a fast and intelligent solution.

"We can host the most luxurious Olympics and send satellites into space, but we can't seem to fix this drainage system," wrote one frustrated Beijing-based micro-blogger in the days after the flooding.

City officials were listening. Less than one year after the flooding disaster, Beijing has improved the drainage capabilities of its storm water system, and Xylem's Flygt-brand submersible pumps are major part of the current and ongoing upgrade.

The first part of the solution focused on pump stations near Beijing's fly-overs – the bridge-like sections of road built at major intersections to reduce traffic jams. The roads that pass under these fly-overs are usually below grade and become dangerous, potentially deadly spots during major floods; hazardous road conditions and closures impose further costs on this city of nearly 12 million people.

As of June 2013, the long-used "dry" pumps in 20 of these stations were replaced by Xylem's Flygt brand submersible pumps, enhancing resilience of these key transport junctions. Unlike the old dry pumps, these submersible pumps can operate underwater, so if the pump stations fill with floodwater – as they did on July 21, 2012 – the pumps will continue their normal operation. The new Flygt pumps from Xylem are also more powerful than their predecessors, providing twice the dewatering capacity of the dry pumps so they can move more water per minute away from the city streets and to safe water storage facilities. In the next two years, another 65 pumping stations throughout Beijing, near fly-overs and other flood-prone areas, will be improved or built.

Xylem's pump technologies don't just provide greater flood protection. They are designed for easy installation and take up less space than similar dewatering pumps. That means less engineering and construction costs for the pump station contractor, the state-owned Beijing Drainage Group. The money saved can be used for the many other drainage system renovation projects that are now underway to ensure that heavy rainfalls will never again take such a heavy toll on Beijing and its residents.

Railways

Xylem Delivers the Water Technology for Singapore's Mass Rapid Transit Project

Singapore is one of the most densely populated countries in the world – and one of the least congested. That may sound counterintuitive, but it's actually a case of intelligent and resilient infrastructure design.

Each day, millions of people move effortlessly around this small city-state with few traffic jams or train delays, thanks to smart roadway and rapid transit systems brought to life by forward-thinking city leaders, highly skilled urban planners and engineers, and support from Xylem technologies. Over the past three decades, the Singapore Land Transport Authority has used more than 1,000 Xylem products in its projects. Our submersible pumps, booster pumps and ultraviolet treatment systems are part of the transit lines, train stations, tunnels and expressways that make up one of the most advanced city transportation systems on the planet.

Singapore continues to search for ways to make its transportation systems more sustainable and resilient and is turning again to Xylem for its latest ambitious project. Xylem was selected to supply water-handling equipment and services for Singapore's new Downtown Line (DTL) Mass Rapid Transit project.

"Singapore has one of the best integrated transportation systems in the world, and we're very proud to be part of this latest infrastructure project," said Allan Hendry, Vice President and Regional Director for Xylem Greater Asia.

When completed in 2017, the DTL will connect the northwestern and eastern ranges of Singapore to the central business district and Marina Bay. Stretching 26 miles (42 kilometers) with 34 stations, it will be the longest underground driverless transit line in Singapore and provide faster traveling times and easier connections for more than half a million passengers each day.

According to the Land Transport Authority, construction of the DTL is one of its most challenging projects. The line traverses varied ground conditions and requires excavation near many downtown buildings and roads. In addition, it crosses under the Singapore River, and part of the construction includes diverting the river to make way for the new Fort Canning Station.

Our Flygt submersible drainage pumps, Lowara e-SV booster pump sets and WEDECO Spektron ultraviolet disinfection units will be utilized to help make the new train line operational, and our level regulators and control panels will coordinate operation of all the pumps.

The operational reliability of these products contribute to the performance of Singapore's world-renowned mass

transportation system. One year ago, PricewaterhouseCoopers rated the world's largest and most influential cities in a number of categories, and Singapore earned the top ranking in transportation, based on the efficiency, reliability and safety of its public transport system. When the new DTL line is up and running - with Xylem providing its water transport and treatment services - this city-state will continue to set the pace in terms of forward-thinking mass transit systems.

France-England Tunnel

From the Norman invasion of Hastings in 1066 to the time of Napoleon to the comedy sketches of Monty Python, England-France relations have not always been as strong as they are today. But in 1994, France and England worked together to complete the world-famous Channel Tunnel, also known as the Chunnel. They turned to Xylem's Flygt pumps to address critical drainage and water transport challenges raised by the engineering challenge of building and maintaining the 31-mile, underwater rail line beneath the Strait of Dover. To this day, Flygt pumps maintain this vital commercial and social pathway, keeping it safe, dry, and operational.



Xylem's Contribution to Water and Wastewater Infrastructure Resilience

When a disaster hits a city, two of the first questions that go through the minds of city managers or municipal leaders are: will we continue to have running water and are we going to have a health crisis on our hands? The dual challenge of delivering clean water to citizens and removing wastewater safely becomes one of a city's top priorities after disasters strike.

From emergency sewer bypass systems that allow wastewater infrastructure to continue to operate in crises, to pump station backup systems, to the emergency water technologies that get clean water where it needs to be, Xylem provides innovative technologies and services to help cities protect their critical water infrastructure.

Emergency Sewer Bypass

No matter what the day's agenda holds for a municipal leader, if a major city sewage line breaks, all plans are off. Whether due to earthquakes, flash floods, unsupervised digging, or just plain infrastructure collapse, when untreated sewage breaks free from the protective confines of a sewer system, the health and safety of surrounding communities are immediately put at risk. From Godwin emergency bypass services to Flygt submersible pumps, when stakes are high and rapid response is critical, Xylem's emergency sewage bypass technology and support can protect public health and support rapid recovery.

Xylem Responds to Wastewater Treatment Plant Emergency in NYC

A catastrophic fire at New York City's North River wastewater treatment plant in July 2011 caused the shutdown of the plant, and the environmental consequences were severe. On the banks of the Hudson River, the North River plant in Manhattan is one of the city's fourteen sewage treatment plants, treating about 125 million gallons of wastewater every day. With the shutdown, all of this raw sewage was diverted directly into the Hudson and Harlem Rivers, creating an immediate and highly visible emergency.

As firefighters fought to bring the four-alarm blaze under control, officials from the New York City Department of Environmental Protection (NYC DEP) moved quickly. One of the first calls the NYC DEP made was to Pumping Services, Inc., a New Jersey-based representative for water and wastewater equipment and a distributor for Xylem's Flygt branded submersible pump products. John Corkery, Pumping Services' municipal sales manager, remembered receiving the call.

"After understanding the situation, I immediately contacted the Xylem team and determined that we had numerous large Flygt submersible pumps available to help fix the situation - but they were hours away in Ohio and Georgia," he said.

With the plant's main pumps out of service, Corkery recommended an emergency "pump-around" to transport raw sewage to the plant's primary treatment equipment, a necessary but complex undertaking. "We were being asked to lift wastewater 65 feet, so it immediately became a submersible pump application," said Corkery. That's when he called his colleagues who handle Xylem's Godwin Pumps. While the Flygt submersible pumps were being sourced, Xylem's Godwin Pumps team moved into action. Godwin Pumps are portable dewatering pumps and are well known in the global market for drainage pump rentals and for being available for emergency response and disaster recovery.

Xylem began to organize equipment and logistics required for immediate shipment. Sales engineer Ryan Booth recalled, "We began to mobilize the high density polyethylene pipe (HDPE) required for the pump-around." The company maintains a large inventory of HDPE for rental along with fittings, adapters and self-contained fusion machines for on-site pipe fusion and installation. Approximately 9,000 feet of HDPE were needed in addition to the fusion machines and operators required to get the plant up and running again. "The critical issue was getting the pipe here immediately," said Booth. "The pumps are no good without the pipe."

Once the NYC DEP authorized the emergency equipment on Thursday night, Xylem trucks hit the road from as far west as Ohio and as far south as South Carolina and began arriving on site on Friday morning, about 10 hours after the notice to proceed with Flygt and Godwin Pumps. Xylem's Scott Myers took the wheel of one truck, driving through the night from Ohio to bring the pumps to New York. By Friday morning, in record-breaking heat, Booth had organized the necessary personnel

for building the pump-around, and set up a 24-hour operations center to channel information to the DEP and other contractors working at the plant.

In addition to the HDPE piping and valve equipment, there were submersible Flygt sewage pumps and simplex controls and miles of electric cable in service on-site, each lowered into individual 8-foot wide by 70-foot deep trash-rack channels. Pumping Services and Flygt also provided several large submersible dewatering pumps that were used to remove several feet of residual firefighting water from the pump room. Pumping Services provided start-up services and training to NYC DEP personnel on the operation of this pump-around system.

By 9:30 p.m. on July 23, the NYC DEP reported that it had succeeded in ending the flow of sewage into the river. The Flygt pumps were operating smoothly and reliably, and each was performing at a rate of 10 million gallons per day. This was good news for the boaters, bathers and business owners who use New York City's waterways for recreational activities and who in recent years have come to expect a clean environment in the city's waterways.

"Our ability to react and have what they need when they need it is a real value added to our customers. We are known for that," said Corkery. "We were able to get pumps for this emergency because of the equipment they have available and the people who understand how emergencies come about and how they are dealt with."

Summing up the response to the emergency, Steve Askew, DEP Plant Superintendent for the North River facility said, "It is really an impressive installation. The timetable that it took to get it here and get it up and running, from the thought process to operation, was literally just a few days. It really was quite a monumental effort."



Emergency Bypass in Southern California

Situated in the Mojave Desert, 100 miles east of Los Angeles, there is a cluster of small cities - Victorville, Apple Valley and Hesperia - that do not take their water supplies for granted. In a region that gets just thirteen inches of rainfall a year, residents and city officials have become de facto water experts, moving quickly and intelligently to preserve every single drop of water that lands in or runs through city limits.

One of their cooperative efforts was the formation of the Victor Valley Wastewater Reclamation Authority (VWRA), created in 1981 to treat the cities' wastewater and recycle a portion of it for irrigation. For the past 13 years, Xylem has been providing pumps and technical support to help VWRA create safe and sustainable wastewater solutions.

One of the latest projects is the construction of two new water-recycling facilities. As part of this project, VWRA is building a new pipeline that will deliver wastewater to these plants while bypassing the Mojave River. Building a sewer pipeline beneath the river was the simplest and easiest solution, but before the project could be completed, a violent storm changed everything.

In 2011, flash floods undermined a 36-inch sewer line that crossed the riverbed and millions of gallons of wastewater began pouring into the Mojave. It was a desperate situation, but instead of delivering the pumps needed for a new emergency bypass pipeline, the incumbent supplier delivered a complicated contract that would take several critical days to review and approve.

Enter Xylem. With the spill growing more serious, VWRA placed a call to the local Xylem office Nate Warren, Xylem's branch manager in Mira Loma, CA "We were onsite the same day with personnel and equipment," remembers Warren. Xylem provided two 18-inch Godwin Dri-Prime® diesel pumps, each capable of moving 10 million gallons of wastewater per day through one of VWRA's bypass pipelines and two eight-inch Dri-Prime pumps that can each feed up to 3.5 million gallons of wastewater per day through a second pipeline. With these pumps in place, the wastewater spill was stopped in a matter of hours.

These emergency bypass pumps have been running continuously ever since and Xylem personnel have been onsite to provide support services. Every ten days, Xylem field technicians visited the site to service the four pumps, making oil changes and troubleshooting potential problems.

When the Victor Valley Water Reclamation Authority embarks on the construction of a more permanent bypass pipeline that runs around the Mojave River, Xylem wastewater transfer pumps will be part of the project. "Our pumps are designed as critical path equipment, capable of working reliably and coming through for customers - like VWRA - in situations where there is little or no room for error," said Warren. For cities large and small, investing in resilience is crucial to protecting citizens and the surrounding environment.

Urban Sewer Pump Station Backup

When violent storms knock out a city's power, more than the lights go out; water and wastewater infrastructure can also be shut down. While emergency solutions like those described above can solve a short-term break in system performance, the long-term solution is to develop redundancies, fail-safes, and backups that kick in automatically when power fails and pump stations seize up.

When pump stations fail, sewage builds up and overflows, leading to dangerous sanitary sewer overflows (SSO), an unfortunately common occurrence in many major cities around the world, especially when power outages combine with heavy rainfall. Once considered an inevitable consequence of power failures, SSOs are coming under greater scrutiny and regulation by health and environmental agencies. Xylem's Godwin pumps have been at work providing a seamless backup system that can help prevent SSOs from happening in the first place. A permanent, automated, off-grid system is just what a city needs to become more resilient.

Pump Station Backup Systems in Coastal Florida

As regulatory authorities strengthen enforcement for sanitary sewer overflows (SSOs), more municipalities have been forced to assess the reliability of lift station backup plans. In an effort to avoid SSOs and also facilitate preventive maintenance an increasing number of urban utilities are replacing traditional backup generators with independently powered backup pump stations.

For decades, traditional lift station designs included backup diesel generators to power submersible electric sewage

pumps. Typically, when a power outage occurs, the main control transfers power to the diesel generator, which then directs power via a transfer switch to a breaker panel controlling the pumps. Absent failures in the generator, transfer switch, pump controls, or the electric submersible pumps themselves, lift station operations will continue uninterrupted. If, however, any of these components fail for an extended period, gravity takes hold, guiding sewer to the lowest points in the system, resulting in an SSO.

Precisely this phenomenon took its toll on the coastal city Boynton Beach, Florida, in October 2005 when Hurricane Wilma left the entire region without power.

“During Wilma, we lost power at all of our stations,” said Boynton Beach Deputy Director of Utilities Pete Mazzella. “We didn’t have the manpower to monitor all of those stations when that happened, so we were looking for something that didn’t rely on utility power.”

Pasco County Utilities Services Branch (PCUSB) experienced a population explosion and system demand requirement that was disproportionate to its staffing and ability to perform preventive maintenance on its lift stations. The result was an agreement between PCUSB and the Florida Department of Environmental Protection. Taking advantage of an in-kind benefit program, PCUSB implemented standby pumping to both mitigate the possibility of future SSOs and to provide a reasonable amount of time for primary lift station maintenance and repair.

Mazzella is one of many utility directors who have made the switch to backup pumping. “The municipalities we serve are aware of the increased sophistication of temporary bypass pumps. Because of our experience with both temporary and permanent pump applications, we are working to educate our customers that the same pumps that pull their weight during bypass applications can serve an equal and effective purpose for permanent backup pumping,” said Godwin’s Vice President for Dewatering Sales, Mike Delzingaro.

Godwin’s self-priming backup pump is a stand-alone unit that operates on diesel or natural gas power. Using automatic start and stop controls via a pressure transducer or float switches located in the wet well, the pump is activated when the sewage level in the wet well rises to a predetermined height. The self-priming pump creates a vacuum that allows the sewage to rise, which then primes the pump. The backup pump continues to operate and pump the required flow, then shuts off when

either the wet well is lowered or the electricity is restored and the primary system restores control. The net effect is that the emergency backup pumping system and the lift station pump system are capable of operating independently.

Xylem’s Godwin Pumps provided 41 of its Dri-Prime Backup System (DBS) pumping stations, including pumps in critically silenced DBS enclosures. With pumping capacities from 350 to 1,700 gallons per minute (GPM), these DBS pumps handle solids from 1 5/8 inches to 3 inches in diameter and are automatic priming to 28 feet using the Dri-Prime automatic priming system with no moving parts and simple maintenance. Using the Godwin PrimeGuard Controller, PCUSB customers can rely on these DBS backup pumping stations to start and stop the pumps automatically without operator intervention. Once started, the PrimeGuard Controllers work to auto-throttle the engine in an effort to meet the flow requirements without overburdening the pump or engine, thereby increasing the longevity of the pump and efficiency of the engine.

The immediate benefit of continuous pumping is that SSOs can be avoided, but there are other benefits. Routine maintenance is now possible during downtime. Extra pumping capacity is available during periods of excessive flow, providing for peak shaving (that is, switching from electric power to diesel power to avoid peak power costs), and continuing operations during mandatory rolling brownouts.

“When we responded to this request, we knew we had the range of pumps and that we could meet the delivery schedule,” said Delzingaro. “More importantly, we knew that the county was making the best decision to protect its environmentally sensitive areas. It just makes sense to back up your pumps with another pump. They have gone to great lengths to choose the most efficient pumps and prioritize the most sensitive areas, and we think that this level of preparation will result in a better defense against unforeseen events.”

Emergency Water Treatment

Sometimes the greatest water infrastructure challenge that a city faces is less visible than a catastrophic storm or flood. The threat of unsafe drinking water is an emergency that requires an immediate and complete solution. Whether it is chemical contamination, disease outbreak, or sewage overflow, the cleanliness of a city’s water can come under threat quickly and unexpectedly.

Xylem Treatment Technology Fights Legionnaire’s Disease

In late summer 2013, hospitals in the German city of Warstein began seeing a surge of patients with Legionnaire’s disease, a potentially fatal form of pneumonia contracted by breathing in small droplets of water contaminated with the legionella bacterium. By early September, more than 150 people were

infected and two people had died from the disease. In an attempt to stop the frightening and fast-escalating outbreak, city officials and environmental regulators immediately turned their attention to Warstein’s wastewater system.

The legionella bacteria thrive in stagnant water and the first target was an industrial cooling tower that showed traces of the bacteria. The tower was shut down, but the people continued to get sick. Attention then turned to a local wastewater treatment plant. Sure enough, the wastewater plant was emitting water with high levels of legionella into the same river that serves as a source of water for the industrial cooling tower.

Knowing the reputation of the Xylem Herford team in developing solutions for reducing pharmaceuticals and other micro-pollutants in wastewater treatment plant emissions, the Warstein wastewater treatment plant leadership immediately reached out for help in treating the legionella outbreak. Located just eighty miles from Warstein, the Xylem site manufactures WEDECO ultraviolet (UV) disinfection systems for households, industries and drinking water and wastewater treatment plants.

"They were simple and urgent requests: help us find a treatment solution very fast," says Achim Ried, Chief Engineer of Higher Order Solutions for Xylem's Water and Wastewater Solutions business. "We had just a little information about the water matrix and the level of legionella in the water, so we did a quick estimation and looked for a system that would be available right away."

The Xylem team immediately looked to UV treatment technologies to solve the problem. UV disinfection works by directing light that deactivates viruses and bacteria - including legionella - by physically damaging their DNA. Within the hour, a team of experienced service technicians armed with a

WEDECO LBX 1000 UV system assembled, was ready to take on the challenge. By this time, the Warstein outbreak had become world news, and the pressure was on to find a fast fix. "Usually, it would take weeks to find the right system for the situation and then get it ordered, delivered and installed," says Sven Baldig, managing director of Xylem Services. "But this was a case where quick action was vital, and we responded to the acute needs of the city."

In less than one day - cooperating closely with the wastewater treatment plant operators and communicating with one another constantly - the Xylem business team and service team in Herford had the system in place, with all the water piping and all the electrical connections complete.

By late September, a matter of days following installation of the WEDECO UV system, no further cases of legionella were reported and the crisis was over. In the months that followed, the Warstein city health officials had a number of questions still remaining about the source and cause of the outbreak; but there was no question that Xylem and the WEDECO UV technology had saved the day.

When outbreaks hit the dense population of an urban area, they can move quickly. That is why it is crucial for health and environmental officials to invest in the capability to respond quickly and effectively to water contamination in order to maintain a health and safety of their city.

Xylem WET Containerized Water Treatment Systems

Xylem New Zealand received an order from the Water Authority of Fiji to provide three mobile water treatment plants that will be used in cyclone-affected areas, where the local water supply or treatment capacity is disrupted. The order was delivered to the Xylem sales offices in Australia and New Zealand. WET's containerized reverse osmosis (RO) plants were a natural choice for the customer, as they make it possible to load the mobile water treatment plant onto a truck and transport it to an affected site during an emergency. Xylem Water Equipment Technologies manufactures seawater RO systems with outputs ranging from 3,000 gallons per day (GPD) to several million GPD with modular units. Xylem has years of successful experience in seawater systems to produce drinking water for hotels, resorts and drilling platforms in the Caribbean, Latin America, the Middle East and the Far East. Our high purity water systems are capable of producing up to 30 million gallons per day.

Xylem's Contributions to Resilient Energy Infrastructure

One of the first signs that disaster has struck an urban area is when the lights go out. Whether it is a failure in the production or distribution, the end result is the same: darkness. When the power fails, the effects are felt widely; households may struggle to heat or cool their homes, businesses close early, data is lost and costly power backup systems fire up. Disasters can also impair production and distribution of other fuel sources, including refineries for petroleum products or disruptions to the energy supply, which can exacerbate disasters and hamper recovery efforts. Xylem helps strengthen the resilience of urban energy infrastructure by protecting the production and distribution of energy from water-related risks.

Power Substations

Beyond the common hazards of wind, snow, and ice that often disable power lines, the greatest threat to a city's power infrastructure is from flooding and storm surges. Many New Yorkers remember the moment during Hurricane Sandy when it seemed that lightning had struck lower Manhattan. The ensuing darkness showed that it was something else: flooding harbor waters had caused the major power substation in downtown Manhattan to short and explode. The result was days of darkness in the heart of America's financial hub.

In the aftermath of Superstorm Sandy, many buildings, communities, and households are responding to the risk

of flooding by hardening their power infrastructure, taking transformers, generators, and breakers from flood-prone basements up to higher elevations. But for some major infrastructure, like power grid substations, elevation alone is not enough. Using the same flood-resistant drainage technologies that transportation and water infrastructure companies are using to maintain operational continuity, energy companies and municipal power managers can take a system vulnerable to water damage and increase the likelihood that it will remain operational even if there is a failure in the system elsewhere.

Nuclear power plants backup systems in Florida, Texas, and Spain

Of the various forms of power generation that keep a city humming, none demands the same level of attention and care as nuclear power stations. In the wake of the Fukushima Daiichi nuclear disaster, nuclear power has come under even greater scrutiny and emergency backup systems have become all the more important. In Fukushima, tsunami flooding caused the generators powering circulator pumps to fail. These pumps are critical to circulating coolant water which is the only thing preventing the nuclear fuel rods from overheating and melting down.

Following the disaster in Japan, nuclear power plants and regions they support have reinvested in durable, survivable backup systems to ensure that similar disasters do not occur. Around the U.S. and the world, nuclear power plants are turning to Xylem to solve their emergency backup needs.

Xylem's Dewatering team has worked with utility operators to increase resilience associated with water management in nuclear facilities; high-pressure Godwin pumping packages now support nuclear power plants all around the world. The projects typically involve the installation of diesel-powered pumping units on mobile trailers. The portability of the highway trailers allows for a plug-and-play install and quick removal for any emergency water pumping situations. Each package also contains a custom manifold or regulator, allowing plant managers to tailor the system to their emergency backup pumping needs.

Xylem's applications experts worked closely with the plant managers at each site to ensure that the system was designed to meet the unique flow, head, system, and operational requirements of each power plant to plan for emergency situations. This close coordination around water-related risks is a hallmark of Xylem's customer service and a critical part of increasing the resilience of urban energy infrastructure.



Godwin pumps positioned in front of cooling towers.

Refinery Recovery in Argentina

When natural disasters strike, multiple systems are affected, such as transport, power, and telecommunications. Rapid recovery requires jump-starting several different types of critical infrastructure systems at once - especially infrastructure networks that are required to get other systems up and running. If fuel production and distribution networks are flooded, for example, many other services will have trouble resuming operations.

In Argentina, as a result of a severe electrical storm, the state-run Ensenada oil refinery caught fire and the oil refinery's pump station and surrounding pathways were completely flooded. Yacimientos Petrolíferos Fiscales (YPF), which operates the facility, leapt into action and commissioned Xylem to remove the flood water in order to get the refinery back in operation as soon as possible.

Four of Xylem's Godwin dewatering pumps removed a total of 208,000 cubic meters of water from the refinery, enabling the refinery to resume operations quickly. Following removal of

the water, YPF purchased 15 high-power Godwin dewatering pumps in order to be prepared for future flooding emergencies.

"The Ensenada plant is a significant facility with the capacity of refining 188,000 barrels of oil on a daily basis," said Gustavo Chaab, YPF refinery manager. "It is crucial that a plant of this size have the ability to restore plant operations quickly following an incident. The Godwin pumps that we purchased will ensure that we are fully prepared for such an event in the future."

With a rental bank of 20,000 products, Xylem offers the world's leading range of surface-mounted and submersible dewatering pumps, as well as services and support to clients facing emergency situations. With a rapidly expanding global footprint, our emergency dewatering services are a major component of our strategy to solve the world's most challenging water issues.

Conclusion: Towards a More Resilient World

Demographic shifts are accelerating urbanization even as natural hazards increase urban vulnerability. At Xylem, making urban areas more resilient is at the heart of how we create value, and a critical part of our mission, as reflected in our tagline - Let's Solve Water. We work closely with cities and communities by providing water management technologies that meaningfully increase resilience. Whether it is Flygt submersible pumps keeping roads, airports, railways, and subways dry during floods or storm surges, the Godwin Dri-prime Backup System keeping pump stations running even when the power fails, WEDECO UV treatment to disinfect contaminated water, or high-pressure Godwin pump packages protecting nuclear power plants, Xylem offers distinctive technologies to help prepare for and recover from water-related disasters that affect critical infrastructure. Let's work together to solve water.

Xylem |'zīləm|

- 1) The tissue in plants that brings water upward from the roots;
- 2) a leading global water technology company.

We're more than 12,700 people unified in a common purpose: creating innovative solutions to meet our world's water needs. Developing new technologies that will improve the way water is used, conserved, and re-used in the future is central to our work. We move, treat, analyze, and return water to the environment, and we help people use water efficiently, in their homes, buildings, factories and farms. In more than 150 countries, we have strong, long-standing relationships with customers who know us for our powerful combination of leading product brands and applications expertise, backed by a legacy of innovation.

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