



Hurricane Ike

Preparing for the unknown

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Houston, located on the hurricane-prone coast of the Gulf of Mexico, is the nation's fourth largest city with a population of approximately 2.1 million. The City of Houston's Public Works and Engineering (PWE) Department Wastewater Operations Branch collects and treats the area's wastewater. The staff is responsible for 11,185 km (6950 mi) of sewer pipelines, 130,000 manholes, more than 380 lift stations, and 40 water resource recovery facilities (WRRFs) that treat an average of 852,000 m³/d (225 mgd).

On Sept. 1, 2008, a tropical depression formed in the Atlantic Ocean near Africa. Twelve days later, 805-km (500-mi) wide Hurricane Ike blew into Houston. Ike was the third costliest Atlantic hurricane (Superstorm Sandy ranks second) and caused damages estimated at \$37.5 billion. The effects from this storm were felt from the Texas Gulf Coast all the way to the Florida panhandle. Hurricane Ike was responsible for 195 deaths, 112 in the U.S. and 83 in the Caribbean.

PWE, as well as the Wastewater Operations Branch, had developed standard operating procedures (SOPs) for emergency operations and hurricane preparedness well in advance of the hurricane season. The hurricane preparedness document included tiered assignments and related policies. It also outlined where each employee was to report and any alternate locations. Although all PWE employees are considered

essential to the department, some classifications are not required during emergency operations and were on standby. Staffing tiers generally are defined as the following:

- **Tier 1.** All personnel required for the continued operation of critical wastewater functions. Tier 1 employees are expected to report as directed under any and all situations.
- **Tier 2.** All personnel without immediate, specific emergency roles but who may be necessary to execute duties under certain circumstances.
- **Tier 3.** All remaining personnel not specifically designated as Tier 1 or 2.

All Tier 1 employees were instructed to arrange to stay at their designated locations for up to 3 days and prepare accordingly. Preparation included bringing cash, items for personal hygiene, medications, a few changes of clothes, any bedding required for personal comfort, and any foods for special dietary needs.

The plan also outlined steps to ensure family members and pets were taken care of and planned for well in advance of the storm so employees could work through the duration of the hurricane or until their assignments were complete. The preparedness document also mandated each operating division under PWE responded according to their divisions SOPs and operating guidelines.

◀ **The hurricane caused extensive flooding throughout the Houston area's water resource recovery facilities (WRRF), including at the 69th Street WRRF. It took 6 days for full operations to resume.**

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The Wastewater Operations Branch updated their SOPs for emergency operations in March 2008. This plan included

- familiarization with all SOPs related to emergency operations,
- that Public Works is represented at the City of Houston's Emergency Operations Center,
- that all critical employees are located strategically with all other employees on standby,
- that a review is made of the geographic information system and supervisory control and data acquisition (SCADA) systems to confirm they were functioning accordingly,
- verifying chemical tanks were filled to ensure adequate supplies over the duration,
- that preventive maintenance is performed on all portable pumps and generators, and
- strategically placing portable generators.

General preparedness

Staff assisted in emergency inspections of shelter locations to ensure compliance with life safety requirements and hardened facilities to withstand potential threats. All construction projects were suspended and prepared for emergency conditions. All city vehicles were filled with fuel to expedite the recovery efforts.

In the event of power loss, the department prioritized all facilities for generator deployment based on

- collection system storage capacity,
- potential for sanitary sewer overflows (SSOs),
- maintaining Texas Pollutant Discharge Elimination System compliance,
- population served, and
- a commercial power restoration schedule.

Each treatment facility and lift station was assigned a number for reference as well as their power requirements, which included voltage, kilowatt, and the number of phases.

The eye of the storm

On Sept. 13, Ike made landfall. The eye of the hurricane passed over Houston as a Category 2 hurricane, but its destruction was comparable to that of a Category 4. Storm surges ranged from 2.4 to 6.4 m (8 to 21 ft) with water reaching several miles inland. Houston endured unrelenting winds of up to 97 km/h (60 mi/h) and gusts up to 180 km/h (112 mi/h) that wrought havoc on the city's infrastructure.

The power supply for the city was affected as soon as Ike approached. The storm damaged individual lines, distribution lines, transmission lines, transformers, and panels.

Effects on the wastewater system

All WRRFs and lift stations lost power. Wastewater communications systems, including phones, e-mail services, and the SCADA system, all were affected by the power loss.

The number and volume of SSOs spiked due to power outages. Various streets and intersections experienced SSOs, which elevated

human health concerns from the potential contact with untreated wastewater. Also, the wastewater in the collection system turned septic due to a stagnant flow, which resulted in odor complaints.

Wastewater operations' response

The recovery effort began as soon as the storm and winds diminished. Some efforts were stalled by debris on streets and highways, extensive flooding, and inaccessible facilities. The Wastewater Operations Branch's response involved restoring communications, assessing damage, bringing temporary power supplies online, and containing and cleaning up SSOs.

Communications. During the first days following the storm, mass chaos had to be managed. Wastewater personnel had to respond to numerous requests for information from the director's office, the mayor, city council, regulatory agencies, media, and customers.

Wastewater Operations held internal meetings daily during the initial recovery period to delegate assignments and receive status updates. Facility status reports were prepared four times a day to enable an organized and current system to aid in the communications that took place with the local electric utility, the Federal Emergency Management Agency (FEMA), the director's office, and assessment teams.

Damage assessments. Despite the conditions left by Ike, damage assessment teams were dispatched to gain all information necessary to perform an initial assessment. Ten teams inspected facilities by documenting and photographing the extent of damage. These assessments detailed information regarding power, damage to buildings, general site condition, damage to fleet vehicles, and other equipment or sampler machines. The damage assessment documentation drove the scope and extent of the response.

Temporary power supply and generator deployment. A total of 93 generators provided temporary power to facilities during the outage. Of the 93, 36 were property of the city, 12 new portable generators were purchased after the storm, 43 FEMA or U.S. Army Corps of Engineers portable skid- and trailer-mounted units were loaned to the city, and two were loaned by private entities. The deployment, connection, operations, and fueling was performed by city personnel, FEMA representatives, and FEMA and city contractors.



When Hurricane Ike hit in September 2008, the City of Houston's Public Works and Engineering Department Wastewater Operations Branch mobilized its emergency response plans to restore service and recovery from the storm. City of Houston



Flood waters were only some of the problems the storm brought. High winds also damaged equipment. City of Houston

SSO containment and cleanup. The city wastewater operations personnel took mitigating steps to handle SSOs that were identified internally, called in by constituents, and identified by the fire and police departments. All SSO sites were barricaded to prevent contact with the public, and departmental standard operating procedures were followed to contain and stop the overflows.

Moving forward

A damage assessment is the first step when dealing with a facility disaster response. The assessment should include information on power supply status, site accessibility, structural damage, equipment damage, water levels, and site security and safety.

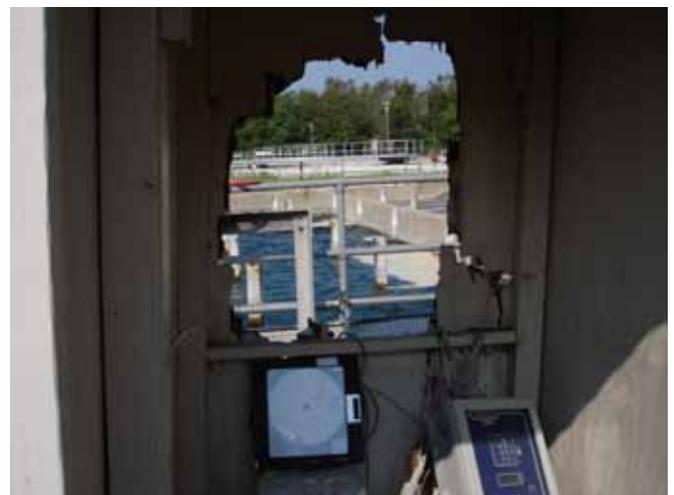
A more detailed and in-depth damage assessment should include if the service life of equipment was compromised and to what extent.

FEMA. It was determined that city personnel should be well versed prior to a catastrophic event about FEMA procedures. This includes FEMA damage-type categories, how they are organized,

and what information is required to complete all FEMA paperwork. This knowledge will expedite the reimbursement process and avoid any frustration in obtaining evidence that may not have been captured fully during the event. Suggestions and examples of the information that should be documented to obtain and retain FEMA grant dollars include the following practices:

- A liaison or a team should be assigned to handle all documentation that is required to complete FEMA paperwork.
- Keep detailed records of the time that employees worked during and after the event. This should include what tasks employees worked on and for how long.
- Take as many pictures as possible to show the extent of the damage and to use as a visual aid to support your documentation. If you know in advance that an event will strike, try to obtain “before” pictures as well to prove the event caused the damage.
- Keep records of all advertisements and noncompetitive proposals. When audited, FEMA might de-obligate funds due to improper documentation. This de-obligation can include taking back acquired FEMA grant funds.
- Obtain copies of all invoices for items that were purchased. FEMA requires proof of payment for reimbursement. If your organization has a separate group or department that handles invoicing and payments, make sure to have a system in place where copies of those documents are sent to the FEMA paperwork team.
- Log all equipment miles by equipment type and use type hours. Having a dedicated team ahead of time to track and coordinate dispatched equipment is paramount.
- Track the percentage of completion and cost overrun and underrun for all FEMA grant related work along with an estimated time for completion. Perform a cost analysis when possible.
- Try to avoid time and material contracts. FEMA will not pay for markups. If that is the only type of contract that can be used, then a ceiling price should be incorporated.

Power supply and generators. It was determined that a systemwide backup power plan should be developed to avoid a massive disruption to wastewater services. If possible, power



Hurricane Ike punched a hole through this wall at the Easthaven WRRF. City of Houston



Flooding not only affected wastewater treatment, it also made it difficult to reach facilities to begin restoration and repair. City of Houston

should be delivered to WRRFs from two separate substations to have redundancy in feed options. A power restoration schedule should be created and distributed to all appropriate personnel to ensure systems are ready for full-power reestablishment.

Generators with manual transfer switches are preferred to provide the choice between generator and power company. Trailer-mounted generators are ideal for ease of transport and use when dealing with numerous facilities.

All generators should be tracked using global positioning system and their installations should be secured to prevent theft of equipment or power.

Preventive maintenance should be performed to ensure that deployed generators will work. There should be a healthy stock of connection supplies and repair parts on hand. Time should be added to the response disbursement time to prepare the generators for deployment; this includes topping off fluids and other pre-operation checks.

During Ike, the brand-new generators were not supplied with fluids, keys to open the doors, or programming instructions. Try to ensure that those items are in place before the generators are delivered.



The storm knocked out power to all treatment facilities and lift stations. All wastewater communications systems, including phones, e-mail services, and the SCADA system, were affected by the power loss.

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Houston's Wastewater Operations Branch knew the storm would topple trees, making travel difficult. Before the storm, some employees were instructed to prepare to stay at their designated locations for up to 3 days. City of Houston

Annual emergency contracts should be in place to provide generator hauling, fueling, and coordination as well as electricians, mechanics, and technicians. This will help expedite scheduled work as well as relieve staff who had been working prolonged intense shifts.

Representatives from the city should be stationed at the FEMA–Army Corps emergency power logistic center to help with communication and coordination. Federally supplied generators have rigid delivery instructions that typically are not deviated from; this means coordination among the organization, the power company, and the delivery team are paramount to avoid wasted efforts. It is quite possible to have a generator delivered to a location that just had its power restored. If that is the case, that generator could be returned to the provider as opposed to being delivered to another location where it is needed.

Sanitary sewer overflows. Prior to an event, try to make sure that all process units (wet wells, lift stations, etc.) that can provide extra capacity are pumped down to ensure maximum storage volume.

The most efficient way to curtail SSOs during Ike was using a “spider web” approach. This involved bringing equipment online from a central location and then branching out from there. Starting with the WRRF as the middle of the web, move upstream in a step fashion to the feeding lift station and then out further into the collection system bringing each part of the “web” online one section at a time.

Spill cleanup plans and procedures should be in place to minimize environmental effects, expedite restoration, and reduce the number of community complaints. Methods to properly communicate cleanup status and efforts to the public also should be planned. Effective communication is essential for customer relations and the reputation of the organization.

The most valuable lesson learned is this: You cannot prepare for everything. Murphy's Law will strike when you least expect, but hardening infrastructure, having proper plans, establishing emergency contracts, and gaining an in-depth understanding of FEMA procedures will help reduce chaos, capture and record information, and ease recovery efforts.

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