

# Shore & Beach

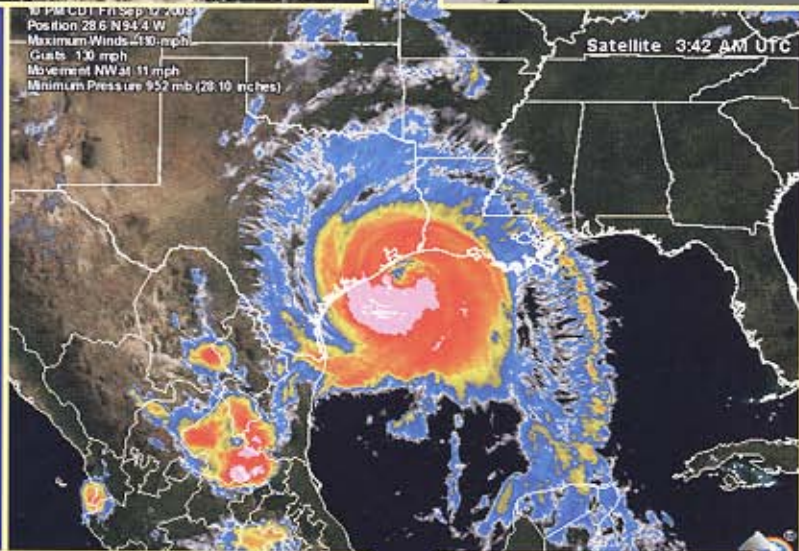
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## LESSONS FROM HURRICANE IKE

—Impact & Insights—



# United States Army Corps of Engineers, Galveston District Operational experiences and response to Hurricane Ike

By

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## ABSTRACT

On 13 September 2008 Hurricane Ike made landfall at Galveston, TX, as a Category 2 storm with sustained winds of 110 mph (49 m/s) and an estimated Category 4 storm surge ranging 10-20 ft (3-6 m) above normal tide. The Galveston District of the United States Army Corps of Engineers, headquartered in Galveston, responded and provided assistance in the recovery of the local community and the region that was impacted by Hurricane Ike, all while the District and its employees were themselves victims of the storm. Before, during, and after landfall of the storm the District coordinated and executed emergency operations missions such as monitoring employee evacuations, restoring navigation, debris removal and Federal Emergency Management Agency (FEMA) missions of bottled water and ice deliveries, and providing power to critical public facilities. In addition, although most of the workforce was displaced for a period of about three weeks, the District's critical operating missions continued.

On Saturday, 13 September 2008 at approximately 2 a.m. Central Daylight Time, Hurricane Ike made landfall at Galveston, TX, as a Category 2 storm with sustained winds of 110 mph (49 m/s) and an estimated Category 4 storm surge ranging 10-20 ft (3-6 m) above normal tide. A little more than a century earlier, the most deadly natural disaster experienced by the United States occurred on Galveston Island during the Great Storm of 1900, in which an estimated 6,000 to 8,000 lives were lost. As back then, when the United States Army Corps of Engineers (USACE) responded and assisted the community with the construction of the seawall and the grade raising of the island, the USACE Galveston District again responded and provided assistance in the recovery of the local community and the region that was impacted by Hurricane Ike, all while the District and its employees were themselves victims of the storm.

The Galveston District was established in 1880 and is one of the oldest Districts in USACE. It includes approximately 400 miles (644 km) of coastline, 720 miles (1,160 km) of shallow-draft channels, 260 miles (420 km) of deep-draft channels and eight federal jettied entrance channels serving a dozen major

ports (Pendergrass and Pendergrass 1990; USACE 1992). The District boundary extends inland approximately 150 miles (241 km). District headquarters is located in the Jadwin Building (Figure 1) situated on the northeastern tip of Galveston Island. The building is named after Captain Edgar Jadwin, later Lieutenant General, and Chief of Engineers in 1926. CPT Jadwin was the USACE officer who directed the construction of Galveston's seawall extension between 1904-1905. The Northern Area Office is co-located within the District headquarters; the Southern Area Office is in Corpus Christi in the central portion of the Texas coast; and resident offices are located in Port Arthur, near the Louisiana border and in Brownsville, near the Mexican border. Numerous project offices are located throughout the District boundaries. Approximately 350 full-time employees execute the District's missions.

## PRIOR TO LANDFALL

As Hurricane Ike headed towards the Texas coast the week of 7 September, preparations for a potential strike were implemented throughout the District. The Emergency Operations Center (EOC), which provides command and control for the District's preparedness, response, and recovery operations, was activated for Ike and was staffed with the District's

## ADDITIONAL KEYWORDS:

Storm surge, storm damage, Galveston Seawall, emergency response, evacuation, beach erosion, Texas.

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Crisis Management Team (key District leaders) and the Crisis Action Team (action element that supports and executes field operations). These teams reported to the alternate EOC located at the Addicks Field Office in west Houston (Figure 2). The Addicks office is normally occupied by five people. However, for three weeks following the storm, upwards of 50 people worked there. The District's server was relocated to the EOC, and lines of communications with USACE Southwestern Division and Headquarters offices, along with other federal, state, and local agencies, project sponsors and stakeholders were established.

On Wednesday, 10 September, a presidential declaration of emergency was issued for the state of Texas. As part of the federal response framework, the USACE provides managing support to the Federal Emergency Management Agency (FEMA) missions that are initiated under an emergency declaration. As FEMA assigned emergency missions to the USACE, the District EOC was responsible for executing them. However, as part of the District's Emergency Operations Plan (EOP) the FEMA missions were transferred to the Fort Worth District to ensure the Galveston District staff could focus on recovering its own personnel and facilities and key statutory missions such as restoring navigation on Texas waterways and emergency repairs to flood control works.

The Galveston District Operations Division, including the Navigation Branch,

initiated close coordination with their partners on the Texas Joint Hurricane Response Team whose members include the U.S. Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), the barge industry, ship pilot organizations, and deep- and shallow-draft stakeholders. The Response Team is responsible for assessing channel conditions, implementation of the port readiness states and communications on status of waterway closures ahead of the storm, and, after landfall, re-establishing aids to navigation and conducting post-storm surveys to assess channel conditions. The Northern Area Office's hydrographic survey coordinator was also prepositioned at the EOC to provide advice, identify assets available for performing surveys following passage of the storm, and prepare scopes of work that would best accomplish the mission of clearing the navigation channels. By Wednesday afternoon, District offices were ready to evacuate. Buildings, equipment and work stations were secured, and vehicles and boats fueled and relocated out of harm's way.

On Thursday, 11 September (about 40 hours prior to landfall), the mayor of Galveston issued a mandatory evacuation order for Galveston Island, which was soon followed by the District Commander's evacuation order for employees and their families residing in Hurricane Ike's path. Some employees went to work in an emergency management mode whereas others, with their families and pets, evacuated inland to higher ground. Fort Worth District (located near Dallas in northern Texas) assumed Lead District responsibilities while Galveston District focused on personnel safety. Accounting for everyone in the District was "Job One" (pers. comm., Colonel David C. Weston, Galveston District Commander). On Friday and Saturday, 12-13 September, the EOC was focused on tracking the whereabouts of the 350 or so employees that evacuated from District facilities up and down the Texas coast.

#### POST LANDFALL

Following passage of the storm, damage assessments began. Helicopter flights were conducted, not only to inspect District facilities but also to assess damage to Galveston Island and the entire region impacted by the storm. Other Galveston District crews ventured out by land to assess damage and to start the recovery process of the region. Personnel work-

ing from the EOC at Addicks, the Sims Bayou Project Office in southwest Houston, the Joint Programs Military Office in San Antonio, and employees working from their residences allowed the critical mission functions to continue.

### GALVESTON DISTRICT CRITICAL MISSIONS

#### Emergency Operations/ FEMA Missions

After the wind died down, the EOC staff began reviewing damage estimates and shifted from evacuation to reconstitution of staff and property. Daily contact was made with all employees until the District reopened for normal business.

The Fort Worth District, taking the lead on the FEMA missions, quickly established the Recovery Field Office (RFO) in Pasadena, in southeast Houston. USACE personnel from around the nation were brought in to support the response efforts. Emergency supplies of ice and bottled water were delivered to distribution points (Figure 3), and emergency generators were installed at critical facilities such as hospitals, police stations, and water-treatment plants. Technical assistance was also provided for the debris removal mission. They also installed FEMA blue plastic tarps on damaged roofs as part of the "Blue Roof" mission. USACE personnel provided oversight of the installation of mobile home units.

The Galveston District resumed command and control of the RFO on 8 October. In total, 1,215 truckloads of bottled water and 1,071 truckloads of ice were delivered. One hundred seventy-six generators were installed at critical facilities, and 25,708 "blue roofs" were installed. In December, three months after the storm, technical assistance and coordination of the installation of the mobile homes was still ongoing.

#### Navigation

Within days of landfall and with the help of the EOC providing logistical and communications support, the Northern Area Office survey crews conducted visual inspections of dredged material placement areas along the Gulf Intracoastal Waterway (GIWW) from High Island to Matagorda Bay, the Sabine-Neches Waterway, and the Galveston, Texas City, Freeport, and Houston ship channels. In addition, more than 1,500 miles (21,414

km) of channel were surveyed, the data assessed, and channel status reports disseminated to the USCG. Area Office personnel also provided oversight of salvage operations in the GIWW in the vicinity of the Bolivar Peninsula where many houses and other buildings were destroyed by the storm surge. Much of the debris ended up in the GIWW and had to be removed by a salvage company prior to restoring navigation along the waterway. Contracts for repairs to dredged material placement areas along the Houston Ship Channel and in Port Arthur, along with emergency dredging contracts initiated for Freeport and the GIWW from High Island to the Galveston Causeway, were initiated by the end of September.

In some instances, placement areas within a dredging reach were destroyed or burdened with hurricane debris (Figures 4-6), requiring engineers to coordinate with the Texas General Land Office and the Texas Department of Transportation to find alternative locations to place dredged material. Each day that went by with waterways closed had a huge economic impact not only on the Texas coast, but also on the country as a whole because of the petrochemical industry and commodity shipping interests on this part of the coast (pers. comm., Johnny Rozsypal, Chief of Operations).

#### Programs and Projects

Programs Management personnel working from Fort Sam Houston in San Antonio (some were deployed prior to landfall), the EOC, and at the Sims Project Office provided critical financial support. They not only assisted in the emergency and recovery efforts related to Hurricane Ike, but were also deeply involved in federal fiscal year-end (30 September) closeout activities for the District including securing additional funds for contract awards and answering numerous data calls from USACE Southwestern Division, USACE Headquarters, and the U.S. Congress. Personnel from the District's contracting office also spread out from San Antonio to Houston, worked fiscal year-end actions as well as hurricane-related contracting issues.

The Corpus Christi Regulatory Field Office acted as the regulatory liaison for the Galveston District Regulatory Branch until the District office reopened. The field office along with the Fort Worth District Regulatory Office notified the public



Figure 1 (left). The Jadwin Building, USACE Galveston District Headquarters, Galveston, TX.

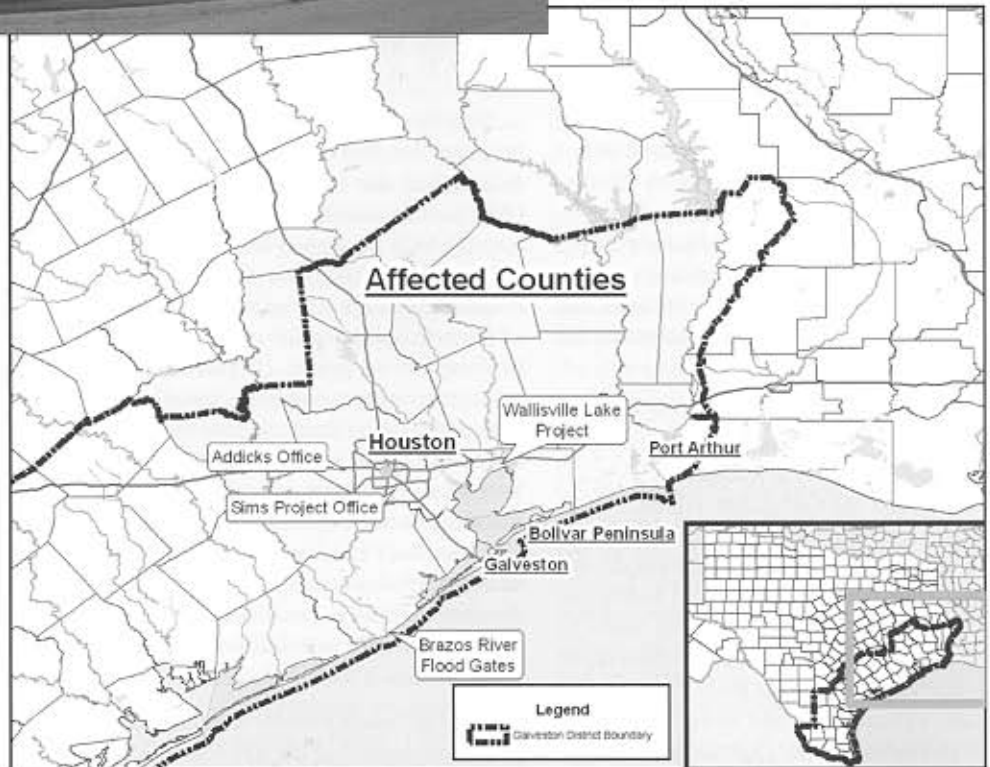


Figure 2 (right). Location map for Texas counties affected by Hurricane Ike and USACE offices near Galveston.

Figure 3 (below). Brigadier General Kendall Cox, USACE Southwestern Division Commander, and Colonel David C. Weston, Galveston District Commander (third and fourth from left) at the Galveston POD (point of distribution) for water and ice.





Figure 4 (above). Shrimp boat swept into dredge material placement area 39, located on the northern side of the Gulf Intracoastal Waterway (GIWW) and across from the Bolivar Peninsula.



Figure 5 (left). House swept into dredge material placement area 38, located on the northern side of the GIWW and across from the Bolivar Peninsula.

Figure 6 (below). Debris in dredge material placement area located on the northern side of the GIWW and across from the Bolivar Peninsula.



about USACE's emergency permitting program and information about the various authorizations available for making emergency repairs to previously authorized projects. More than 100 permitting inquiries associated with the storm were responded to by the field office.

The General Investigations (GI) and Construction General (CG) Programs (feasibility studies and construction projects, respectively) primarily suffered schedule delays as a result of the hurricane. Although personnel were separated from their working files, project sponsors were contacted and kept apprised of District activities until normal business resumed.

One GI project, a shoreline erosion and ecosystem restoration project for the area between Sabine Pass, TX, near the Louisiana border, to San Luis Pass on the west end of Galveston Island was significantly altered both physically and economically and is currently being assessed to determine whether existing-conditions data collected prior to the storm will have to be reanalyzed. The study area includes the completely devastated Bolivar Peninsula (Figures 7-10). Most homes and businesses were destroyed, State Highway 87 was significantly damaged, and large areas of freshwater wetlands remain severely impacted with daily inundations of saltwater. In addition, the beaches of Galveston and elevated beach homes on the western portion of Galveston, outside of the protection from the seawall, suffered severe erosion (Figures 11-12). Meetings with the project's nonfederal sponsors, state agencies, and USACE experts are being conducted to determine the direction of the project.

Project managers for the Ft. Bliss (military construction) and border fence projects are based in Galveston. The projects were not physically impacted by the storm. However, personnel either worked from Fort Worth or teleworked from hurricane impacted areas so that progress was not interrupted. Contracts totaling \$222 million were successfully awarded for the two projects prior to the end of September during the evacuation period for Ike.

## FEDERAL PROJECT SUCCESS STORIES

### Galveston Seawall

The historic seawall effectively held back Ike's massive waves and storm

surge from the Gulf of Mexico. However, the massive waves and storm surge damaged several areas along the historic seawall. Hardest hit were the west end of the seawall, where the wall stood, but the sidewalks and road behind the wall collapsed from erosion (Figure 13). Rock groins extending gulfward from the wall, stairs, handrails, and down ramps were also damaged (Figure 14). In addition, several spots behind the face of the seawall collapsed, leaving sink holes and broken sidewalks.

The Galveston District has received Flood Control and Coastal Emergency (Public Law 84-99) funding for seawall rehabilitation. The entire seawall will be inspected by means of ground-penetrating radar. The repairs are scheduled to be completed by 1 July 2009 so the seawall will be fully repaired at the beginning of the next hurricane season.

### Hurricane Protection Levees and Flood Gates

There are three federal hurricane protection levees that were affected by Hurricane Ike. The levees are located in Texas City, Freeport, and Port Arthur and were constructed after Hurricane Carla, which roared into Texas in September 1961 and caused extensive flooding up and down the Texas coast. Although each of the levees sustained damage, all performed as designed and provided protection to the cities and industries behind them. All three areas are home to major shipping ports and petrochemical complexes.

Texas City is the only community in the lower Galveston Bay area that did not sustain damage from Ike's devastating storm surge. Some portions of the levee at Texas City suffered limited erosion, and some of the shore protection riprap was displaced. Storm surge came within 2 ft (0.6 m) of overtopping the levee. The Moses Lake Floodgate at Texas City sustained minor damage from the storm surge. The levee system along the Sabine Neches waterway in Port Arthur also suffered from erosion and riprap displacement. The storm surge in Port Arthur came within 1.5 ft (0.5 m) of the top of the levee. The temporary closure structure and levee system in Freeport also sustained some damage, but performed as designed. All of these projects will be repaired with the Flood Control and Coastal Emergency funds.

### Facilities and Return to Work

Galveston District facilities affected by the hurricane suffered varied amounts of damage. The most severely impacted of all District facilities was the Port Arthur area office. The storm surge flooded the office facilities with 2 ft (0.6m) of water and mud, with the warehouse suffering the worse damage with over 4 ft (1.2m) of water and mud. This water and mud damage destroyed all the furniture, files cabinets, files, and equipment that it inundated. As a result, the District's real estate office had to locate a facility that offered office, administrative, and storage space within close proximity of Port Arthur and functionally capable to allow USACE mission requirements to be performed. The facility is currently being considered for repair.

The Wallisville Lake Project, which serves as a salt water barrier on the Trinity River and protects freshwater intakes surrounding that of the city of Houston, sustained damage to the administrative buildings and other infrastructure including the dam, navigation lock and numerous recreational facilities from the 15.6-ft (4.8-m) storm surge. The surge carried with it 1,000 cubic yards (764 cubic meters) of debris, including an estimated 1,000 refrigerators, freezers and television sets; hazardous material containers including propane tanks; numerous 55 gallon (208 liter) drums; cans of paint; gas cans; tires, about 100 navigation buoys of various sizes; roofing materials; furniture; plastics; and organic debris, such as logs and marsh vegetation (Figure 15). Much of this debris came from the homes and businesses destroyed on the Bolivar Peninsula 20 miles (32 km) away. About the only structure that did not sustain extensive damage was the administration building. Due to the rapid response of the staff, the building was reoccupied on Monday, 15 September 2008, using generator power, just two days after Ike's landfall. Restoration and the removal of debris began within the next few days, and as of December 2008 still continued.

The Brazos River Floodgates suffered minor damage in the form of saltwater inundation to electric motors in machinery pits that operate sector gates. It was necessary to clean the motors by flushing them with fresh water and spraying with electric cleaner, then allowing them to dry under heat lamps before attempting to operate. Two out of four motors were



Figure 7 (above). Broken slabs, downed support pilings, and damaged residential infrastructure on the Bolivar Peninsula.

Figure 8 (below). Beach erosion on the Bolivar Peninsula. The sand in the right foreground of the photograph was placed after the storm. Note damaged geotextile tubes near the shore. The tubes were placed in the 1990s to simulate dune protection to beach front homes. The homes in this area were washed away by the 16-18 ft (4.8-5.5 m) storm surge.





Figure 9 (top). Clay outcrop exposed on the beach front on the Bolivar Peninsula. The estimated 16-18 ft (4.8-5.5 m) storm surge and high waves severely eroded the beaches.

Figure 10 (above). Beach erosion and exposed septic tanks along with toppled pilings that once supported a house on the Bolivar Peninsula.

Figure 11 (left). Beachfront home on a Galveston beach west of the seawall. The foundation is now about 5 ft (1.5 m) above the beach, and the structure is currently in the surf zone.



salvaged and the faulty motors were pulled and replaced with a spare motor kept on-site and a spare motor borrowed from Colorado River Locks. The sector gates were fully operational by 24 September.

The Jadwin Building (District headquarters), a four-story concrete structure located near the south jetty of the Houston-Galveston Navigation Channel entrance, received little damage. Storm surge entered the parking garage on the ground floor at elevation 13 ft (4.0 m) mean sea level, leaving muck and debris. The grounds around the building were also inundated with floating debris from the surge. Many trees and shrubs were toppled or killed by the wind and saltwater. The boathouse and pier suffered major damage (Figure 16). Primary utilities of electricity, water, and gas were not restored until late September. Employees returned to work at the District headquarters on 3 October, 23 days after the Commander's evacuation order.

Overall, 354 District employees were directly affected by Hurricane Ike. Almost all were forced to evacuate, and most experienced extended power outages and minor to moderate damage to homes or apartments. The homes of 52 employees were rendered uninhabitable by the hurricane. Most, if not all, of the employees who suffered major damage lived on Galveston Island. Although the Galveston seawall did an exceptional job of protecting the main part of the city from being pounded by surf more than 17-ft (5.2 m) high, storm surge inundated the island from the bayside. It is estimated that 75% of the 24,000 structures on the island flooded (Jones 2008) to a maximum of 10-12 ft (3-3.5 m)

of water. Damage to employee's homes ranged from water in garages, but not living areas, to 4-6 ft (1.2- 1.8 m) of water in homes, to elevated homes that had the bottoms destroyed due to the surge (Figures 17-18). One employee's beach getaway home located on the Bolivar Peninsula was completely washed away. As of this writing three months after the storm, most employees whose homes were uninhabitable were still displaced, and their homes were in various stages of rebuild.

### CONCLUSION

More than 900 USACE employees and retirees supported the Galveston District's response that assisted in Hurricane Ike related missions. Lessons learned from past storms, primarily Hurricanes Rita and Katrina, that struck Texas and Louisiana in 2005, were valuable during the planning and execution of the response to Ike. Some of those successes include better evacuation of those that were in eminent danger due to storm surge, better coordination among local, state, and federal emergency response teams, and improved post-storm responses with the FEMA missions and execution of the District's critical missions. The USACE response to Ike will also be reviewed so that in the future our storm response will be further refined and improved.

Those of us that live here knew that history could repeat itself, and that the region could be devastated by a major hurricane, but it is not something that is thought about on a daily basis until it is experienced firsthand. As coastal communities all along the Gulf and Atlantic coasts experience these natural disasters — and there will be more — the lessons

learned are invaluable to prepare for the next one. As this region is currently in the midst of rebuilding the damaged communities, now is the time to learn from the past and follow the paths that the leaders of Galveston took after the 1900 storm — think "out of the box" — and develop a long-term sustainable protection plan for the coast and future development along the coastal areas. Move forward with redevelopment in a manner that will reduce the amount of storm damage to the coastal communities. Possibilities include reinforced construction methods, overall design of residential areas, and economically and environmentally sustainable structural coastal barriers. All of the above should be evaluated as a coordinated effort among the local, state, and federal agencies, so that in the future, the region will be better prepared to withstand the next major hurricane.

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### REFERENCES

- Jones, Leigh, 2008. "Easing permit process carries a risk," *Galveston County Daily News*, Texas, 14 December 2008.
- Pendergrass, Bonnie B. and Lee F. 1990. "In the Era of Limits A Galveston District History Update," 1976-1986. USACE publication, 188p. (available at <http://www.swg.usace.army.mil/pao/Docs/inthecraoflimits.pdf>)
- U.S. Army Corps of Engineers (USACE) 1992. "Inlets along the Texas coast," Planning Assistance to the States Program, Section 22, U.S. Army Engineer District, Galveston, Galveston, TX, 56p.



Figure 12 (above).  
Damage to houses  
along the beach west  
of Galveston seawall.  
After the storm, sand  
in left foreground  
of photograph was  
placed under an  
adjacent home.

Figure 13 (right).  
West end of Seawall  
Boulevard. Note that  
the wall is still intact  
(on left), the roadway  
and sidewalks  
collapsed due to  
erosion caused by  
storm surge.





Figure 14 (left). Damage to Galveston's seawall; note the damage at the base of the wall, the stair rail and the sidewalk. The battered pilings in the foreground once supported a gift shop and a restaurant. Both were destroyed by the storm.

Figure 15 (right). Debris in dam at the Wallisville Lake Project.





Figure 16 (above). Damage and debris at Galveston District Headquarters boat dock facility.



Figure 17 (left). Loretta Buddenhagen, a program analyst in the Programs Management Division, sorts through a few saved memories in the garage of her home. Four ft (1.2 m) of water inundated Buddenhagen's home and garage. Note the water line on the garage doors in the background.

Figure 18 (right). Employee's elevated home with breakaway garage ripped out by Hurricane Ike. The house, in a neighborhood behind the protection of the seawall, is located on the water on the bay side of the Island. The water line almost reached the top of the window on the left side of the house.

