



by Thomas Colbert

Ready or Not?

AS HURRICANE SEASON PROGRESSES, A **TONE OF UNCERTAINTY** CLOSES IN.

WHEN KATRINA CAME ASHORE TWO YEARS AGO, New Orleans was caught flat-footed. Municipal, state, and federal governments were completely unprepared for a disaster of this magnitude. The levees had been poorly designed, the evacuation plan left out the most needy citizens, and the handling of the aftermath confirmed a lack of foresight. If such a hurricane were to hit Houston today, what would our government's response be? With the help of officials working for FEMA, Harris and Galveston counties, the City of Houston, the Houston-Galveston Area Council, and scientists at the Louisiana State University Hurricane Center, it has been possible to construct a picture of what the governmental response would be to a major hurricane hitting the Houston-Galveston metropolitan area. And it's clear that there are ways in which we are ready and others in which we are not.



Evacuation Zone B (in response to the prediction of a Category 3 or higher) are advised or ordered to depart. The government's major effort is to get people away from the tidal surge area. Galveston County's evacuation of the special needs population begins at 48 to 36 hours out and people in Evacuation Zone C (anticipating a Category 4, 5, or higher) are advised or ordered to leave. Evacuation from Galveston County is through Harris County, along I-45 North, I-10 West, State Highway 290 North, and State Highway 59 North. State Highways 59 South and I-10 East do not lead away from the coast and are not evacuation routes. The reason for the government's emphasis on evacuation is simple: Many of those who stay in lowland areas will not survive.

According to government officials and the scientific community, another storm such as Rita or Katrina would bring with it the possibility of a tidal surge of 20 to 30 feet. In such an event, along the Galveston coast there would be 10-to-15-foot waves on top of the tidal surge. Waves in Galveston Bay would reach 8 to 10 feet above tide levels, and in Clear Lake those heights are expected to be 3 to 5 feet higher than the surge tide. In some areas storm-driven tide would be rapidly flowing, and in many locations it would be filled with the debris of homes, cars, and trees. Most buildings and many bridges in the main tidal surge zones would be destroyed by the action of water and debris. The incoming surge would not only demolish houses and businesses, but would also make evacuation routes impassable.

As traffic generated by evacuating motorists increases, the contraflow system is to be activated. Since the record-breaking traffic jams associated with Rita, government officials want to ensure that municipalities along the evacuation routes and the appropriate agencies are well rehearsed and to be certain that gasoline, water, and police protection are available. The contraflow system is designed to redirect traffic at the outskirts of Houston, where the freeways narrow to two lanes going in each direction, so that all four lanes will carry outbound cars. Access ramps in the contraflow areas are to be closed if they are going the wrong direction, and supplies are to be prepositioned. Only secondary roads will be available for traffic heading into the Houston-Galveston region.

So that everyone in low-lying areas will be able to reach safety, people who live outside of the defined storm surge zones will be encouraged to stay home. Those who are worried about the vulnerability of their houses to hurricane-force winds will be asked to either evacuate or move to a more secure structure. It's not clear, though, how one can know if a home or apartment building will be safe. It is recommended that every building be evaluated by an

How the government responds to the threat of a hurricane varies based on the specific risks posed by a particular storm, but a provisional timetable of events has been developed.

As a hurricane crosses over the Florida Keys, its progress is monitored by state, county, and municipal emergency-management personnel. When it reaches the middle of the Gulf of Mexico, some 96 to 120 hours before landfall, the Harris County Homeland Security & Emergency Management center and other comparable agencies are activated and manned around the clock, bringing elected officials together with disaster-management staff, representatives of the utility companies, the medical community, meteorologists, and additional specialists.

Preparation for the evacuation from low-lying areas of the elderly, hospital patients, and those with special needs begins, together with a recommendation for others living in low-lying areas or in weak structures to leave. As the storm reaches 96 to 72 hours out and the infamous "cone of uncertainty" prevails, healthcare facilities must decide whether to have their staff leave or stay, and fuel is surged to evacuation routes, where it is to be distributed to needy motorists by prepositioned tanker trucks and by filling stations, which are now required to remain open. At 72 hours out, people in Evacuation Zone A (in expectation of a Category 1, 2, or higher storm) are encouraged to leave. Whether this action is voluntary or mandatory is a local jurisdictional decision by mayors and county judges. (Citizens are advised or ordered to evacuate according to their zip codes, since this information is better understood than the zone maps.) Between 72 and 36 hours out, people in

great deal of disaster planning and many evacuation rehearsals have taken place since Hurricanes Katrina and then Rita battered our part of the Gulf Coast. Local and state agencies have committed substantial resources to preparing for "the big one." But much of our rapidly growing metropolis lies within the deadly tidal surge area that such a hurricane would create, and many of our existing buildings and industrial facilities were not built to withstand the winds and debris generated by a storm such as Rita. (Had it not turned away from Houston, Rita, at a Category 5 intensity, was predicted to create wind speeds of 155 miles per hour or more at the coast and throughout Harris County, and 110 miles per hour as far north as Conroe.) Progress has been made in minimizing and preventing flooding from rainwater, but many places in Houston are still not safe from the kind of rainfall that a hurricane or major tropical storm could create, especially when combined with tidal surge. With that said, significant improvements to the city's drainage system are planned and under construction, and there have been ameliorations in evacuation and disaster-response planning since Rita.

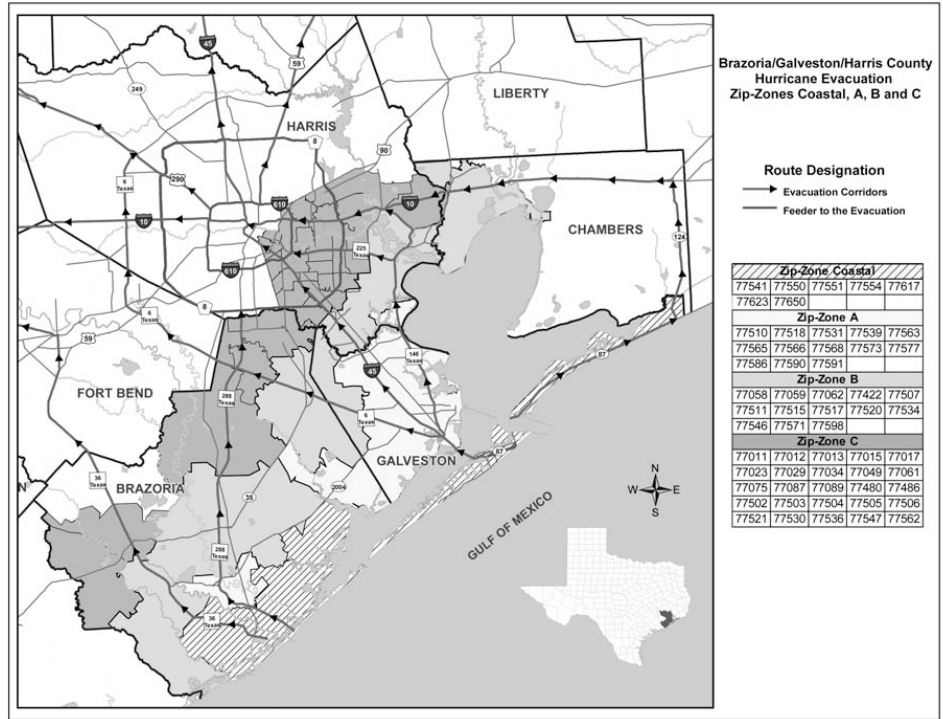
engineer to see if it meets current building-code requirements, but few structures have undergone that process, and there is debate about the adequacy of code requirements for strength. However, it must also be recognized that the number of fatalities associated with wind damage due to hurricanes is small. Andrew, a Category 5 hurricane that passed over densely populated areas of Florida in 1992, resulted in seven wind-associated casualties. Water is what usually kills people in hurricanes, particularly tidal surge waters.

Disaster planners are pleased that during Hurricane Rita there was a 90 to 95 percent compliance rate for evacuation of low-lying areas (the normal rate is 80 percent) and the freeways were clear of traffic 12 hours before gale-force winds made landfall. But they are worried that enough lead time may not be available for the next evacuation. Hurricanes Alicia and Brett formed in the Gulf of Mexico and came ashore in under 60 hours. Katrina entered the Gulf of Mexico and hit land in only 55 hours. Other hurricanes could sprint over Florida and reach Texas in less than the 96 hours that government agencies anticipate.

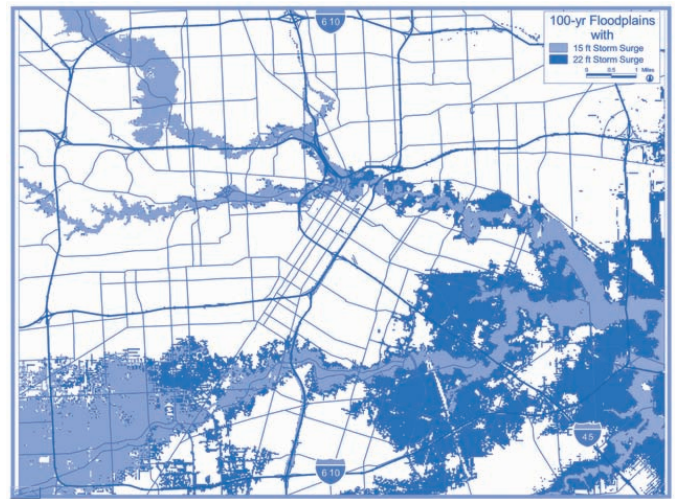
While the region's hurricane evacuation plans are fundamentally dependent on the private automobile, other options do exist. Anyone in an evacuation zone who is identified as a part of the special-needs population will be picked up from neighborhood collection points. People who cannot leave their homes without assistance will be accommodated. Everyone taken in for evacuation will be given a bar code ID for tracking their progress and to make reassembly of families easier. The special-needs population automatically includes all residents of retirement homes, prisoners, and hospital patients, as well as anyone without access to transportation. All that is required to register for assistance is for locals to call 211, but, despite widespread advertising and coverage by the television and print media, only a small portion of those estimated to have special needs have requested assistance.

For those who require more protection from wind than their homes can provide, "refuges of last resort" will be opened. These places are not called shelters because the term implies that there will be cots and supplies at these locations. Refuges of last resort are merely wind-resistant structures such as school gymnasiums. They're not announced in advance because different facilities will be opened up for various kinds and levels of emergency. As soon as an evacuation is necessary, shelters will be set up in other cities to receive evacuees who were unable to arrange to stay with friends or family or at a hotel.

In preparation for all categories of hurricanes, people are advised to have previously determined several alternate routes to high ground, to maintain a



Zip-Zone Evacuation map (above); 100-Year Floodplain Storm Surge map (right).



fully stocked evacuation kit, and to have a prearranged family communications plan in case telephone and cell phone service breaks down. The recommended contents of an evacuation kit are daunting: three to five gallons of water per person and food for three to five days, as well as important legal and insurance documents; medical supplies, bedding, and clothing; flashlights and battery-powered radio; cash or travelers checks; a fire extinguisher; and extra supplies for children, the elderly, and pets. Before leaving home, garbage cans, lawn furniture, and other loose objects are to be brought inside homes, garage doors reinforced, and windows boarded up. During hurricane season, all residents of coastal areas are asked to keep trees trimmed and to remove weak or dead branches. Residents are advised to ask their insurance agents about storm coverage requirements, since some companies have claimed that houses damaged by Rita and Katrina were not covered because residents didn't take "reasonable precautions," including boarding up windows.

While the rest of the population is fortifying their homes and fleeing, first responders will organize

themselves for relief and recovery efforts. Fire engines, ambulances, and construction equipment from the evacuation zones will be sent to assembly points on high ground, as will units being brought in from other regions. Utility companies will organize crews and equipment to facilitate rapid reoccupation and reconstruction of affected areas. Hospitals will gear up to receive large numbers of casualties, and other emergency workers will be required to report for duty.

Katrina taught us that first responders and other essential personnel are unlikely to report to work during a disaster if they are worried about the safety of their own families. It has therefore become a top priority of all levels of government to provide special

facilities for the families of first responders. The number of workers described as essential personnel has been expanded based on experiences gained during Katrina and Rita, so that government agencies not only have administrative staff in place but support staff available to keep offices running for extended periods of time after a disaster.

When the storm has passed, seriously affected areas are to be sealed off by the police. Hazard assessment teams will be sent in to these regions to identify toxic spills and gas releases, downed power lines, and unstable buildings and bridges, and to cordon them off. As this work progresses, fire and EMS teams will begin the search for victims and casualties. Debris management will be a critical problem. A high priority is to be given to clearing roads and bridges so that emergency personnel have access to areas from which they

have been cut off and construction and utility crews and heavy equipment can be transported to critical locations. National Guard troops are to be stationed, if necessary, throughout

the most damaged areas. Local Red Cross shelters will be set up to take care of the returning population. As soon as it is safe to do so, residents will be allowed to go home, but this may not be for a number of days or even months, particularly in seriously affected areas. In some cases it will not be possible at all.

The question of toxic releases is of particular importance for our region. A slow-moving Category 3 to Category 5 hurricane with winds from the south or southeast creating up to a 30-foot tidal surge would direct Gulf waters up Galveston Bay and into the Houston Ship Channel. In such a storm, rapidly flowing water and large, debris-filled waves would pass over the nation's largest petrochemical refining and storage center and the contents of those refineries and storage tanks would be driven toward the center of Houston. When the storm passes and waters recede, these chemicals and toxic soils would wash over the entire Galveston Bay and Houston Ship Channel area. It has been reported that refineries and chemical companies along the Ship Channel plan to rush their product inland by pipeline and rail car as soon as a hurricane is seen as a threat. It is not clear that they would be able to move their entire inventory in time. It is also not clear what their clean-up plans are for an event of this magnitude.

While tidal surge and high winds would cause the most damage during a major hurricane, rainwater also represents a major threat that challenges government agencies. Rainfall in the range of 10 to 12 inches is considered normal during a hurricane,

with significantly more possible. As a part of the Tropical Storm Allison Recovery Project, the Harris County Flood Control District has partnered with FEMA to update flood insurance rate maps using state-of-the-art LiDAR (Light Detection and Ranging) aerial mapping technology. These maps are much more accurate than earlier versions, making flood-control planning more effective. Also inspired by Allison, which dropped 28.5 inches of rain on northwest Houston in a 12-hour period, a number of major flood-reduction projects have been initiated. These include widening and deepening bayous, excavating storm-water detention basins, and initiating a voluntary home-buyout program for residents in areas prone to flooding due to rain.

Projects are under way for Brays, Sims, White Oak, Armand, Greens, and Halls bayous, as well as Goose Creek. Along Brays Bayou alone, \$458 million is being spent to widen and deepen 21 miles of chan-

nel, to excavate 3.5 billion gallons of storm-water detention, and to raise 32 bridges.

When completed, this project will remove 30,000 residences from the 100-year floodplain map. Approximately 2,500 homes have been bought in Harris County so that their sites can return to their natural state or be used as parks. The objective of these efforts is to reduce flood damage from rainwater.

Working together with the City of Houston Parks Department and the U.S. Army Corps of Engineers, the flood control district is creating a vast new metropolitan park system, one that will reduce but not remove the risk of flooding in the event of a hurricane or tropical storm. Because of the continuing risk of flooding, residents of the Houston-Galveston region are being encouraged to have flood insurance, whether or not their homes or businesses are in a floodplain; not having been flooded previously is not a future indication of safety. However, living in a flood-prone area or having to pass through one may make early evacuation necessary for individual families and neighborhoods.

Although it has been almost 25 years since a Category 3 or higher hurricane hit the Galveston-Houston area, meteorological records indicate that such storms have struck our area on a roughly predictable 17-year cycle ever since 1900. Since Carla flattened Kemah and Seabrook in 1961, the popula-

tion and the number and size of refineries and chemical plants around Galveston Bay and in low-lying coastal areas have grown enormously. According to the Houston-Galveston Area Council, there are over 350,000 homes and almost a million people living within the evacuation zone area today. They estimate that this number will increase in the next 25 to 30 years to over 550,000 thousand homes and almost 1.5 million people. The Independent Insurance Agents of Texas have identified 405 chemical and refining plants in the same area. They estimate that over \$130 billion dollars of losses to the Texas economy would be caused if a Katrina-like storm hit the Port of Houston, and over 850,000 jobs could be lost. Aside from the economic damage, after the Rita experience, when nothing significant happened to our region, it isn't clear who will evacuate next time.

While there are plans for the approach of "the big one" and for its immediate aftermath, what about economic reconstruction and recovery afterward? What about protection against tidal surge, by either engineering wetlands areas, the construction of levees and floodgates, or other means? There are

no plans to require raising minimum floor heights throughout the flood zone, to buy out homes and factories that are most at risk of flooding, or to

prevent future construction of homes in the most at-risk locations. Finally, there do not appear to be any plans to fortify existing or future chemical and refining plants against tidal surge, or to clean up the vast volume of chemical pollutants that could be released after a hurricane. A number of years ago there was a proposal by the Army Corps of Engineers to build a levee around Galveston Bay, but it didn't get very far, probably because of the high cost of construction, the low cost of flood insurance, and the perception that major storms were unlikely to have a serious impact on our area. But now we have seen the devastation that can be caused by major storm events, and have been reminded of what old-timers along the Gulf Coast have always known: It's just a matter of time.

The challenges for government are huge. The expense of dealing with these dangers leaves few politically attractive alternatives. But the scale of disaster that our region can in all probability expect should create the political will to make Houston as prepared as possible. The challenges for designers are enormous as well. How can we fortify cities and homes? How can livable cities and great architecture emerge from these challenges? The need for the design community to be involved is increasingly clear, even if the answers aren't yet apparent. ●

A Katrina-like storm hitting the Port of Houston would jeopardize over 850,000 jobs and may

result in losses of more than \$130 billion to the Texas economy.