The Senate Subcommittee on Flooding and Evacuations

INTERIM REPORT

Report to the 82nd Legislature
January 2011

TEXAS SENATE
SUBCOMMITTEE ON FLOODING & EVACUATIONS

SENATOR MARIO GALLEGOS
Chairman

SENATOR DAN PATRICK
SENATOR ROBERT NICHOLS

December 1, 2010

The Honorable David Dewhurst
Lieutenant Governor
P.O Box 12068
Austin, Texas 78711

Dear Governor Dewhurst:

The Senate Subcommittee on Flooding and Evacuations hereby submits its report to the 82nd Legislature. The recommendations are based on the oral and written testimony taken at our two hearings, as well as the input of numerous subject matter experts contacted over the course of our research.

Respectfully submitted,

Mario Gallegos Jr.

Senator Mario Gallegos, Jr., Chairman

Robert Nichols

Senator Robert Nichols

Dan Patrick

Senator Dan Patrick

P.O. Box 12068 • E1.804 Capitol Extension • Austin, Texas 78711
(512) 463-0106 • FAX: (512) 463-0346 • Dial 711 For Relay Calls

The Senate Subcommittee on Flooding and Evacuations -- Interim Report

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Acknowledgements

The Senate Subcommittee on Flooding and Evacuations would like to recognize those who have assisted in the drafting of this report. The hard work and cooperation of our partners and experts are greatly appreciated. Additionally, the subcommittee would like to thank the Lieutenant Governor for the opportunity to investigate the relevant public policy issues contained in our interim charges.

The Chairman would like to specifically thank those who took the time to testify at our hearings and/or submit written reports. Evaluating the public policy of the State of Texas was made a much easier task with their valuable contributions.

Interim Charge One

Study the benefit of legislation that would require coastal regions, when making routine improvements to drainage systems and other infrastructure, to take into account probability of future flooding and any upgrades necessary to prevent future flooding.

Background

The Senate Subcommittee on Flooding and Evacuations met in Austin, Texas on Monday, October 18, 2010, in the Capitol Extension Room E1.016 to hear testimony pertaining to the subcommittee's Interim Charge One.

Shortly after receiving this charge, the subcommittee was encouraged to specifically investigate planning and mitigation efforts related to coastal drainage issues. More specifically, to look at vehicles that have been successful in certain coastal areas of Texas in planning drainage infrastructure on a large-scale or regional basis. Furthermore, the subcommittee was advised that researching different models could potentially have applicability in different regions of the Texas Coast. However, the subcommittee was specifically directed to research flood control and drainage issues for the Counties of Hidalgo, Cameron and Willacy in the Lower Rio Grande Valley.

Initial research revealed a general shift that has been occurring in flood management circles over the past several years -- trending away from drainage planning based on political boundary lines and instead focusing on watershed boundaries or larger geographical regions that face similar problems and risks. This shift has generally resulted in a regionalized approach in the planning of drainage infrastructure.

The storm season of 2010 served to illustrate issues of drainage and flood control along the Texas Coast. On September 19, 2010, the heavy rains associated with Hurricane Karl descended on Corpus Christi with disastrous results. The high-impact rain event brought flooding to nearly 200 Corpus Christi area homes. Unfortunately, the majority of impacted residences were not in a designated 100-year flood plain. As such, very few of the damaged homes had flood insurance. Residents of certain neighborhoods described the unfortunate and disastrous effects as "typical." In the wake of the flooding, area residents and local elected officials publicly spoke about forming an organization that could implement flood control and drainage solutions.

In addition to Hurricane Karl, the Lower Rio Grande Valley (LRGV) was also subjected to major storm events in the Summer of 2010. Hurricane Alex arrived in South Texas on June 30, 2010, producing widespread flooding across Northern Mexico, which was exacerbated by the arrival of Tropical Depression #2 only days later. Saturated soils compounded the arrival of additional precipitation with Tropical Depression #2. The effects of Hurricane Alex ultimately affected the LRGV region for over 40 days. During this time, floodwaters in the Rio Grande reached levels that had not been measured in over 40 years and the system of internal floodways was used for the first time since 1988 to divert a regional flood. Because of the wide distribution of water and complex drainage patterns present in the LRGV, the region ultimately faced a serious threat of inundation from three flood waves converging on the area.

While flooding was serious and major damage occurred, most commentators seemed to indicate that the effects of Hurricane Alex could have been potentially worse if the path of the storm would have been only slightly different. Many local observers recall the challenges of dealing with the large amount of precipitation received during Hurricane Dolly in July of 2008, which left over $1 billion in damages, making it the fourth most destructive hurricane in Texas history.

Correspondence with local authorities quickly revealed that the notion of a regionalized drainage plan for the LRGV has been in existence for some time. Indeed, in the wake of Hurricane Dolly and Hurricane Alex, the Lower Rio Grande Valley Development Council (LRGVDC) stated a need for "a regional or multi-jurisdictional plan to meet the needs of a growing population to mitigate and/or minimize any economic impacts of the LRGV area from flooding and damage from natural disasters." In fact, studying drainage in the LRGV appears as a recommendation in the report authored by the Governor's Commission for Disaster Recovery and Renewal in January of 2010.

In 2009, the LRGVDC was awarded a sizeable federal grant from the Economic Development Administration. The overall goal of this grant is to study geographical and topographical conditions and the propensity for flooding, leading to recommendations for a framework to collaboratively plan and manage current and future public works infrastructure and storm water systems. Ultimately, the end goal is to make recommendations on prioritizing projects that would efficiently address the drainage and flood control needs of South Texas.

The Unique Geography of the Lower Rio Grande Valley

Providing the foundation for complex drainage and mitigation planning is the actual physical landscape of the LRGV. The geography is unique in Texas. The region is located in the center of a large, naturally subsiding fan of sediments comprising the Rio Grande Delta. The primary complicating factor resulting from this geography is the elevation of the River when compared with the surrounding elevation inland -- the River actually stands at a higher elevation. In describing this geography to the subcommittee, Dr. Gordon Wells from the University of Texas specified that the LRGV is "our New Orleans" and that such conditions "don't occur anywhere else in Texas."

The Lower Rio Grande Valley can be impacted by three types of flooding: coastal storm surge from hurricane landfall, local sheet flooding from torrential rainfall and river flooding from the main stem of the Rio Grande. Unfortunately, it is rare that only one type of flooding would affect the area during a heavy rainfall event. In fact, it is more likely that a combination of all three would occur.

Complicating matters -- particularly in areas vulnerable to inland sheet flooding -- is the rapid development that has occurred in the LRGV over the past several years. Intense residential and commercial development has led to the increase of impervious cover, changing both how flooding occurs and the results of models that attempt to provide accurate predictions. Furthermore, development of certain colonias has occurred in areas that tend to be particularly prone to sheet flooding. In such areas, stormwater drainage is inadequate and local officials must resort to pumps to remove water and provide relief.

Another complicating matter in the LRGV is the international border with Mexico and the International Boundary and Water Commission's (IBWC) control of the Rio Grande and several local floodways. Water flow and diversion along the river is controlled by the IBWC, not by local governmental entities, presenting an obvious obstacle to removing local pools of floodwater that need to be drained.

Yet another major concern in planning for flooding and drainage events is water that comes from the interior of Mexico, flowing into the Rio Grande and presenting flooding concerns to the American side of the border. During Hurricane Alex, the vast majority of water received in the River came from the Mexican side of the border. While the fundamental nature of these drainage patterns will not change, the reporting on the amount of water destined for the Rio Grande could potentially be improved. With few exceptions, the amount of water flowing from the interior of Mexico to the River is unobserved or "under-observed" until it reaches the main stem of the Rio Grande. This makes predictions for the IBWC, the National Weather Service, the Texas Division of Emergency Management (TDEM) and local authorities almost impossible. Without proper data and resulting flow predictions, it is impossible for local authorities to accurately plan and mobilize for impending disasters.

Current Organization of Local Authorities

Currently, local authorities with flood control and drainage responsibilities in the LRGV are organized in different ways. In Hidalgo County, a single Drainage District operates, encompassing the majority of the County. The Commissioner's Court serves as the board of directors for the District, keeping county authorities constantly aware of current issues. The District encompasses approximately 65% of Hidalgo County.

In Cameron County, four Drainage Districts and two Irrigation Districts operate within the County. The majority of infrastructure was initially installed by Irrigation Districts and communities eventually formed around the boundaries of the drainage infrastructure. Willacy County currently has three Drainage Districts, but is considering a process of consolidation to form a single district, with an organization similar to the Hidalgo County Drainage District.

In addition to the individual entities named above, the Rio Grande Regional Water Authority (RGRWA) also exists, operating in a total of six South Texas Counties. The RGRWA was created in 2003 with relatively broad authority, but was primarily created to supplement the services provided by local municipalities, districts and other political subdivisions, specifically in the areas of water treatment, wastewater treatment, water conveyance and desalination. In addition to these powers, the RGRWA was also designated with authority in drainage, flood control and eminent domain. The Board of Directors is diversely populated with technical experts, all of whom have a local water or drainage interest and are appointed by the Governor.

The Notion of a Regional Drainage Plan

In researching this interim charge, support was nearly unanimous for some sort of regional entity to oversee efforts in regional drainage planning. The question simply becomes one of implementation. Regional drainage planning has achieved marked success in many different formats throughout the State of Texas. One primary advantage of working in concert towards a common regional plan is the identification and prioritization of infrastructure projects that are most necessary for local communities. However, several other advantages exist. By bringing together leaders of similar ilk, best practices can be traded and exchanged. Training sessions can be easier and more affordably coordinated on a broader scale. Perhaps most importantly, practices for drawing down funding from various sources can be exchanged between members.

The subcommittee took several recommendations that the RGRWA assume the lead role in coordinating a regional drainage plan. This notion is both practical and sensible on many levels. First, the entity already exists. While additional authority may need to be granted or existing powers revised to accomplish this goal, this certainly would be preferable to creating a new organization. Furthermore, as noted above, the RGRWA already has drainage and flood control powers designated in its authority and is currently staffed with technical experts. There would be no need to go through a political appointment process or election of officials. A thorough review of its existing authorities would be necessary. Should any powers need to be tweaked, expanded upon or clarified, an opportunity to do so would likely be present during the next legislative session.

In addition to researching the RGRWA, the subcommittee also conducted research on how other jurisdictions of Texas have handled regional flood control and drainage projects. One very successful operation that has evolved in recent years in the San Antonio area is the Bexar Regional Watershed Management Partnership (BRWM). The BRWM formed in 2004, on the heels of massive localized flooding across the Bexar County area. Public sentiment indicated the need for a large organization to improve flood control, storm water management and water quality.

Initially, popular sentiment favored the formation of a formal, legislatively-created flood control district. But after additional research and discussion, local partners decided that a large-scale interlocal agreement could be formed that would essentially form a "virtual flood control district." This interlocal agreement would specifically allow for a cooperative effort, whereby all local partners have a very specifically designed role in the agreement. After several successful years, the agreement continues to be effective and dynamic, remains voluntary, and holds all partners accountable.

The BRWM consists of Bexar County, the City of San Antonio, the San Antonio River Authority and 20 suburban cities in Bexar County. The cooperative efforts result in a reduction in duplicative efforts and allow each entity to focus on its specific area of expertise. Prioritization of projects undergo a thorough evaluation process, including a matrix of input from citizens, elected officials and technical experts. This process has allowed for an objective method to prioritize flood mitigation projects and has been successful since its inception.

Created out of similar circumstances to the BRWM, the Fort Bend Flood Management Association (FBFMA) was essentially created in 2006. The FBFMA is primarily composed of Levee Improvement Districts (LID's). During 2006, FEMA released a preliminary study of Fort Bend County, indicating that numerous repairs would have to take place across their extensive levee system in order to maintain existing accreditation for the purposes of Flood Insurance Rate Maps. Numerous options were examined for implementing repairs that would need to be completed in a period of 18 months, including dissolving existing LID's and increasing the sizes of other LID's. Additionally, it was also proposed that each district should simply deal with the re-mapping issue on an individualized basis. Eventually, through the cooperation of all interested stakeholders, the LID's adopted a regional solution to the problem, entering into several interlocal agreements to improve the "perimeter levees" closest to the Brazos River. By focusing on the "perimeter levees," the total amount of costly improvements was greatly reduced, the entire system was certified in a more expeditious fashion and regional cooperation and communication were generally promoted.

After initially coalescing around the need for levee certification, the members of the FBFMA realized the benefits of their cooperative efforts and officially formed a Texas 501(c)(6) corporation in December of 2009. The members continue to discuss best practices for maintaining their systems, Federal and State regulatory developments, and the activities of other regional and national stormwater management agencies. Additionally, they actively coordinate flood control efforts to ensure best practices. At this year's first annual FBFMA conference, they provided annual required training classes for their members and hosted several noted elected officials, bringing visibility to their efforts. They continue to expand their scope, as they consider the collective purchase of large industrialized equipment to be shared by all members. While completely voluntary and locally formed, the FBFMA has emerged as a model of success, resulting from their member's unique ability to work together towards a common goal.

Another model worth examining is that of the Harris County Flood Control District (HCFCD). The HCFCD was legislatively formed to encompass Harris County in its entirety in 1937. Local sentiment, combined with The Federal Flood Control Act of 1936, made the formation of a single Harris County entity necessary. By the time the HCFCD was created, 11 other local drainage districts were operating in Harris County. Unfortunately, the boundaries of the drainage districts did not follow natural drainage patterns or watershed boundaries. The drainage districts continued to operate until 1947, when the HCFCD assumed their assets and responsibilities. HCFCD currently manages the 22 primary watersheds that exist within Harris County. Only a very small amount of the flood waters in the most populated portions of the county originate from areas outside of the county.

HCFCD was vested with several key authorities upon creation, allowing it to become very effective in its drainage and flood control responsibilities. First, the power to acquire lands via eminent domain -- in fee or easement -- for flood control purposes. Additionally, a revenue base was created with the authority to collect ad valorem taxes. Finally, the District was given the ability to contract with federal and state agencies and adjacent counties and cities to cooperatively implement flood control plans. Partnerships with groups such as FEMA and the Texas Division of Emergency Management have helped implement projects that have documented more than $2 billion in avoided flood damages. Partnerships with local cities have resulted in complimentary drainage design criteria and policies, joint investment in drainage infrastructure and other cost savings measures via the consolidation of financial resources.

There is much local sentiment in the Lower Rio Grande Valley in favor of regional drainage planning. However, there are serious questions as to what body or organization would be best suited to oversee such efforts. The descriptions of the localized bodies described above represent successful local efforts to overcome very specific local issues. Certainly, the issues faced in these jurisdictions do not exactly mirror those of the LRGV or any other part of Texas. But in investigating what sort of avenues are available to implement large-scale drainage efforts, these organizations demonstrate that flexibility and different options to address regional drainage issues do exist. In implementing their local efforts, each of these organizations has demonstrated a nuanced and balanced approach in addressing the needs of its constituency and implementing solutions. As such, studying their formation and execution of day-to-day practices serves as a beneficial exercise.

Creating a structure to oversee the implementation of a regional drainage plan in the LRGV is a distinctively sensitive and local issue. There has been much support voiced for the Rio Grande Regional Water Authority in both public testimony offered to the subcommittee and research conducted outside the scope of our hearings. From an authoritative statutory perspective, a thorough examination of existing authorities would be prudent. This would ensure that the RGRWA would have necessary powers, if local authorities decided that it is the proper vehicle for coordinating a local drainage plan. Regardless of what entity is chosen to carry such an effort locally, this subcommittee stands to support locally autonomous groups and the decisions that are made to designate a regional authority on designing and implementing a drainage plan.

Recommendations

1. The Subcommittee recommends that regional drainage plans continue to be studied throughout flood-prone and coastal areas of Texas. Approaching regional drainage issues from a larger perspective allows for the consolidation of resources and the sharing of best practices between jurisdictions, serving as a benefit to all parties involved.

2. The Subcommittee recommends that local leaders in the Lower Rio Grande Valley develop a regional drainage plan that best suits their unique needs. Research has shown that the LRGV faces very unique challenges in drainage and flood control issues. No one is better suited to address these concerns than the local technical experts and elected officials.

3. The Subcommittee recommends a thorough examination of the powers and authorities granted to the Rio Grande Regional Water Authority. Numerous local experts suggest that the Water Authority would be the proper vehicle to oversee and coordinate a regional drainage plan. If local experts and elected officials do indeed decide that the Water Authority is best suited for this task, it is imperative that their authority is properly defined and that any necessary powers be granted. Should it be decided that the Water Authority is best suited to serve this purpose, the subcommittee recommends granting any necessary authority that will enable the Water Authority to effectively operate.

4. The Subcommittee recommends state and local leaders continue to work with both Mexican authorities and the International Boundary and Water Commission to improve communication and information sharing during high impact weather events. Without proper data, predicting water flow, flooding and potential impacts becomes nearly impossible. By working at the local, state and federal level, any improvements that can be made in obtaining data from the Mexican side of the border will be beneficial to those attempting to run predictive models regarding volume of water affecting the U.S. side.

5. The Subcommittee recommends the creation of drainage districts in areas where repetitive flooding issues have occurred. Drainage districts provide a vehicle for improving drainage infrastructure. Most drainage districts have a funding mechanism to provide funding for repairing or improving existing infrastructure. Creation of such a district(s) would provide relief to recently developed or historically underserved areas.

6. The Subcommittee recommends that counties utilize current statutory authority that does exist regarding development in areas designated as "100 year floodplains" on FEMA Flood Insurance Rate Maps (FIRM's).

7. The Subcommittee recommends that any jurisdiction considering a regional drainage plan study the models introduced in this report. By all accounts, the Bexar Regional Watershed Management Partnership, the Fort Bend Flood Management Association and the Harris County Flood Control District have all enjoyed immense success in their respective jurisdictions. While no two jurisdictions are exactly alike and no "model plan" exists, these three groups all represent successful local responses to drainage and flood control needs. As each model is unique, the subcommittee recommends that any coastal region considering a

regional drainage plan should study each model to understand the purposes behind its formation and the way that each group ultimately enacted a successful plan.

8. The Subcommittee recommends the continuing education of children and the public at large with the "Turn Around Don't Drown" program. In many areas prone to flooding -- be it coastal flooding or flash flooding -- motorists have consistently made improper choices when driving in flooded areas. As flooded roadways are distinctively related to drainage and flood control issues, continuing to promote education via the "Turn Around Don't Drown" program ultimately serves to save local jurisdictions costly swift water rescues. But more importantly, educating the public about the dangers of driving through moving water serves a vital purpose: saving lives.

Interim Charge Two

Study and make recommendations on methods of emergency notification during a natural disaster. Look into alternative systems and new technologies for rerouting 911-type calls to become more efficient and effective. Study and make recommendations to streamline the process of informing citizens impacted by an emergency or disaster prior to the event about re-entry and aid.

Background

The Senate Subcommittee on Flooding and Evacuations met at The University of Houston in Houston, Texas on Tuesday, August 24, 2010, in the Melcher Room of the Alumni Athletic Building to hear testimony pertaining to the subcommittee's Interim Charge Two.

The Subcommittee's Interim Charge Two is effectively three charges rolled into one, with each portion of the charge addressing a different form of emergency communication. First is the Emergency Notification System or ENS. The second portion of the charge addresses 9-1-1 and prompts research on the implementation of the next generation 9-1-1 system (NEXT GEN). The final portion of the charge addresses the Emergency Alert System or EAS. The charge calls for the subcommittee to consider and evaluate the past usage of these communication systems during times of natural disaster, to consider the efficiency and effectiveness of these systems in their current state, to inquire as to what improvements are necessary, and to suggest the best way to implement these improvements.

A common theme emerged after talking to numerous elected officials and subject matter experts with regard to communication during a time of natural disaster -- effective communication must take place on all platforms available to ensure that emergency communication is received by as many citizens as possible. While certain platforms are very successful in certain situations and reach a significant portion of the population, alternative platforms exist that reach a different portion of the citizenry. In researching these issues, emergency management experts consistently stressed the need for clear and coherent messaging that would reach as many members of the population as possible. Effective communication during a time of natural disaster represents more than a government communicating effectively with its citizens. It also involves the ability of local governments to correspond effectively with state and federal leaders, for law enforcements groups to effectively communicate with each other, and for both local and state leaders to understand the methods of communication available to reach out to citizens and keep them informed. The following is a review of the individual platforms of communication the subcommittee studied.

Emergency Notification Systems (ENS)

An emergency notification system (or Service) is a platform of communication that is typically utilized by local authorities to inform residents of a localized disaster. Typically, computer software allows a user to define an affected geographic area. After the region is defined, a pre-recorded message is then delivered to homes and businesses that have a telephone number associated with their physical address in the 9-1-1 database. Emergency notification systems can be utilized to warn the public of various problems, dangers, and issues, including toxic releases at chemical plants, fires, a shooter or dangerous individual(s) located in a neighborhood setting, flooding, or even decisions to evacuate. Occasionally, the usage of ENS is referred to as "Reverse 9-1-1."

An emergency notification system typically requires numerous dedicated telephone lines to effectively operate. As such, efficiency ultimately becomes a key consideration when attempting to convey a message to a large amount of the population. Because of the large amount of dedicated telephone lines that are necessary and the time associated with making each call, large scale public messaging via an emergency notification system is not always practical. For example, local authorities in Harris County indicated that attempts to promote evacuation orders via ENS were largely inefficient due to the extremely large volume of calls required. They were unable to effectively convey the message to such a large portion of the population in an efficient amount of time utilizing ENS, even with the most modern technology.

However, when utilized in smaller communities, such systems remain very effective. For instance, the communities of Alvin and Kemah utilized their emergency notification systems to brief residents on the approach of Hurricane Ike, provide details of city preparations and issue instructions to shelter in place. Local officials from these communities reported that ENS continues to be a very reliable form of mass communication during times of disaster.

One key component that greatly affects the overall effectiveness of ENS is the data that supports it. More specifically, the known phone numbers and associated physical addresses in local databases. In Texas, many emergency notification systems utilize the Commission on State Emergency Communications' (CSEC) 9-1-1 database to determine relevant phone numbers in a specific geographic area. CSEC's data is populated uniquely with landline information. Currently, there is no method of associating a cell phone number with a physical address at the state level.

Modern trends of telecommunication show a distinctive move towards the use of cellular and mobile technology. This trend has been ongoing for years and clearly will not be reversed. Estimates suggest that the amount of landlines in major metropolitan areas shrink by approximately 10% each year. In sum, fewer and fewer telephone numbers are associated with physical addresses in the CSEC 9-1-1 database. In an attempt to mitigate this issue, some communities have begun programs that allow residents to register their cell phones at a specific physical address in their databases. This expands upon the landline-based data that makes up local 9-1-1 databases and allows for cell users to receive ENS alerts.

Because of the general shift in telephone usage from landline to cellular, emergency management coordinators tend to discount the effectiveness of ENS in its current state. In fact, testimony from our Houston hearing indicated that during recent events that required emergency communication in the San Antonio area, the highest success rate achieved -- defined by an actual user actually receiving the intended message -- with local emergency notification systems was approximately 17%. That said, certain jurisdictions report continued success with ENS, particularly for smaller, localized events.

It is important to note that technological developments related to ENS could greatly expand the effectiveness, impact, and scope of ENS use in the very near future. As noted above, decline in the effectiveness of landline-based ENS in recent years is primarily attributable to the increased use of cellular and mobile technology. Currently, researchers are attempting to develop the ability to isolate and identify cellular users in a particular geographic area -- very similar to current ENS -- and relay emergency messages based on geographic location. Testimony taken on this topic at our Houston hearing was not conclusive on when this technology would be widely available.

In August of 2010, the State of California announced a pilot program that would test such a system. The Commercial Mobile Alert System (CMAS) will be tested in San Diego County, where wildfires are an annual concern for local authorities and emergency management coordinators. This will allow for testing across urban, suburban and rural areas. By all indications, this pilot program is the first of its kind. Estimates currently state that the technology behind the pilot program could potentially be available for public use in the Fall of 2011.

During the time period that research took place on this interim charge, another form of cellular based ENS technology was successfully used during an emergency event very close to The Capitol in Austin. On Tuesday, September 28, 2010, a gunman was present on The University of Texas-Austin campus during the mid-morning hours. Thousands of students and faculty members were either on or traveling to campus. After confirming initial reports, The University began disseminating messages via their emergency communications system.

Part of The University of Texas's emergency communication system integrates cellular technology and texting. When students and faculty become associated with The University, a cellular number is requested for the purposes of emergency communication. This database was successfully utilized during this event, as thousands of text messages were sent and successfully received. To date, University of Texas officials have not been able to quantify the numerical success rates of those contacted. However, the results seem to indicate a very successful effort.

In addition to communicating via text message, University of Texas emergency management officials also posted warnings through social media outlets, such as Facebook and Twitter. Overall, messages were communicated on nine different platforms. While local governmental authorities may not be able to build a database for text messaging that mirrors that of The University of Texas, the emergency communications utilized by UT officials demonstrate a successful effort by a large state organization to promptly and effectively notify thousands of individuals of emergency conditions via numerous communication platforms.

Next Generation 9-1-1 and 9-1-1 During Times of Disaster

The second portion of the subcommittee's Interim Charge Two calls for an examination of 9-1-1 systems during times of disaster, specifically with the purpose of improving efficiency and effectiveness. Currently, 9-1-1 systems throughout the State of Texas operate on what is referred to as the legacy system. 9-1-1 service throughout the State is typically administrated by local authorities. Call centers are often housed in the offices of local police departments or sheriff's offices.

One of the biggest issues facing current 9-1-1 service providers is the transition from the existing legacy systems to what is termed Next Generation 9-1-1 (NEXT GEN 9-1-1). Although the term NEXT GEN 9-1-1 has essentially morphed into a generalized notion of how our future 9-1-1 system will function, there are definitive characteristics that our future systems will certainly contain. Specifically, NEXT GEN 9-1-1 will be Internet Protocol (IP) based, changing the basic format of 9-1-1 services and greatly enhancing the forms and amount of data that can be received by 9-1-1 call takers. In addition, NEXT GEN 9-1-1 will expand the ability of local authorities to transfer 9-1-1 calls.

However, in hearing testimony regarding 9-1-1 during times of disaster, local authorities provided numerous details on transferring calls in the current system and the importance of retaining local calls whenever possible. With the existing legacy systems, contingency operations are pre-programmed to occur if and when local systems fail. As such, if a single call-taking center goes down, calls are automatically re-routed to another facility within the same jurisdiction. If for any reason the secondary facility is down, another contingency is pre-programmed for re-routing. Additionally, calls can be dynamically re-routed as necessary. These capabilities and contingency plans are typically audited on an annual basis.

Testimony made it very clear that the effectiveness of local responders is greatly enhanced by having local 9-1-1 calls received at local call centers. As it pertains to both current conditions and infrastructure, local call takers know their jurisdictions best. Similarly, local radio communication is much more likely to be effective if handled by a local user who is familiar with local procedures. Thus, doubt was cast on the notion that a 9-1-1 operator would ever want to transfer a 9-1-1 call from the Houston area to San Antonio, even during a major storm. In fact, hardened facilities exist within the jurisdictions of many coastal 9-1-1 groups, providing a safe, local facility to handle calls in the event of a large scale natural disaster. So while NEXT GEN 9-1-1 will provide enhanced ability to transfer calls, locals operators made it clear that existing systems have been very effective during recent natural disasters.

It is worth noting that certain weather issues associated with natural disasters affect the ability of a local 9-1-1 system to operate. First, not all of the coastal call centers are in hardened facilities that can withstand hurricane winds and large amounts of precipitation. Thus, if the integrity of a building's structure is compromised, call takers must evacuate and move to another facility. Similarly, call taking facilities are often on public power grids and are susceptible to power outages. While most facilities prepare in advance with generators, funding and maintenance of the generators are potential issues. Moreover, a fuel supply must be kept or procured to ensure generators can operate as long as necessary during times of disaster.

In sum, testimony to the subcommittee indicated that local 9-1-1 groups have already integrated some of the IP-based aspects of NEXT GEN 9-1-1. Furthermore, it was demonstrated that these groups do an extremely effective job of networking, sharing best practices and planning for the upcoming systemic changes to the existing systems. NEXT GEN 9-1-1 will ultimately bring greater capabilities to those choosing to call 9-1-1, including the ability to text for help and/or provide streaming video or photographs. Local authorities will also have the capability to transfer calls to different regions of the State with ease, if desired. While NEXT GEN 9-1-1 will provide a greater amount of flexibility to local operators, it is clear that there is a distinctive preference among local operators to keep 9-1-1 calls within their jurisdictions whenever possible. In viewing the success that operators have had with the existing legacy systems, it is likely that local operators will continue to successfully administer local calls as the industry transitions to NEXT GEN systems.

Emergency Alert Systems (EAS)

The Emergency Alert System is a national warning system that superseded the previously used Emergency Broadcast System. The necessity of such a system was prompted during the Cold War as a way to warn the nation of an event of war or national crisis. It has never been utilized on a nationwide basis. The EAS covers AM and FM radio and VHF, UHF and cable television, in addition to other radio and television platforms.

EAS is predominantly used at the local level to warn residents of school or road closures, hazardous weather conditions, and to issue warnings pertaining to localized dangers -- such as a fire or plant explosion. The most common use of the EAS is by the National Weather Service for hazard weather warnings. One of the distinct advantages of EAS is the ability to immediately communicate with a large audience in a specific geographic area.

As discussed above, the definitive advantage of communicating via the EAS is the ability to connect with a very large percentage of the population. As such, the EAS is not always a practical form of emergency communication for smaller, localized events. Additionally, the EAS is only effective if an individual is using a radio or television at the time of the communication. There are certain times, such as during an evacuation, where the typical citizen would be tuned in to radio or television, expecting emergency communication from authorities. However, many disasters happen on a moment's notice. As the EAS requires citizens to have a radio or television on, it cannot be considered a foolproof method of communicating with citizens.

The Emergency Alert System in Texas is administrated by the Texas Association of Broadcasters. As a part of Federal FCC regulations, local television and radio broadcasters are required to test their systems regularly to ensure functionality. As such, from a technical perspective, the public can rest assured that our systems are operable as necessary. However, testimony taken during our hearing revealed that emergency events have occurred in Texas and the EAS was not used when it probably should've been. It is important for local authorities to be cognizant of the Emergency Alert System and to activate it whenever necessary.

The decision to utilize the EAS is typically made at the local level by a county judge or mayor. It is worth stating that, with the evolution of a seemingly omnipresent news media and the ability to immediately disseminate information and images in real time, the media often directly reports on hazardous events immediately. Information that could potentially be conveyed in an EAS message is often disseminated via news reports. Thus, official usage of the EAS is potentially redundant if the same event is being covered by local media. That said, real time reporting does not always occur, such media markets do not exist in every part of Texas, and viewers/listeners are never guaranteed to be watching/listening to a station that would be providing such updates. In sum, although the use of EAS can be highly specific, it is an important tool for authorities in emergency communication and its usage must be properly understood and utilized.

Recommendations

1. The Subcommittee recommends that authorities continue to use all appropriate methods to communicate during times of disaster. Whether by Emergency Notification Systems (ENS), the Emergency Alert System (EAS), mainstream media or some other form of communication, the goal is to reach the widest audience possible. By ensuring that all avenues of communication are utilized, state and local authorities can ensure that emergency messages reach as many citizens as possible.

2. The Subcommittee recommends that state and local authorities closely monitor the piloting of the Commercial Mobile Alert System (CMAS) in San Diego County, California. The effectiveness of traditional ENS systems continues to erode as landlines are replaced by cellular phones and other mobile devices. The ability to isolate cell users in a specific geographic area and convey an emergency warning stands to be a huge step forward in the realm of emergency communication.

3. The Subcommittee recommends that local emergency communication groups implement plans to collect cellular telephone numbers of local residents to correspond with physical addresses. As ENS systems work off of landline-based geographic data, most homes without landlines cannot be reached via ENS communication. By encouraging local residents to register their cell phone numbers at specific physical addresses, the overall efficiency of existing ENS can be improved.

4. The Subcommittee recommends that any public group with the responsibility of emergency communication stay well advised on modern formats of communication and utilize all appropriate formats as necessary. The introduction of social media websites -- such as Facebook and Twitter -- and mobile devices have revolutionized normalized communication in our society. It's imperative that local and state authorities understand modern methods of communication and utilize them to warn citizens during times of emergency.

5. The Subcommittee recommends that the State of Texas continue to monitor and encourage improvements in the field of interoperability. Research indicates that great strides have been made over the last several years in terms of how first responders communicate with each other. However, questions still exist on whether first responders from different jurisdictions can effectively communicate, if necessary. Effective communication during times of disaster is quintessential to success. By continuing to progress in promoting issues of interoperability, we can ensure effective emergency communication between our first responders.

6. The Subcommittee recommends that 9-1-1 call centers located in areas subject to natural disaster be housed in hardened facilities. Research has indicated a definitive local preference for retaining the ability to take 9-1-1 calls in home jurisdictions during times of disaster. This ability is compromised when conditions force evacuation of facilities with 9-1-1 call centers.

7. The Subcommittee recommends thorough preparation efforts with regard to backup generators and fuel at 9-1-1 call centers. By procuring equipment and supplies in advance, local operators can ensure that 9-1-1 calls are received by the intended local jurisdiction during times of disaster.

8. The Subcommittee joins the Sunset Advisory Commission in recommending that the Commission on State Emergency Communications establish an advisory committee for the development, implementation and management of NEXT GEN 9-1-1 systems. The Subcommittee's research indicated that many local jurisdictions are well prepared for the implementation of NEXT GEN 9-1-1 systems. However, having a centralized authority to assist in the development and implementation of NEXT GEN 9-1-1 systems on a statewide basis will help to provide necessary coordination and assist in establishing best practices for all interested parties.

9. The Subcommittee recommends that local jurisdictions be required to conduct annual drills to ensure proper understanding of how the EAS functions and the proper time to utilize such systems. Local broadcasters are required by federal law to conduct regular testing to ensure their emergency alert systems are effective. Testimony revealed that, in certain cases, local authorities were either unaware of the existence of the EAS or did not know how to activate the EAS. As the systems are regularly tested for effectiveness, it seems prudent to require local authorities to establish a plan or protocol for using the EAS and to regularly test this plan to ensure effectiveness.

10. The Subcommittee recommends that locals issuing emergency communications be cognizant of relevant language issues in their area. Research has indicated that the EAS is utilized in both English and Spanish at least some of the time in certain areas of Texas. However, there are also portions of the State with a significant number of Spanish-only speakers -- or speakers of other languages -- that only issue alerts in English. This is simply an issue of informing the largest portion of the public as possible and ensuring effective, targeted messages to those who receive them.

11. The Subcommittee recommends that local television and radio stations be prioritized when power is re-connected after a natural disaster. Prioritization would be similar to that currently given to critical care facilities. However, stations would not be prioritized ahead of critical care facilities. As local stations provide vital information to citizens concerning recovery in the aftermath of a storm, they should be prioritized for electricity re-connection accordingly.

Interim Charge Three

Study and make recommendations relating to cost effective options to either retrofit or require new building structures to be built as shelters for use during future evacuations.

Background

The Senate Subcommittee on Flooding and Evacuations met in Austin, Texas on Monday, October 18, 2010, in the Capitol Extension Room E1.016 to hear testimony pertaining to the subcommittee's Interim Charge Three.

Interim Charge Three addresses the need for either constructing or retrofitting large public buildings in evacuation zones to house local populations during times of natural disaster. While retrofitting or building fortified new structures could potentially benefit different regions of Texas, the primary portion of the state that would stand to benefit from such construction is along the coast. Specifically, these structures would stand the forces of hurricane winds and the precipitation that would accompany such an event.

Research on this topic has revealed that the State of Texas has enjoyed success as a "coastal evacuation state." This conclusion is reached by measuring the mobility of the population and the transportation infrastructure in place. Recent evacuations in the State of Texas have revealed that coastal populations have evacuated in a successful fashion. Unfortunately, other Gulf states have not fared as well in recent evacuations and instead typically shelter in place as opposed to evacuating. This is illustrated in certain parts of Florida, where large percentages of the population are elderly and lack the mobility to evacuate. Similarly, other areas along the Gulf Coast do not have the transportation infrastructure in place to successfully evacuate.

However, coastal evacuation does not serve as the best answer for every region of the state and every member of the population. As an example, for three distinctive reasons, the population of the Lower Rio Grande Valley tends to evacuate at a lower rate when compared with the rest of the State. First, mobility issues affect the ability of the local population to evacuate. Concerns about existing transportation infrastructure and sufficient vehicular mobility serve to compound this issue. Secondly, the amount of necessary emergency vehicles is not in place to evacuate the amount of citizens in the Lower Rio Grande Valley that are considered to have medical special needs. Finally, due to immigration checkpoints along evacuation routes, certain portions of the population decline to evacuate based on fears of going through immigration checkpoints. With such concerns, entire families decline to evacuate based on concerns for one individual family member.

Issues limiting coastal evacuation are by no means limited to the Lower Rio Grande Valley. Evacuation is both difficult and costly for special needs populations throughout coastal Texas. Evacuating special needs populations can be very expensive, as the methods of transportation are highly specialized and limited in the number of service providers available. But more importantly, such evacuations can be complex and difficult when coordinating medical care, doctor's orders, and prescriptions. Additionally, evacuating patients with serious medical conditions ultimately serves to jeopardize their health.

Testimony at our hearing highlighted the notion that evacuations are a highly localized issue. Evacuation orders are issued by either locals mayors or county judges. Furthermore, an overwhelming majority of the buildings that are used to house evacuees are owned by local governmental entities. As such, while the Texas Division of Emergency Management plays a very centralized role in terms of supporting local jurisdictions, the actual anatomy of an evacuation is specifically local in nature.

Policymakers and elected officials alike seem to support the notion that additional public evacuation facilities need to be constructed in coastal evacuation zones. Furthermore, testimony indicated that by reducing the amount of medical special needs evacuations, an overall cost savings will be realized over time. From both a practical and financial perspective, there seems to be considerable support for additional construction of facilities that could be used as evacuation centers during future hurricanes or high-impact storm events.

With due consideration of this notion, policies must be considered to ensure that any such facilities that are constructed are done with proper, established standards for hurricane evacuation shelters. Standards for the construction of evacuation shelters to be used in coastal areas originated with policy recommendations by the American Red Cross. These standards were then utilized and extended by the State of Florida in their sweeping course of policy changes following the storm season of 2004 and 2005. FEMA standards then evolved with regard to the construction of evacuation shelters.

Structural requirements go well beyond structural design considerations. There are specific elevation requirements, relating to both storm surge and 500-year floodplain designations. Additionally, standards are established that address dangerous high speed winds, addressing concerns of roof uplift. Moreover, roofs, windows and walls must all be debris impact resistant to ensure that uplifted objects do not damage the structures. As well, emergency vehicles must be able to access buildings without traveling through a floodplain area. (*See additional materials on specific design requirements in the Appendix*)

In addition to the various design requirements, hurricane shelters in Florida undergo frequent inspections. Inspections are mandated prior to each season and following any significant high-impact weather event. Additionally, shelters must be re-certified every five years to ensure that all engineering and materials are compliant with current techniques and methods. Unfortunately, the integrity of a hurricane shelter containing 1,400 evacuees was compromised in Florida during Hurricane Charley. The building had yet to be evaluated for compliance with enhanced hurricane protection and design requirements, illustrating the necessity of a frequent inspection schedule.

Interim Charge Three also directs the subcommittee to examine the costs of building hurricane shelters, addressing both retrofitting existing shelters and constructing new shelters. General consensus seems to indicate that retrofitting existing structures is generally not a cost effective option. However, testimony indicated that buildings constructed after the late 1980's can be retrofitted at much more reasonable costs when compared to older buildings. The primary consideration in such a determination relates to a structure's ability to withstand high speed winds associated with a hurricane.

Costs of retrofitting tend to fluctuate greatly depending upon original construction. However, more uniform cost estimates can be established for new construction. Such an estimate depends specifically on which code or standard is used to determine the extent of mitigation measures used in construction. New construction that is built to standards established by Florida Building Codes would add 3-6% to the total cost of a new facility. Complying with FEMA/ICC-500 standards could add an additional 6-8% in cost.

It is worth noting that FEMA matching grants are available for many construction projects involving hurricane safe evacuation shelters. However, due consideration must be given to the specific standards that would apply when designing such a facility. Another applicable issue related to FEMA funding involves which governmental entity applies for the applicable grant(s). In Texas, potential shelters are often in the form of school gymnasiums or other multi-use facilities. Typically, the independent school districts who own these facilities do not have a hazard mitigation plan on file with FEMA and must partner with a local governmental body in order to receive such grants. This issue is not unique to coastal regions, but is also relevant for host jurisdictions where evacuees are ultimately sheltered. It is important for school districts to partner with local governmental entities when attempting to draw down federal funding to offset construction costs of hurricane shelters.

Recommendations

1. The Subcommittee recommends the construction of additional hardened facilities in coastal areas that can be used as evacuation shelters during times of natural disaster. While mobility and infrastructure allow for inland evacuations, evacuation is not the best option -- or even possible -- for every member of the population. Providing a safe local option for shelter ultimately serves to save money over time and reduce potential complications in evacuating certain members of the population.

2. The Subcommittee recommends local authorities refer to the relevant written testimony included in the appendix of this report, including structural standards established by FEMA, the State of Florida and the authors of the International Building Code. Relevant engineering standards must be followed to ensure structural integrity during times of heavy impact storms. Additionally, compliance with established standards is often mandatory when attempting to solicit federal financial assistance for construction costs.

3. The Subcommittee recommends the aforementioned inspection model established by the State of Florida relating to evacuation shelters. This would include inspections at the beginning of each storm season and after any high impact event. Given the importance of structural integrity at such facilities, it is imperative that local authorities frequently ensure that buildings are certified and inspected to meet all established standards.

4. The Subcommittee recommends continued cooperation between local school districts and local governmental entities in applying for FEMA grants. As school districts typically cannot apply directly for these grants (requirement of a local hazard mitigation plan), it is imperative that local entities foster cooperative relationships to ensure they are prepared for potential natural disasters. This cooperation is not just imperative in jurisdictions where populations are evacuated from, but also in host jurisdictions where evacuees are routed to.

5. The Subcommittee recommends that local authorities prudently evaluate retrofitting existing structures against building new structures with elevated design standards. Testimony taken during our hearings revealed that the costs of retrofitting can vary greatly, depending on the time and method of the original construction. While different engineering standards exist that ultimately affect projected cost, the general rule seems to be that new construction is more practical and predictable in terms of overall cost. This should be given due consideration when evaluating whether to retrofit or undertake new construction.

6. The Subcommittee recommends that local construction of hardened facilities be taken in the context of other necessary local construction. Although more expensive, hardened facilities can also serve as small gymnasiums and/or recreational centers. Evacuation shelters need not be viewed as limited use facilities that incur exclusive costs. Even when built to the most stringent standards, proper planning can ensure that such shelters function as multi-use facilities.

Interim Charge Four

Monitor the implementation of legislation addressed by the Senate Subcommittee on Flooding & Evacuations, 81st Legislature, Regular and Called Sessions, and make recommendations for any legislation needed to improve, enhance, and/or complete implementation.

Background

The Senate Subcommittee on Flooding and Evacuations met at The University of Houston in Houston, Texas on Tuesday, August 24, 2010, in the Melcher Room of the Alumni Athletic Building to hear testimony pertaining to the subcommittee's Interim Charge Four.

The Subcommittee heard specific testimony regarding SB 361, which was authored by Senator Patrick and was passed out of the subcommittee during the 81st Legislative Session. The bill was originally filed with the following description, "Relating to the requirement that certain water service providers ensure emergency operations during an extended power outage." Effectively, the bill called for certain water providers to acquire a backup electrical generator for use during times of disaster. In so doing, the provider ensures that water service will continue, even if residents are without power and coping with the effects of a natural disaster.

Testimony regarding the bill revealed that most of the affected entities have been able to comply with the legislation with little issue. Furthermore, very little sentiment against the requirements of the bill existed amongst the affected operators. Many utilities that had experienced problems during Hurricane Ike or other events were eager to comply and worked promptly to correct any issues. Additionally, there was little sentiment indicating that the requirements of SB 361 instituted a financial hardship on any district. In fact, testimony at the hearing indicated that, in many cases, compliance with SB 361 resulted in no cost increases to the customers of individual districts.

As passed, SB 361 was intended to target water providers in Harris and Fort Bend County. However, after passage of the bill, determination of affected areas eventually utilized the 2000 census. Using the 2000 Census data as the standard, a determination was made by the Texas Commission on Environmental Quality (TCEQ) that only districts providing water in Harris County were subject to the requirements of the bill. It is likely that affected counties will change with the release of the 2010 Census data.

Following passage of the bill, it was determined by the TCEQ that 695 utilities were affected. Each affected utility was required to submit a plan of compliance. The TCEQ has gone to great lengths to inform affected districts of impending changes, attending trade affairs, conferences and taking telephone calls regarding compliance. As of August 11, 2010, 549 plans had been received, 344 of which had been approved. Certain utilities have requested an extension and/or a financial waiver. At the time of our hearing, a total of 45 affected utilities had failed to respond. The next step in the process for the TCEQ will be enforcement. The non-compliant districts will be contacted and ultimately referred to the TCEQ's compliance department as necessary.

Recommendations

1. The Subcommittee supports the efforts of the Texas Commission on Environmental Quality in implementing SB 361 -- communicating with affected districts and ensuring compliance with the bill's requirements.

2. The Subcommittee encourages all non-compliant districts, as defined by the TCEQ, to come into compliance as soon as possible. Should districts fail to comply, the subcommittee supports the TCEQ's plan to refer such districts to their compliance division.

3. The Subcommittee recommends ongoing and continued monitoring of the implementation of SB 361. This will ensure efficiency and keep officials informed of any modifications or enhancements that are necessary.

Appendix

I. **Witness List -- August 24, 2010**
II. **Witness List -- October 18, 2010**
III. **Written Testimony: Dr. Gordon Wells**
IV. **Written Testimony: Dr. Sharon Wood**
V. **Written Testimony: Larry J. Tanner**
VI. **Written Testimony: Dennis Quan**

Witness List -- August 24, 2010

Bill Order / Bill Format

S/C on Flooding & Evacuations
August 24, 2010 - 10:00 AM

Charge 2 -- 9-1-1 & Emergency Notification Services

ON:
De La Cruz, Pete Director, 9-1-1 Emergency Network (Southeast Texas Regional Planning Cmsn.), Beaumont, TX
Heffernan, Stan Chief Technical Officer (Greater Harris County 9-1-1 Emergency Network), Houston, TX
Kidd, Nim Chief (Texas Division of Emergency Management), Austin, TX
Mallett, Paul Executive Director (Commission on State Emergency Communications), Austin, TX
Schwender, Lavergne Executive Director (Greater Harris County 9-1-1 Emergency Network), Houston, TX
Wilkins, Jack Operations Manager (Galveston County Emergency Communication District), Dickinson, TX

Charge 2 -- Emergency Alert System & Mass Communication

ON:
Arnold, Ann Executive Director (Texas Association of Broadcasters), Austin, TX
Kidd, Nim Chief (Texas Division of Emergency Management), Austin, TX

Charge 4 -- Overview of Bills Passed from 81st Session

ON:
Allen, Joe B. (Self; Allen Boone Humphries Robinson), Houston, TX
Brookins, Linda Director, Water Supply Division (Texas Commission on Environmental Quality), Austin, TX
Garibay, Chuck President (Association of Water Board Directors), Spring, TX

Public Testimony -- Charge 2

ON:
Downs, Ben (Self; Bryan Broadcasting), Bryan, TX
Ley, Susan Director of Sales (Tech Radium), Sugarland, TX
Miller, Jeff (Self; Advocacy Incorporated), Austin, TX

Witness List -- October 18, 2010

Bill Order / Bill Format

S/C on Flooding & Evacuations
October 18, 2010 - 2:00 PM

Interim Charge #1 -- Regionalized Drainage Planning

ON: Eckels, Robert Former Harris County Judge (Self)
Guerra, Aurelio County Judge (Willacy County), Raymondville, TX
Jones, Ken Executive Director (Lower Rio Grande Valley Development Council), McAllen, TX
Kidd, Nim Chief (Texas Division of Emergency Management), Austin, TX
Lambert, Sonia General Manager (Cameron County Drainage District #3), San Benito, TX
Oliver, David General Counsel (Allen Boone Humphries Robinson) (Fort Bend Flood Mgmt. Assoc.), Houston, TX
Ramirez, Rene County Judge (Hidalgo County), Edinburg, TX
Scott, Suzanne General Manager (San Antonio River Authority), San Antonio, TX
Sesin, Raul Planning Administrator (Hidalgo County), Edinburg, TX
Tamayo, Edna County Commissioner (Cameron County), Harlingen, TX
Wells, Gordon Dr. (UT-Austin, Center for Space Research), Austin, TX

Interim Charge #3 -- Evacuation & Hurricane Engineering

ON: Kidd, Nim Chief (Texas Division of Emergency Management), Austin, TX
Ramirez, Rene County Judge (Hidalgo County), Edinburg, TX
Tanner, Larry J. Research Engineer (Texas Tech Wind Science Engineering Ctr.), Lubbock, TX
Wood, Sharon Dr. (UT-Austin, Dept. Chair Architectural Engineering), Austin, TX

Public Testimony

ON: Hazen, Vincent Lone Star Logos & Signs (Self), Austin, TX

Public Testimony -- Charge #3

ON: Garcia, Claudia (La Union del Pueblo Entero), Mission, TX
Martinez, Francisco (U.F.W. La Union Pueblo), Mission, TX
Soto, Eva (A Resource In Serving Equality (ARISE)), Alamo, TX
Torres, John-Michael (La Union Pueblo Entero), Mission, TX

Written Testimony: Dr. Gordon Wells

TESTIMONY BY GORDON WELLS

Center for Space Research, The University of Texas at Austin

October 18, 2010

Mr. Chairman and members of the committee:

Thank you for inviting me to join your discussion today.

My name is Gordon Wells, and I manage the real-time satellite Earth observation program at the University of Texas at Austin's Center for Space Research. For several years, I have served as a member of the Governor's Emergency Management Council and as science advisor to the Texas Division of Emergency Management. When a disaster threatens Texas, my team and I work with other scientists, such as the forecasters and modelers at the National Hurricane Center and West Gulf River Forecast Center, with first responders in the field, such as Texas Task Force 1, and with the emergency managers and public officials who guide the State's response to changing events during a crisis. Our primary mission is to interpret the information from numerical forecast models generated by supercomputers that we and other groups create as an early warning of an impending disaster. We then determine the geographic extent and magnitude of the damages that have occurred from a disaster based on satellite and aerial observations and impact modeling.

My testimony deals primarily with the Lower Rio Grande Valley and the threat of catastrophic flooding to Starr, Hidalgo, Cameron and Willacy counties. I want to address three questions:

1) In what ways does flooding impact the Lower Rio Grande Valley?

2) How did the region's flood control infrastructure perform following Hurricane Alex?

3) What challenges arise from the shared responsibility with Mexico to protect our populations from regional floods?

First, the Lower Rio Grande Valley represents a special case for coastal flooding in Texas. The region is located in the center of a large, naturally subsiding fan of sediments comprising the Rio Grande Delta. The main river channel and parts of the distributary system that were active in the recent geological past occupy the high ground with subsiding basins lying in between. Most of the population lives in the naturally subsiding basins. Circumstances are often made worse by networks of canals and transportation corridors that cross the terrain. In the Lower Rio Grande Valley, canal structures can represent the highest topographic features on the landscape and, therefore, create divides and obstructions to natural drainage. Fifty years ago, a sheet flood covering this landscape would have impacted agricultural fields, but suburban development (with accompanying impervious cover) places many residences and high-value commercial properties at high risk. Expanding development also adds to the complexity of modeling the region's vulnerability to future floods.

Topographic conditions conspire to expose the region to three different kinds of flooding. An illustration (Exhibit 1) included in my written testimony shows the surfaces subject to inundation according to historical experience and recent numerical modeling. The Lower Rio Grande Valley can be impacted by coastal storm surge from hurricane landfall, local sheet flooding from torrential rainfall and river flooding from the main stem of the Rio Grande and from combinations of all three kinds of flooding. Hurricane Beulah in September 1967 created the most damaging example of the combined impacts.

The greatest flood risk arises from river flooding that triggers the diversion of Rio Grande floodwaters into the interior floodway system of the bi-national Lower Rio Grande Flood Control Project of control structures and earthen levees. River flooding in the aftermath of Hurricane Beulah reached 220,000 cubic feet per second (cfs) at Rio Grande City and completely overwhelmed the original Lower Rio Grande Flood Control Project destroying thousands of Valley residences from Mission to Harlingen. In the 1970s, the project was reconstructed and fortified to accommodate floods of the magnitude created by Hurricane Beulah. Over the past twenty years, potential design flaws detected by modeling studies and confirmation of the deterioration of earthen levees by the collection of extremely accurate elevation surveys using aerial laser terrain mapping techniques have demonstrated that components of the Lower Rio Grande Flood Control Project are functioning at levels well below their original design capacity.

Since 2006, the International Boundary and Water Commission has taken initial steps to identify and begin repairs on the sections of the levee system most in need of rehabilitation. This effort encompasses both the primary levee bounding the main river channel and the levees along the interior floodway in Hidalgo, Cameron and Willacy counties. A significant portion of the early costs of levee repairs was borne by local jurisdictions in the Valley to accelerate the levee improvements before the next large-scale flood event. As an addendum to my written testimony, I have included a time line for the development of flood control infrastructure in the region that provides further details.

You might ask how well the flood control system fared in the aftermath of Hurricane Alex which made landfall last June 29.

Hurricane Alex was a very large storm that produced the second lowest surface pressure for a June storm in the history of the Atlantic-Gulf Basin. Very little rain from Alex fell directly over the Lower Rio Grande Valley. Instead, the dissipation of Hurricane Alex produced three separate flood waves from exceptionally high rainfall over areas in northern Mexico and the Big Bend Region in Texas. Flooding occurred immediately to produce a massive flood wave along the Rio San Juan and its tributaries in Nuevo Leon and Tamaulipas. Upstream from Laredo to the Big Bend above Amistad Reservoir, a second flood wave originated. And in the interior of Coahuila along the Rio Salado and its tributaries, truly extraordinary rainfall events created a third flood wave that did not reach the main stem of the Rio Grande for over a week after Alex's landfall. The three flood waves converged on the Lower Rio Grande Valley.

The magnitude of the flood waves prompted the emergency release of floodwater from Mexican dams in Nuevo Leon, Tamaulipas and Coahuila and from the International Falcon Reservoir, which reached its highest pool elevation in history on July 17. For the first time since Hurricane

Gilbert in September 1988, floodwaters were diverted into the interior floodways of the Lower Rio Grande Flood Control Project beginning on July 8, a process that has continued even as recently as the past week. The discharge of the Rio Grande at Rio Grande City reached a maximum of approximately 102,000 cfs, less than one-half of the flow that occurred following Hurricane Beulah in 1967, but sufficient to test many segments of the interior floodway system. Fortunately, as a consequence of the efforts of the local jurisdictions to fund recent repairs made to the most vulnerable levee sections, serious flooding was averted. I have included an illustration (Exhibit 2) of one of the critical repairs made to the levee along the Main Floodway located north of the City of Hidalgo.

Some local flooding did impact areas near the primary river levee at Havana, La Joya and Penitas, but major breaches did not occur. The Rio Grande at Rio Grande City stood above major flood stage for 26 consecutive days (July 9 - August 3). So much water entered the Rio Grande floodplain that unusual backflow conditions developed. These conditions were unanticipated and little understood by local officials. For instance, at Rio Grande City, the initial river crest of nearly 58 feet occurred after floodwater from the Rio San Juan entered the dry Rio Grande floodplain. The river rose quickly to major flood level, but did not threaten structures. Several days later following the emergency releases from Falcon Dam, the floodwaters had completely inundated Rio Grande floodplain, and a nearly equivalent river stage of over 57 feet at Rio Grande City resulting from backflow conditions produced widespread flooding across the entire floodplain near the town. County and municipal officials were puzzled why the same river stage would result in such different impacts. This highlights a problem with the standard practice of issuing flood alerts based upon river stage forecasts of the type developed by the West Gulf River Forecast Center. Operationally, the use of river stages in flood forecasts complicates and sometimes obscures the information that local officials need to take appropriate actions. A better warning system would employ advanced hydrodynamic modeling to issue inundation forecasts that specify the geographic area that will be covered by floodwater, its depth and duration. I have included a graphic (Exhibit 3) that we produced during the event to provide guidance to the public officials in Starr County and Rio Grande City.

Another issue that is raised in discussions about the Lower Rio Grande Valley is whether "pass-through flooding" is a problem. "Pass-through flooding" in the classic sense of the construction of upstream structures that magnify the impacts of flooding downstream do not exist in the region. While local development practices, including the construction of canals, causeways, highway ramps, etc., may serve to obstruct flows there is no organized attempt to "pass" floodwaters downstream or downslope to unprotected neighboring areas. There are some prevalent opinions in the Valley concerning what occurred following Hurricane Beulah in 1967 that might lead one to believe that floodwaters were deliberately diverted at the expense of downstream communities, but a careful inspection of engineering reports indicates that only unintentional structural failures occurred, and that the most famous of these at the Mercedes diversion from the Main Floodway to the Arroyo Colorado likely reduced the total impact of flooding downstream.

I would like to conclude my testimony today by considering the challenges presented by our shared responsibility for regional flood control with the nation of Mexico.

Hurricane Alex offers a great example of the problems associated with bi-national management of water resources particularly with regard to the observation and reporting of regional flooding. The vast majority of water entering the Rio Grande originates from sources in the mountains and interior basins of Mexico. With few exceptions, these inflows are unobserved or "under-observed" until they reach the main stem of the Rio Grande.

Even in the case of the most important reports issued from the major Mexican dams in Nuevo Leon, Tamaulipas and Coahuila, many hours of delay can occur between the time a measurement is made in Mexico and the information is relayed through the International Boundary and Water Commission in El Paso to the modelers at the West Gulf River Forecast Center in Fort Worth. I have included an illustration (Exhibit 4) of such a time delay in data from dam releases that occurred during a critical phase of the flooding affecting the Rio San Juan on July 1-3. When information of this kind is missing, flood forecast models can yield results that do not have an upper limit. We cannot determine if Texas will be dealing with a flood of 100,000 cfs, 200,000 cfs or a greater deluge in the Lower Rio Grande Valley. It becomes impossible to issue guidance about the level of impending threat.

In an age of near-instantaneous communications with satellite phones available, we should never experience delays in the delivery of such important reports about dam releases in Mexico.

Moreover, basic hydrographic conditions within the major Mexican tributary basins are currently not quantified. Over a week after the landfall of Hurricane Alex, the lower reach of the Rio Salado became inundated after choke flow conditions resulted in the formation of a temporary "lake" with a surface area comparable to the size of Falcon Reservoir that flooded the city of Anahuac more than 50 miles upstream from the constriction. I have included satellite images (Exhibits 5 & 6) of the new lake on the Rio Salado. The existence of this hydraulic impoundment was completely unknown in Mexico or the United States before Hurricane Alex because Mexican data for topographic elevations and river channel geometry are so poor. In this instance, the unknown and never modeled conditions happened to work to our benefit by delaying the arrival of the flood wave entering Falcon Reservoir from the Rio Salado. We may not be so fortunate during future floods in the region, when our ignorance of hydrodynamic conditions in Mexico may cause us to make an inaccurate forecast of the threat to the Lower Rio Grande Valley.

In essence, we are not going to be able to anticipate and plan for the threats posed by future floods along the Rio Grande until we have a uniform baseline of topographic and hydrographic information from which to model the entire contributing basin.

In conclusion, I hope the committee would urge the exploration of better modeling and simulation techniques to identify the full range of flood threats that could possibly impact the region. Plans for flood control infrastructure need to be based on supercomputing methodologies that represent hundreds of different flooding scenarios. I would also ask that the committee encourage the near real-time transmission of critical information from observations occurring in Mexico, preferably from data gathered by a more widespread reporting network of stream gauges along the major Mexican tributaries.

ADDENDUM TO TESTIMONY BY GORDON WELLS (UT-AUSTIN)

CHRONOLOGY OF FLOOD CONTROL LEVEE CONSTRUCTION AND INTERIOR FLOODWAY DEVELOPMENT IN THE LOWER RIO GRANDE VALLEY

1922 A near-record flood along the Rio Grande breaches the local levee at Mission leading to widespread property loss.

1924 The first local bond is passed to fund construction of a flood control levee along the Rio Grande from Donna to Brownsville.

1932 Under an agreement negotiated through the International Boundary Commission, the United States and Mexico agree to pursue mutual flood control projects on the Lower Rio Grande that would contain a design storm flood of 187,000 cfs measured at Rio Grande City. The system that includes river levees constructed along the Rio Grande and the development of interior floodways in Texas and Mexico becomes known as the Lower Rio Grande Flood Control Project.

1933 Following serious river flooding after a hurricane, the federal government begins to fund projects leading to a comprehensive flood control system in the Lower Rio Grande Valley of Texas. A series of WPA and military projects improves levees from Rio Grande City to Brownsville.

1944 Under the Water Treaty governing the Utilization of Waters of the Colorado and Tijuana Rivers and the Rio Grande, the International Boundary and Water Commission assumes responsibility for the construction and coordination of flood control measures in the United States and Mexico.

1951 Work is completed on the Lower Rio Grande Flood Control Project as conceived in 1932. The Mission Inlet is designed to divert water from the Rio Grande into the Interior Floodway in Hidalgo County.

1953 Construction of the International Falcon Reservoir is completed, providing storage capacity for 3.1 million acre-feet of water and offering flood protection from storm events affecting the main stem of the Rio Grande and its major Mexican tributary, the Rio Salado.

1967 Catastrophic river flooding following Hurricane Beulah overwhelms the levees along the Mission Inlet of the Interior Floodway causing widespread damage in Hidalgo County. The control structure at Mercedes regulating the flow of floodwater between the North Floodway and Arroyo Colorado fails causing extensive damage in the Harlingen area of Cameron County. The river discharge at Rio Grande City reaches 220,000 cfs exceeding the engineering design of the 1932-51 Lower Rio Grande Flood Control Project.

1969 Construction of the International Amistad Reservoir is completed, providing storage capacity for 5 million acre-feet of water and offering additional flood protection for events along the main stem of the Rio Grande and its major Mexican tributary, the Rio Conchos.

1970 The United States and Mexico agree to improve the infrastructure of Lower Rio Grande Flood Control Project to accommodate a design storm flood of 250,000 cfs measured at Rio Grande City. The IBWC supervises the design and construction of the Retamal Dam diversion in Tamaulipas and the Anzalduas Dam diversion in Hidalgo County. The Mission Inlet is abandoned. Construction occurs along the Main Floodway and North Floodway in Hidalgo and Cameron counties.

1988 Following the landfall of Hurricane Gilbert, floodwaters from the Rio San Juan cause the Rio Grande discharge at Rio Grande City to rise to 51,000 cfs. The Interior Floodway system is used for the first time since Hurricane Beulah. No failures occur in the system.

1992 The first modern hydraulic modeling study conducted by the U.S. Army Corps of Engineers concludes that the Lower Rio Grande Flood Control Project fails to meet its design criteria, and that levees are inadequate over 35 miles of the 274 total miles of levees in the system.

2004 A comprehensive hydraulic modeling study by the U.S. Army Corps of Engineers concludes that the Lower Rio Grande Flood Control Project would be overtopped along 38 miles of levees primarily upstream from Anzalduas along the Rio Grande and two miles of levee along the U.S. Interior Floodway. LiDAR elevation survey data collected by the University of Texas indicates additional areas where levee crests fail to meet their design height.

2006 The International Boundary and Water Commission releases the Rio Grande Flood Control System Rehabilitation Plan that identifies $125 million in levee construction projects in the Lower Rio Grande Valley. The report uses data from LiDAR elevation surveys to designate the sections most in need of repair.

2009 Congress appropriates $224 million to repair levees in the Lower Rio Grande Flood Control Project and build additional flood control infrastructure.

2010 Floodwaters from the dissipation of Hurricane Alex cause the Rio Grande discharge to rise to 102,000 cfs at Rio Grande City. Floodwater is diverted into the Interior Floodway system for the first time since Hurricane Gilbert.

Summary

The large-scale flood control system in the Lower Rio Grande Valley has developed in three phases: **1)** The 1932-51 design and construction of the original Lower Rio Grande Flood Control Project believed to be capable of containing a flood of 187,000 cfs measured at Rio Grande City. This system failed catastrophically in the aftermath of Hurricane Beulah in 1967. **2)** The redesign and construction of new flood control infrastructure beginning in 1970 to accommodate a flood of 250,000 cfs. The new system diverted floodwater to the Interior Floodway in 1988 following Hurricane Gilbert, when river discharge at Rio Grande City reached approximately one-fifth of the new design criteria. **3)** The identification of design flaws and physical limitations of the modern flood control system using hydraulic modeling techniques beginning in 1992 and aerial LiDAR elevation surveys in 2004. Further modeling has identified the levee sections most in need of rehabilitation.

During the development of the flood control system, metropolitan populations in the Lower Rio Grande Valley have increased by factors of 6-10 (1930 population: Brownsville 22,021; McAllen 9,074; 2000 population: Brownsville 139,722; McAllen 106,414). The flood control system originally protecting farmland now must protect large suburban populations.

Written Testimony: Dr. Sharon Wood

Texas Senate Subcommittee on Flooding and Evacuations
18 October 2010

Testimony Regarding Design and Retrofit of Commercial/Public Structures for Hurricane Evacuation Shelters

Sharon L. Wood, P.E.

Mr. Chairman and Committee Members, thank you for inviting me to speak to you today. Recent hurricanes along the Gulf Coast have highlighted the need and importance of hurricane evacuation shelters. Several national standards have been adopted over the past ten years that govern to the design of hurricane evacuation shelters. I would like to discuss these design standards briefly today and provide an indication of the costs of designing or retrofitting commercial and public structures to meet these standards.

The American Red Cross was among the first organizations to develop guidelines for selecting hurricane evacuation shelters [1]. These guidelines address acceptable locations for shelters, structural design criteria, risks due to hazardous materials, and space recommendations for each shelter resident. These guidelines alone are not sufficient to design or retrofit a hurricane shelter, but they summarize the lessons learned during Hurricane Andrew in Florida in 1992. For example, many large public or commercial buildings in the immediate hurricane impact area are not viable emergency shelters because they are located within the storm surge inundation zone for a Category 4 hurricane, located within the 100-yr floodplain, located on a barrier island, constructed before modern structural design codes were adopted in the community, or constructed from unreinforced masonry or other structural material that is susceptible to wind damage during extreme storms.

Shortly after Hurricane Andrew, the State of Florida began a program to increase the number of hurricane evacuation shelters throughout the state [2]. In addition to adopting higher design wind speeds than the national standards [3] in several high-risk areas, the 2007 Florida Building Code [4] includes provisions that portions of new public school buildings must be designed as enhanced hurricane protection areas. These enhanced hurricane protection areas provide at least 20 ft^2 for each evacuee and are designed to provide emergency shelter and protection for up to 8 hours. Specific design requirements for enhanced hurricane protection areas include:

- The minimum floor elevation must be above the maximum storm surge inundation elevation associated with a Category 4 hurricane.
- Wind design loads are 15% higher than those for buildings with regular occupancy. (The enhanced hurricane protection areas must be designed as essential facilities in accordance with national design standards [3].)
- All door, window, and roof openings must be designed for impact caused by wind-borne debris.
- All roof systems must be rain resistant and anchored against wind uplift.
- Emergency overflow scuppers on the roof must be sized for 6 hours of rainfall associated with the design hurricane.

- At least one emergency vehicle access route must be above the 100-yr floodplain.
- Parking for evacuees must be at least 50 ft from the building to reduce the risk of rollover hazards.
- Landscaping around the building must not represent a laydown or impact hazard for the building envelope.
- A standby emergency electrical power system must be provided.

In addition to the design guidelines, special inspection of the enhanced hurricane protection areas is also required:

- Inspection of the building and emergency electrical systems is required during construction.
- All shutter systems, roofs, overflow scuppers, structural systems, and emergency power systems must be inspected before the hurricane season begins each year and after each major hurricane.
- All structural systems must be inspected and recertified for compliance every five years by a professional engineer.

The Florida Division of Emergency Management develops an annual report to document their progress toward increasing the number of hurricane evacuation shelters. The 2007 report [5] notes that buildings designed and constructed before the mid-1980s rarely meet the structural criteria in the American Red Cross guidelines [1] and typically require major structural renovations to serve as hurricane evacuation shelters. In most cases, renovation of these older buildings was not considered to be cost-effective.

Using the Florida Building Code, buildings constructed in accordance with the modern, national standards for wind loads [3] (buildings constructed since the late 1980s) can often be retrofit by installing window protection or reinforced doors [6] to address shelter requirements for debris impact. The average cost of retrofitting buildings in this category was approximately $150 per evacuee space (in 2007 dollars) [5]. The cost of complying with the Florida Building Code provisions for enhanced hurricane protection areas for new construction was estimated as increasing the cost of constructing a new school building by 3 to 6% [5].

In spite of the design standards for enhanced hurricane protection areas, significant structural damage (Figure 1) was observed at a modern, hurricane evacuation center in Arcadia, Florida during Hurricane Charley in 2004 [7, 8]. Approximately 1,400 evacuees were housed in the building at the time of that the roof and exterior walls began to collapse. After the hurricane, it was determined that the building had not yet been evaluated for compliance with the enhanced hurricane protection areas design requirements [7], raising the possibility that this shelter had not been designed in accordance with the Florida provisions. Wind damage to roofs, cladding, and gutters led to rainwater intrusion was observed in several other shelters, however [7, 9].

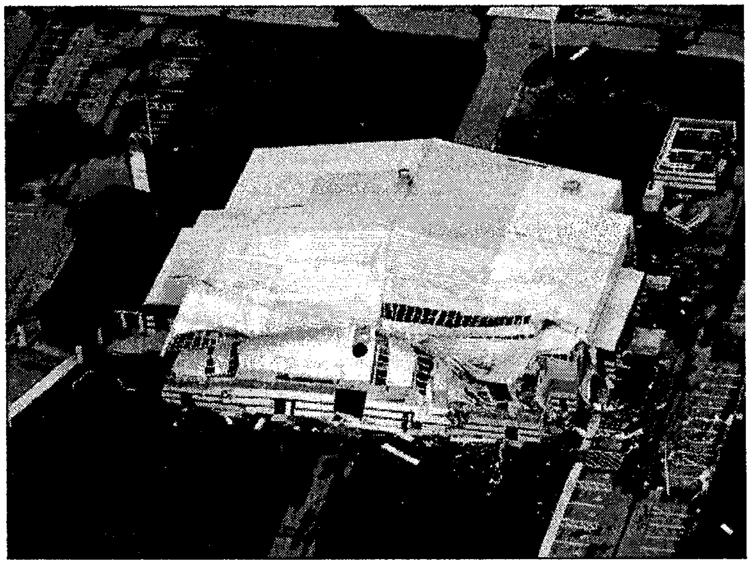

Figure 1: Turner Agri-Civic Center Damage Caused by Hurricane Charley [7]

More recently, two national standards have been developed that specifically address the design of hurricane and tornado shelters. The ICC 500 [10] provisions for community hurricane shelters are more stringent than the Florida Building Code [4] provisions for enhanced hurricane protection areas. For example, the design wind speeds are higher, design loads corresponding to debris missiles are considerably higher, and the minimum floor elevation must be above both the 500-yr floodplain and the maximum storm surge inundation elevation associated with a Category 5 hurricane.

The FEMA 361 provisions [11] for safe rooms are even more conservative than those in ICC 500 and are intended to provide "near-absolute protection" to the occupants. Because most residents are able to evacuate the immediate impact area before a hurricane, the FEMA 361 provisions are intended only for first responders and individuals who are physically unable to leave the immediate impact area [11].

The recent development of ICC 500 [10] and FEMA 361 [11] provides specific guidance regarding the design and construction of hurricane shelters and safe rooms. The 2009 edition of the International Building Code [12] adopts ICC 500 by reference. Therefore, these provisions will govern the design of hurricane shelters once communities in Texas adopt the 2009 IBC.

FEMA 361 [11] provides cost data from recent community safe room projects. Assuming a basic wind speed from the model building code of 140 mph, the incremental cost of hardening a portion of a new building to create a safe room with a 250-mph design wind speed is estimated to be 5 to 7% [11], based on the area of the safe room. The basic wind speed along the Texas Gulf Coast ranges from 130 to 140 mph [3]; therefore, these costs are considered to be representative of new construction in Texas, and are similar to the reported costs in Florida [5].

It is important to note, however, that observed damage during hurricanes is often attributed to minor changes from the original design [13]. Therefore, it is important that if Texas adopts a policy of constructing hurricane evacuation shelters, the requirements for periodic inspection of be adopted as well.

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Written Testimony: Larry J. Tanner

Testimony to the

<u>State of Texas</u>

Texas Senate Subcommittee on Flooding and Evacuations

At the

Capitol Building,
Austin, Texas
October 18, 2010

Testimony Regarding

Mitigating Damage to Residential Structures from Hurricanes & Coastal Windstorms

Testimony of

Larry J. Tanner, P.E.
Wind Science and Engineering Research Center
Texas Tech University
Lubbock, Texas

Texas Senate Subcommittee on Flooding and Evacuations

Testimony Regarding

Mitigating Damage to Residential Structures from Hurricanes & Coastal Windstorms

by Larry J. Tanner, P.E.

Introduction

Thank you Mr. Chairman and committee members.

My name is Larry Tanner. I am an engineering researcher with the Wind Science and Engineering Research Center at Texas Tech University. I have documented 12 storms, tornadoes and hurricanes, in the last ten years, including the devastating Oklahoma/Kansas Outbreak of 1999, Hurricane Katrina in 2005, and Hurricane Ike in 2008. I was also a member of the FEMA Mitigation Assessment Teams for those storms. My CV is appended to this testimony.

Subcommittee Charge:

1. **Methods of mitigating hurricane damage to existing residential structures.**
2. **Methods of mitigating hurricane damage to new residential structures.**
3. **Comparable costs of these methods.**
4. **Recommendations relating to cost effective options to either retrofit or require new building structures to be built as shelters for use during evacuations.**

Background

According to the U.S. Census Bureau, as of July 1, 2007, 35.3 million people lived in areas of the United States most threatened by Hurricanes.[1] These areas are defined as the coastal portions of Texas through North Carolina and represent approximately 12% of the U.S. population.[2] Disaster losses paint a compelling picture of our economic and societal vulnerability to windstorms. From 1987 to 2006 the inflation-adjusted, insured losses break down as follows:[3]

- $297.3 billion - Total Disaster Losses
- $137.7 billion (46.3%) Tropical Cyclone Losses
- $77.3 billion (26%) Tornadoes
- $19.1 billion (6.4%) Earthquakes

Vulnerability will continue to increase due to a variety of economic and other factors, including the aging of our built environment, the percentage of the built environment constructed without use of model building codes, the increased cost of new construction, and the increase in coastal population.

Hurricane Hazards

The hazards of hurricanes and coastal storms include the following:

- Erosion of barrier sand dunes and foundation structures
- Coastal flooding, wave action, and storm surges
- High winds

Homes in Velocity Zones (National Flood Insurance Program - NFIP V Zones and Coastal A Zones) are vulnerable to wave action and storm surges if not elevated to or above the Base Flood Elevation (BFE) and properly constructed on an open and elevated foundation (piles), see **Figure 1**. The loss or alteration of the dune structures and vegetation can lead to erosion produced by wave and surge forces that can scour foundation piles and undermine the structure's stability. Although not subjected to wave and velocity surges, inland area homes in NFIP mapped Special Flood Hazard Areas (SFHA) should have appropriate foundation structures and their first floor elevated to or above the NFIP or jurisdictional Base Flood Elevation (BFE), shown in **Figure 2**.

Tropical storms and hurricanes produce winds far in excess of normal winds in inland and interior land areas. The wind forces will produce inward pressures on the windward face, outward pressures on the sides and leeward face, and depending upon the roof slope, outward pressures on the roof surfaces, see **Figures 1&2**. .

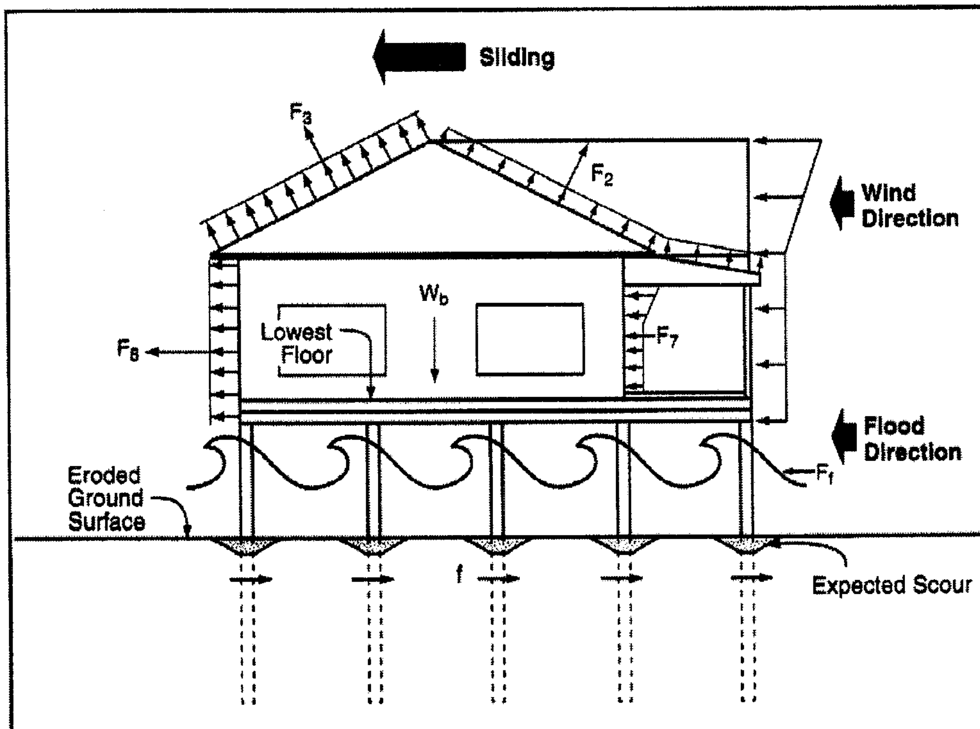

Figure 1

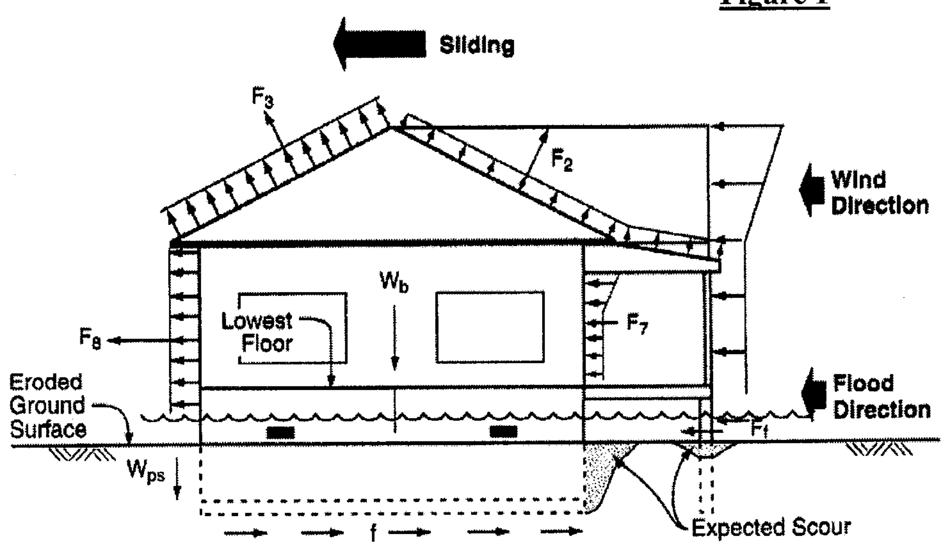

Figure 2

Figures 1 & 2. Wind and water forces on coastal construction[4]

Construction Guidelines

Numerous surveys have been conducted over the years to determine the primary causes of building failures in hurricanes. Differences in building performance are routinely observed in adjacent structures. Initially, these differences were assumed to be the result of some anomaly in wind forces and water loads. However, post storm inspections and documentation routinely reveal this disparity to be the result of design and construction differences. In general, those homes that are better connected from roof top to foundation (load path) are more resistant to hurricane forces. **Figure 3** illustrates the concept of Load Path.

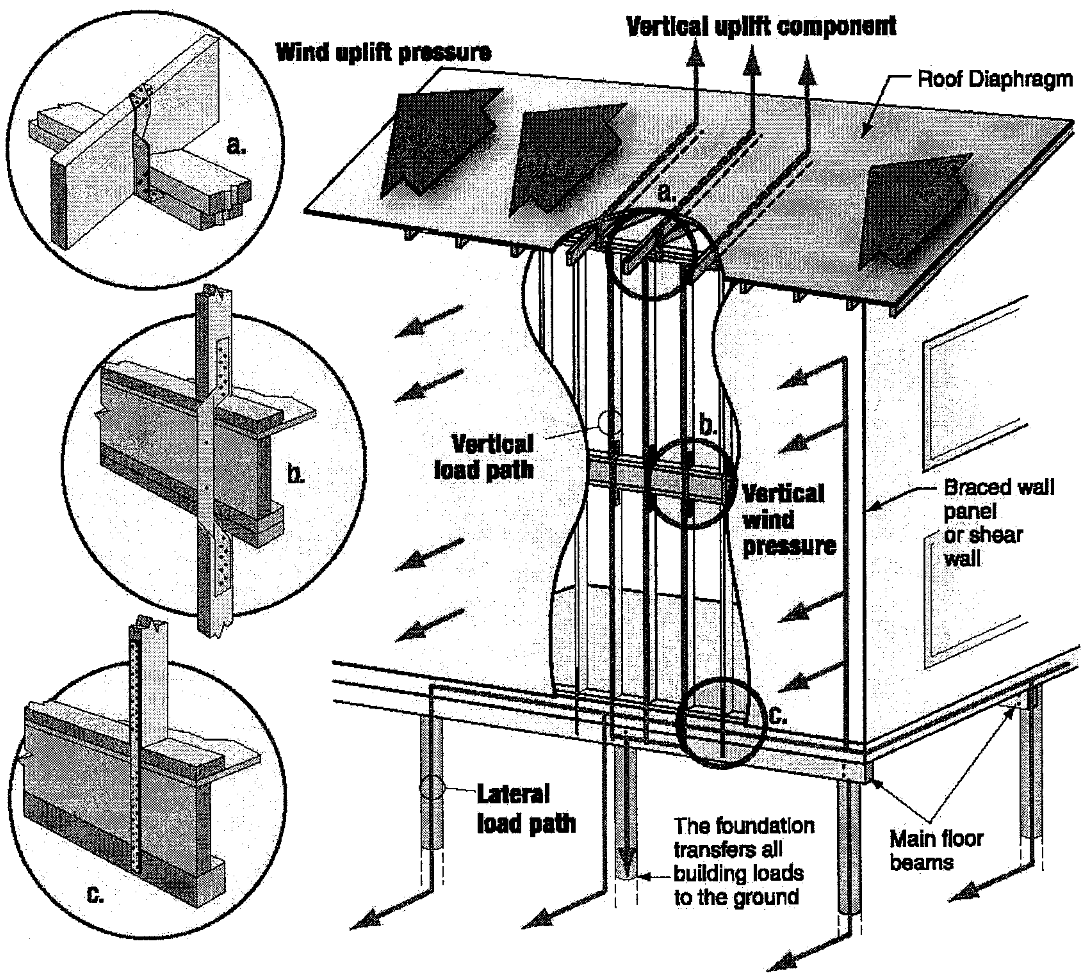

Figure 3. Building Load Path[5]

Building codes are written to provide a minimum design and construction standards, to diminish this divergence in building performance. Prominent building codes, standards and guidelines relevant to hurricane resistant construction include:

- *2006 International Building Code* [6]
- *2006 International Residential Code* [7]
- *Minimum Design Loads for Buildings and Other Structures,* ASCE 7-05[8]
- *Flood Resistant Design and Construction,* ASCE 24-05[9]
- *Standard for Hurricane Resistant Residential Construction,* SBCCI SSTD 10-99[10]
- *Guidelines for Hurricane Resistant Residential Construction,* IBHS[11]
- *Coastal Construction Manual,* FEMA 55[4]
- *Florida Building Code*[12]
- The Texas Department of Insurance – Windstorm Program[13]

<u>Retrofitting Existing Homes to Diminish Hurricane Damage</u>

Hurricane Katrina, Hurrican Rita, and Hurricane Ike produced surge and flooding that exceeded the mapped the National Flood Insurance Program (NFIP) Base Flood Elevations (BFE). Thus, many homes were destroyed or severely damaged by these storms, including: 1) older homes constructed at or near grade; 2) homes constructed to the BFE; and 3) homes constructed outside the Special Flood Hazard Area (SFHA, shown on the Flood Insurance Rate MapsI and without regard to flood resistance. Short of moving or raising homes, very little can be done to improve the flood resistance of homes that are built at/or below the BFE, or just outside the SFHA.

Many recent hurricanes have resulted in significant amouts of wind damage to homes, despite having wind speeds below the Design Code speeds. Typical hurricane wind damage includes roof and siding damage, and wind propelled debris damage to doors and windows. Improper use of non-hurricane wind-zone materials, or the poor installation of rated materials, account for most of the observed wind damage. Unless a home has been gutted by a storm, the installation of "wind clips" and similar hidden metal connectors is virtually unreasonable:

Flood

1. For an elevated home with non-breakaway walls, install one 8"x16" flood vents per every 150 sf of enclosed space.
2. For an elevated home, remove and replace all visible corroded metal connectors and bolts.
3. Provide additional elevation of a home elevated at/or below the current BFEs. The lowest floor elevation should be equal to the Effective (i.e., shown on the currently adopted NIFP Map) BFE + 3-feet (Freeboard), see **Figure 6.** Homes in all flood hazard zones would qualify for a flood insurance premium reduction; however, unlike the case of new construction where freeboard costs are recovered quickly, the time to recover elevation costs through flood premium savings for existing homes (payback time) can be many years.

Wind

1. Improve and/or replace observable connections of elevated structures, overhangs, and porches.
2. Where gable ends are accessible from attics, provide wind bracing to prevent hinging of the gable end.
3. When re-roofing, the existing decking should be re-nailed to ensure a positive connection.
4. When re-roofing, the installed asphalt shingles should comply with ASTM D 7158, with Class G (120 mph) installed in Inland Zone I & II, and Class H (130 mph) installed in the Seaward Zone.

Hurricane Mitigation in New Residential Construction

New construction affords the builder/developer/owner to site, elevate, connect, and clad the home to be less affected by the hurricane forces of water, waves, and wind. Building location is a sustainable issue requiring extensive studies by affected communities and counties, as well as the State. Guidance on this issue is provided in the FEMA Mitigation Assessment Team Report, *Hurricane Ike in Texas and Louisiana, FEMA 757*.[14]. Resistance to water and erosion is a function of foundation depth and type (**Figure 4**), whereas wave resistance is a function of elevation (**Figure 5**). Resistance to hurricane wind forces is a function of good connections (**Load Path, Figure 3**), proper installation of hurricane rated roofing and cladding systems, and the protection of building openings with shutters or impact resistant glazing, see **Figures 4 & 5**.

Figure 4. Erosion along the Galveston Island shoreline, west of the seawall (Oct. 17, 2008, photo C.P. Jones)

Figure 5. Bolivar Peninsula house on left sustained minor flood damage (to access stairs and below-BFE enclosures) during Ike, while the house on the right was severely damaged. The house on the left was constructed 5.5 ft above the BFE, the house on the right was estimated to be at the BFE (Oct. 18, 2008, photo C.P. Jones).

Flood

1. The only protection from waves and water is through sufficiently elevating the structure on a strong foundation. Many homes built to the current BFEs were damaged or destroyed by Ike. Until new Digital Flood Insurance Rate Maps (DFIRMs) are developed and adopted, a Freeboard of three feet should be added to the current Effective BFEs as shown in **Figure 6.** Though each foot of freeboard will cost more than the at-BFE construction cost, flood insurance premiums will be reduced. A V-Zone home should have a 1-3 year payback and an A-Zone home should have a payback period of approximately 6 years. [14]

2. Elevated homes frequently have parking slabs constructed below the home. Reinforced and stiffened concrete parking slabs should not be allowed under and around the residential structures, since they can become eroded and can transfer extreme wave and water loads onto the structure's foundation system. Parking slabs should be un-reinforced frangible slabs that will break-up under the water forces. Frangible slabs cost less than reinforced slabs.

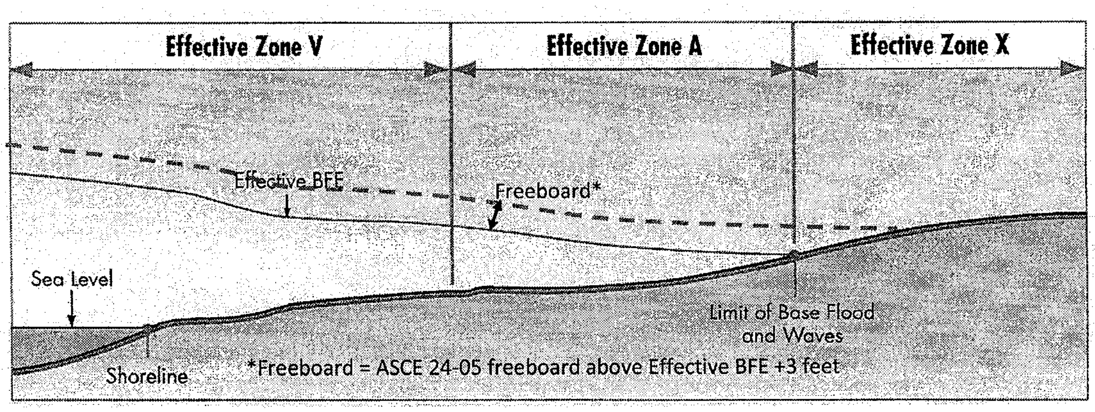

Figure 6. Comparison of Effective BFEs, flood hazard zones, and recommended Freeboard.

3. Below-BFE walls constructed of lattice or louvers are preferred over solid breakaway walls and will reduce flood insurance premiums by a couple of thousand dollars per year in V Zones.
4. Breakaway walls get taller as homes are elevated higher. Though breakaway walls normally perform as intended, they become large floating debris that produce damage to nearby structures. The installation of flood vents in solid breakaway walls can alleviate unbalanced water pressures, thereby delaying the damage and loss of breakaway walls, which are not covered by the standard flood insurance policy (repair or replacements costs must be borne by the owner)..
5. Tall breakaway wall sizes can be reduced by constructing breakaway joints at mid-height. This type of installation will reduce the size of floating debris and will reduce repair or replacement costs, should the upper section survive the storm.

Wind

1. Roof structures and roofing elements are particularly vulnerable to hurricane winds. Roof gable and shed roof ends must be braced to resist wind forces as recommended in the cited publications. Hip-style roofs are more wind resistant and normally perform better than other styles in hurricanes.
2. Asphalt roof shingles are the predominant roofing material found in coastal areas. The Texas Department of Insurance (TDI) currently allows Class F shingles, rated to 110 mph by the old ASTM D 3161 Standard, to be installed in all three Designated Catastrophe Areas (**Figure 7**). The Seaward Zone and the Inland I Zone are respectively 130 mph and 120 mph wind zones.

Products meeting the newer ASTM D 7158 Standard are available that meet the wind zone requirements. The Class F shingle should only be allowed in the Inland II, 110 mph Zone. The D 7158 shingle, though more expensive than the D 3161, Class F shingle, it is tested to meet the higher wind speeds in the Seaward Zone (Class H shingle) and in the Inland I Zone (Class G shingle).

3. Building felts are nailed to the roof decking to form a secondary moisture barrier below the shingles. Storm damage observations reveal that the building felts are routinely blown off the decking, along with the shingles. Taping of the joints formed by the overlapping felts had disappointing results in Hurricane Ike. It is therefore recommended that the secondary moisture barrier consist of either mopped felts or a self-adhesive membrane. Damage to home contents from water intrusion represents a large percentage of insurance claims.

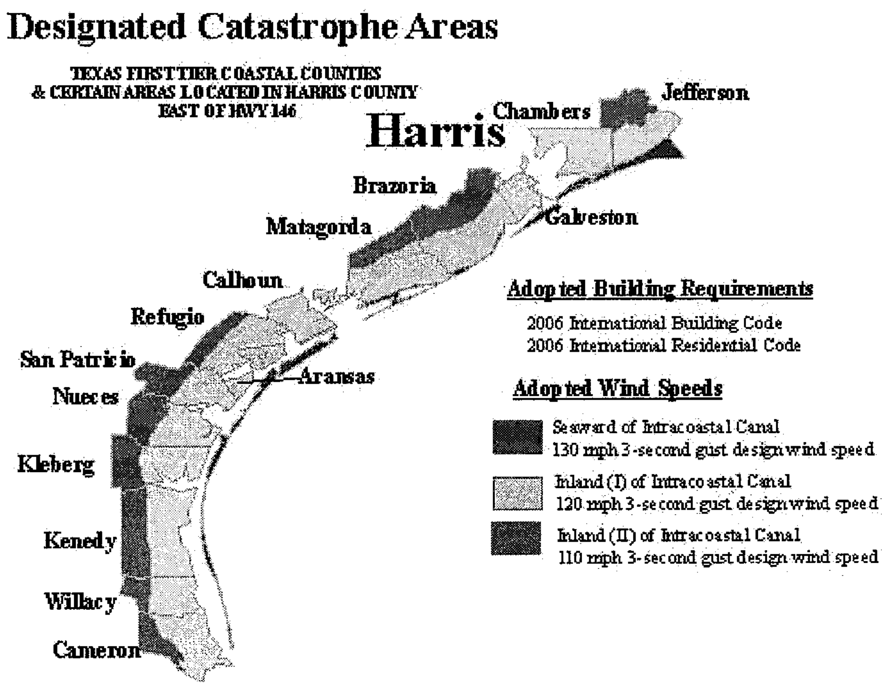

Figure 7. Texas Windstorm Designated Catastrophe Areas

4. Wall cladding materials are vulnerable to hurricane winds, and have been observed to fail when subject to less the "Code Design" winds. Cladding failure is normally associated with installation of "Non-High Wind Zone" products or with installation methods not consistent with manufacturer recommendations for high wind zones. This is a code compliance issue and not a cost issue.
5. Protection of openings is required by TDI in the Seaward and Inland I Zones. The opening protection of choice by most homeowners is plywood. Though

effective, it is difficult and dangerous to install over high windows and is frequently omitted on the non-seaward side of the dwelling. Plywood or shutters should be installed over all openings to protect the home from damage by wind pressures and rain. Though expensive, permanently mounted shutters could be installed over inaccessible or difficult to access openings. Costs for permanent shutters vary by quantity, size, and shutter selected. A less expensive alternative to shuttering inaccessible windows is to install windows with hurricane impact resistant glazing.

Summary of Mitigation Costs

NC	No Cost	MC	Moderate Cost
LC	Low Cost	HC	High Cost

Retrofitting Existing Homes		
1	Install flood vents in non-breakaway walls	LC
2	Install flood vents in solid breakaway walls	LC
3	Improve and replace observable metal connectors and connections	LC
4	Provide additional elevation to home (BFE + 3-ft. Freeboard)	HC**
5	Provide gable end bracing	MC
6	When re-roofing, re-nail decking	LC
7	When re-roofing, tape felt underlayment joints	LC
8	When re-roofing, additional cost for Class G shingles (120 mph)	MC*
9	When re-roofing, additional cost for Class H shingles (130 mph)	MC*
New Home Construction		
1	Elevate homes to BFE + 3-ft. Freeboard*	MC**
2	Install frangible parking slabs instead of reinforced concrete slabs	NC
3	Install flood vents in solid breakaway walls	LC
4	Construct tall breakaway wall in two horizontal breakaway sections	LC
5	Up charge to install Class G shingles (120 mph) over Class F (110 mph)	MC*
6	Up charge to install Class H shingles (130 mph) over Class F (110 mph)	MC*
7	Up charge to install substantial secondary roofing moisture barrier	MC*
8	Install hurricane windows in inaccessible locations	MC*

*Cost as compared to traditional construction or as indicated.
**Anticipated flood insurance premium reduction.

Hurricane Evacuation Shelters[15]

"The Texas coastal area population has grown more rapidly than the capacity of transportation facilities, resulting in congestion or even entrapment, thus creating hazards greater than the one prompting the evacuation. Evacuations are expensive for individuals and communities. Business interruptions are among the greatest of evacuation costs. Many options are available in safe rooms and in building design to improve safety and to reduce economic loss from extreme winds."[15]

The design of "Safer Areas of Refuge" and hardened safe rooms is contingent upon the perils anticipated. Tornadoes represent perils of extreme wind speeds, rain, and hail. Though hurricanes frequently spawn lower speed tornadoes, the greatest perils include high wind speeds, torrential rains, and flooding. Examples of building envelope hurricane resistance standards include those of TDI, Florida, and South Carolina. These standards address protection of building contents from extreme water intrusion, but do not address life safety. In 1997 the State of Florida enacted legislation requiring state university, college, and public school facilities be upgraded to serve as "Enhanced Protection Areas" for hurricane evacuees. The designated locations were selected based upon their perceived envelope resistance. The enhanced areas have generally performed well during recent hurricanes; however a few experienced problems that resulted in relocation of evacuees to other locations.

In 2000, FEMA published the first edition of *FEMA 361, Design and Construction Guidance for the Design of Community Safe Rooms.*[16] In 2008, the *ICC-500 Standard for the Design and Construction of Storm Shelters* was adopted for the *2009 International Building Code* to provide guidance for the construction of tornado and hurricane residential and community safe rooms.[17] Under this standard, community safe rooms were further identified as tornado, tornado/hurricane, or hurricane, and were based upon the differing wind speed and impact criteria. The FEMA 361 publication was updated in 2008 to specifically include hurricane safe rooms and identify parallels and comparisons between it and the ICC-500 Standard.[18] Both standards utilize the same wind speed criteria, but somewhat differ in impact criteria, with the FEMA 361 missile speed being slightly higher. Both standards provide sufficient hardening against wind forces and debris impacts specifically related to the intended peril to provide life safety protection.

Currently the State of Texas has a Hazard Mitigation Program funded by FEMA to provide grant assistance for safe room construction, most of which have been residential.[19] It is recommended that the State encourage the construction of FEMA/ICC-500 Hurricane Safe Rooms in the coastal areas when new schools and community structures are being planned. The incorporation of safe rooms in a host building, such as a school, represents approximately 6%-8% up-charge over traditional construction, whereas stand-alone community safe rooms can cost as much as $200-$300 per square foot. Although more costly to construct, stand-alone community safe rooms are frequently multi-use spaces, small gyms, community centers, etc.

Summary

Low cost to moderate cost measures can be implemented to improve existing home performance subjected to hurricane winds. However, little can be done to protect the home from water and waves if the home is built too low. For new construction, reasonable hurricane resistant construction codes, standards and guidelines currently exist and have proven to be effective. Constructing new homes to elevations that include freeboard, represent a modest increase over current coastal construction costs and provides the homeowner the benefit of a lower flood insurance premium.

It should be understood that codes and standards represent design/construction minimums and too often these minimums are compromised by poor construction practices and a lack of code enforcement. In essence, hurricane resistance is a function of better educated designers and constructors; and improved inspection. It should be also noted that new homes constructed outside of code enforcing jurisdictions are seldom inspected.

With the population growth of the Texas coastal areas, wholesale evacuation will soon not be an option. The lower Rio Grande Valley region is especially vulnerable to loss of life from hurricanes because large numbers of people are unable to evacuate due to personal limitations. The transportation infrastructure in this area is also inadequate to support such a massive evacuation. The State of Florida has already identified "Non-Evacuation Zones" outside of flood prone areas. Minimally and similarly to Florida, Texas should identify "Enhanced Protection Areas" to house those that must evacuate. However, given the life safety concerns for housing masses of people in non-hardened protection areas, it is recommended that the State encourage and support the construction of hardened community safe rooms that meet the FEMA/ICC-500 standards.

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Written Testimony: Dennis Quan

WITT
ASSOCIATES

October 21, 2010

Sean David Abbott, Committee Director
Office of Senator Mario Gallegos, Jr.
Committee Director/Senate Subcommittee on Flooding & Evacuations
PO Box 12068
Austin, TX 78711

Re: Comments to Texas Senate Subcommittee on Flooding & Evacuations

Dear Mr. Abbott,

Thank you for the opportunity to provide comments to the Subcommittee. You asked that I provide comments and recommendations related to the feasibility and cost-effectiveness of both the retrofit of existing facilities and possible new construction, which would be constructed as shelters or safe rooms, for use during future evacuations.

Specifically, you asked what can be done to retrofit existing structures, including:

- What sort of construction practices would be used in a new shelter or safe room building to make it habitable during a hurricane;
- The potential costs associated with retrofitting/new construction, specifically compared with traditional building costs.

You also asked for comments on the feasibility of retrofitting existing facilities versus constructing new facilities, specifically designed and constructed to meet the anticipated wind load for the area.

On behalf of Witt Associates I am pleased to provide comments to the Texas Senate Subcommittee on Flooding & Evacuations.

Founded in 2001, Witt Associates is a public safety and crisis management consulting firm based in Washington, D.C., with offices located throughout the country. We are committed to providing critical planning and consulting services to governments, businesses and non-profits, and implementing solutions to prepare for and recover from disasters and crisis. We continue that commitment today by offering these comments to the Texas Senate Subcommittee on Flooding and Evacuations.

Specifically, Witt Associates offers the Subcommittee the following observations and recommendations for hurricane construction and engineering, including recommendations relating to cost-effective options to either retrofit or require new structures to be built as shelters for use during evacuations.

I have framed my comments in the context of the many components that should be considered in conjunction with any effort to improve public safety during hurricanes. The factors that should be considered are not mutually exclusive, but represent individual elements of a holistic approach necessary to reduce loss of life, injury, and property damage. It should be noted that there is a direct correlation between reducing damage to property and reducing the risk and exposure public safety.

I will first discuss some factors that should be considered in determining if a facility can and should be retrofitted. Below are examples of steps that can help achieve this determination:

Dedicated Building Inspectors

Whenever any type of structure is being built or retrofitted, it is in the public's best interest to have dedicated and trained professional building inspectors involved in the process. Unfortunately, errors or omissions committed in the process of construction are a major contributing factor in building failure. Trained professional building inspectors assure compliance with local and state building codes and applicable industry standards, and help eliminate these errors and omissions.

In the aftermath of Hurricane Charley, which struck Florida in August 2004, forensic inspections were conducted of several hundred damaged buildings for causes of failure. In the course of the examinations, buildings that failed were compared to those in close proximity that had not failed. Buildings that did not fail consistently showed compliance to industry best practices and building codes, while the buildings that failed showed clear evidence of poor practices and non-compliance with building codes and construction standards. The examinations determined that some common building practices directly contributed to the structure failure. For example, in so-called "stick built" construction:

- Instead of toe nailing (nailing at an angle) 2 x 4 studs by using 4 ten penny nails to the bottom or top 2 x 4 "plates", just two smaller, less effective 8 penny nails were often used, or the stud was end nailed, i.e. a nail driven, through the top or bottom plate, into the stud. End nailing provides little resistance in keeping the stud from being separated from the plate by the force of high-velocity wind. Toe nailing is required by most major building codes. Unfortunately, there are many instances of carpenters, when not properly supervised or trained, using the end-nailing method in order to save time and materials.
- Roofing shingles that were often stapled instead of being nailed with the required full-headed roofing nail of sufficient length, having one inch of penetration into the roofing deck or the rafter, usually with three evenly spread nails placed 5 inches from bottom edge of the shingle. Of the roofing systems that failed, most were either stapled or poorly nailed. Failed roofing contributed heavily in failure of the building envelope. In most building codes, stapling is not allowed. Stapling is also contrary to most shingle manufacturer's specifications and instructions, and stapling does not meet industry best practices. I observed workers stapling new roofs, in house after house, just one month after Hurricane Charley hit in Punta Gorda. Clearly, this practice will not help reduce future losses and will likely contribute to repeat structure failure in future events.

In both of the above examples, the use of dedicated, trained, professional building inspectors would have helped in the enforcement of applicable codes and standards, and could have significantly reduced the occurrence of structure failure.

Witt Associates recommends the adoption of strong building codes by states and local jurisdictions as a means of building safe, strong, disaster resistant communities.

Witt Associates recommends the use of trained, dedicated, professional building inspectors for the purpose of enforcing building codes and industry standards.

Concrete Construction Practices

Concrete construction, when properly done to code and industry standards by trained professionals is, by far, the most economic method in achieving hurricane/disaster resistance. A few examples of concrete construction are:

- Structure Insulated Panel (SIP) method, which can be easily built to withstand wind velocity of 200 mph. Three buildings using SIP survived a direct hit from Hurricane Charley while many nearby structures were completely destroyed.
- Insulated concrete form (ICF) can be fashioned in any of the same architectural styles as stick-built, and can survive wind velocity of up to 200 mph. The only structure that survived a direct wave hit by Hurricane Katrina on the beach of Pass Christian, Mississippi was an ICF home.
- The thin-shell concrete monolithic domes are the strongest of all concrete styles. Walls typically withstand a force of 2,000 pounds per square foot. An F-5 tornado generates 404 pounds per square foot at 300 mph, or 5 times less then the tensile strength of the dome. The dome can withstand an impact from a runaway semi truck, a single engine Piper Cub, even a rifle bullet. Generally, damage, if any, is highly localized and superficial, and does not affect the structural integrity of the shell. This type of dome construction is often ideal for EOC's and as community shelters or safe rooms.

While it is not possible for me to provide you definitive information on building costs within these comments, I can provide you with some general comparisons. SIP and ICF methods are just slightly more expensive than traditional stick-built construction (wood). ICF methods can add as much 30% to the cost of conventional construction; SIP is generally about 5% more. Monolithic dome construction cost varies with the application and is generally much lower than tradition construction, depending on the use of the building and its interior finishes.

Most concrete construction methods are considered examples of green construction, using a fraction of the usual energy for heating and cooling, and the savings in energy can help recoup the cost of the structure in as little as 10 to 15 years.

Witt Associates recognizes that concrete construction methods offer sound mitigation opportunities for protection against a variety of hazards and recommends that the techniques be considered for construction in areas that are subject to hurricanes and other high-velocity wind events.

Shutters, Garage Doors and Protective Measures

A building engineered to survive high-velocity winds will perform adequately as long as the building envelope is not compromised or breached. As a rule of thumb, there should be no more than a one percentage opening, collectively, in the envelope including leaks around windows and doors. Once an opening is created, the additional pressurization may lead to catastrophic failure of the envelope.

One observation made after Hurricane Charley was that many buildings did not fail because the windows/doors/ or roofing elements were not compromised. It was observed that this was most often because of the use of shutters and other protective measures. The use of traditional wind retrofitting, such as shutters and high-performance roofing, is effective and often very cost effective.

Approximately 40% of all residential building failures as the result of high-velocity wind events are caused by collapsed garage doors. Even garage doors that meet the wind-load rating for a particular wind zone often do not provide adequate protection from hurricane-force winds. Some jurisdictions, like Florida's Miami-Dade County, require that garage doors be able to withstand a 150 mph wind load, be made with at least 24-gauge steel, and remain operable after being subjected to a high-velocity missile test.

An alternative is specially designed garage door braces. Door braces effectively allow the door to withstand a wind speed of up to 160 mph or more. The braces are manually installed just after the notification leading up to hurricane event. The braces will not always prevent the garage door from badly deforming, but will help prevent the door from blowing out. Door braces are also available also for large bay doors, such as those used at fire stations or public works garages.

Another solution that can be effective in protecting buildings is the use of fabric hurricane screens to cover the entire exterior of a building prior to a high-velocity wind event. For example, it is common for fire stations to be built as pre-engineered metal buildings (PEMB). Unless reinforced properly, PEMB's may fail in 80 or 90 mph winds. Many PEMB's, draped with hurricane fabric screens, survive very well during hurricanes. These screens are usually made from the same material used in backyard trampolines. Wind blowing through the screen at 100 mph, may be attenuated to about 6 mph.

Witt Associates recommends the use of properly installed hurricane shutters and other protective devices designed to assure the integrity of the building envelope during high-velocity wind events.

Retrofitting a Building to Survive High-Wind Loading

Some construction methods, available during new construction, are difficult to perform as a retrofit. For example, in order to put in a proper hurricane strap, one needs to remove the roof decking and soffit, to allow/install a full wrap around connectors. Installing a strap that only is nailed on the side of the rafter is insufficient, and will contribute to breaking the rafter from the nail stress loading. Putting in connectors between floors would require removal of siding, which can be very costly, and in the case of stucco or brick, this solution may not be technically feasible. Retrofitting is, in many cases, not a feasible alternative.

However, PEMB construction may be an exception to the retrofitting rule, as long as there is access the interior wall (no permanent interior wall covering). PEMB's can be retrofitted by upgrading wall and roof panels to higher-tensile steel (e.g. 80,000 psi), replacing fasteners with larger, corrosion resistance fasteners, increasing the number of fasteners, increasing the number of internal cross members (purlins and girts) to at least one every 2 to 3 feet apart, use of higher-strength cross members, installation of gussets underneath cap plate on top of columns, eave struts bolted to any masonry where applicable, additional cable or rod cross bracing, use of corrosion-resistant finished on all steel material, use of hurricane-rated doors and windows, and through the use of hurricane-rated coping, gutters and flashing. Using these techniques, it is possible to increase performance from 80-90 mph to 120 mph or more. High performance PEMB, built new, can be easily designed for 200 mph wind loading.

Another exception to the difficulties posed in building retrofitting is in cases of well-engineered concrete and steel buildings. In this type of construction retrofitting can often be achieved by protecting the roof, windows/doors and other openings from being compromised in a high-velocity wind event.

Witt Associates recommends retrofitting buildings to better withstand high-velocity wind events in cases where retrofitting is technically feasible.

Hurricane Rated Materials and the Miami-Dade Hurricane Compliance Code

It is recommended that all materials and protective devices such as shutters, screens, impact windows, doors, roofing, etc., used for protection from high-velocity wind events, achieve or exceed the standard established by Florida's Miami-Dade County Hurricane Compliance Code. These standards for construction practices, materials and products are among the strictest and strongest in the world. The Miami-Dade Approved Product control listing helps take the guess work out of knowing if a product is appropriate for the intended use in hurricane prone areas. Once a product is tested and certified, the product information is posted to the Miami-Dade's website, and a copy of the Notice of Acceptance is available to consumers. This service of Miami-Dade County helps builders and consumers better understand the products in the marketplace and helps eliminate false advertising or exaggerated product performance claims.

Shelters and Safe Rooms

While they have been used interchangeably in the past, the terms "shelter" and "safe room" have different meanings and connotations. While both types of facilities are designed for the protection of life during extreme-wind events, the facilities are designed to differing standards. Shelters are facilities that meet the criteria described in ICC-500, as published by the International Code Council. Safe Rooms, on the other hand, are facilities that are designed and constructed to meet FEMA publication 320 (for residential safe rooms) and 361 (for community safe rooms) standards. All safe rooms meet ICC-500 shelter standards; the reverse is not true.

Both design standards describe the criteria needed to meet the life-safety protection standards applicable to that design, for both new construction and retrofits. Both design standards also correctly note that it is often more cost-effective to implement safe room or shelter design criteria during new construction, rather than to retrofit these design elements into an existing facility.

It's worth noting that FEMA, the agency that funds the majority of mitigation retrofit and new construction projects, will not fund the retrofit or construction of a facility that is designed or constructed to less than FEMA 320 or 361 standards.

Residential Safe Rooms

Residential safe rooms, built to accepted standards, are hardened areas or rooms designed to withstand high-velocity winds that are characteristic of tornadoes, hurricanes and other extreme-wind events. They are considered a cost-effective method of protecting the inhabitants of dwellings from extreme wind events, and have proven to be a valuable life safety measure. In 1999, more than 900 safe rooms were built in private residences in Oklahoma City. When an F-5 tornado struck the city and destroyed homes in its path, all the occupants of dwellings with safe rooms were protected, even though their homes were taken by the winds.

Witt Associates recommends the construction of safe rooms as a cost-effective life safety measure in areas subject to high velocity wind events.

Community Safe Rooms

During Hurricanes Charley, Frances, Jeanne and Ivan in Florida, many shelters were utilized. These shelters were constructed in accordance with applicable safety criteria. Many of them suffered structural failures that forced the occupants to flee in the middle of extreme wind events. It became evident that the widely used safety standards to which the shelters were built were insufficient to offer the required degree of life safety and protection from high velocity wind events.

At a minimum, buildings that are considered for use as shelters or safe rooms in these types of events should be protected with approved hurricane shutters or impact windows, hurricane clips and braces that are appropriately and adequately tied to structural members, and hardened roofs. There should be minimal breaks in the building's envelope, to limit the possibility of failure or wind-entry. The use of buildings constructed of concrete or high tensile steel provides a better alternative. The best manner in which to obtain the highest degree of protection from significant wind events is the use of construction methods found in monolithic domes.

In conclusion, I would recommend the extreme-wind mitigation building practices be adopted and implemented in new construction wherever possible. While retrofitting is a viable option for some facilities, the best possible implementation of protection and mitigation comes during the building's initial design and construction. Retrofitting has inherent limitations that are simply not found in new construction.

Thank you for this wonderful opportunity to assist the State of Texas in encouraging sound construction techniques and appropriate mitigation measures as a means of building safer and stronger disaster resistant communities.

Sincerely,

Dennis A. Quan
Engineer/Benefit Cost Analyst
Witt Associates
(225) 267-2583/2605 fax
dquan@wittassociates.com

Attachments: Curriculum Vitae