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Tropical Storm Allison Recovery: A Facilities And Operations Perspective

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Abstract

The Texas Medical Center was devastated by Tropical Storm Allison on June 8th and 9th, 2001 resulting in diminished operational services for several key healthcare facilities in the Houston community. Memorial Hermann Hospital and Memorial Hermann Children\'s Hospital experienced severe flooding to two lower levels of the facility and the resultant loss of key utility systems necessitated a systematic evacuation of the patient population. The Hermann facility was closed to patient care for a period of 38 days while operational systems were restored and the facility re-certified for health-care operations. Key to the disaster was the unprecedented storm event (estimated at a frequency greater than a 100-year event) (1), changes in watershed development patterns, and the location of key utility systems below-grade in many facilities. Master planning efforts are currently in progress to add system redundancies, improve preparedness for future utility interruptions, install flood mitigation systems, and relocate key systems/functions to areas with reduced risk of future flooding.

INTRODUCTION

Texas Medical Center (TMC) has been reported to be the largest medical center in the world. Geographically, the TMC lies in the Brays Bayou watershed, which includes the cities of West University, Houston, Bellaire, Southside Place and Braeswood place. The Brays watershed covers an area approximating 126 square miles ([2]). The area has well documented problems with subsidence and has had flooding issues in past history although improvements in flood protection installed after the 1976 flood were thought to protect medical center institutions from future flooding events. The most notable previous event was the above referenced June 1976 flood in which the TMC suffered damages in excess of $20 million dollars ([3]). The most recent Flood Insurance Rate Map (FIRM) ([4]) dated April 2000 notes that much of the adjacent areas (including the TMC) lie within both the 100 and 500-year flood elevations. It is interesting to note that the Memorial Hermann campus is documented as lying outside the current FIRM flood plains although its close proximity to the bayou and susceptibility to overland sheet flow from localized rainfall events has been theorized in the past.

Memorial Hermann (Hermann) Hospital was organized from the George Hermann trust in 1925/1926 with its mission to deliver charity care to the community. The Hermann campus is comprised of five major facilities that were constructed from 1926 to 1998. Overall, the Hermann campus is comprised of approximately 2.8 million square feet of healthcare facilities, licensed for 818 beds, and is the larger of two Level 1 Trauma Centers in the Houston region. In addition, the Memorial Hermann campus has Medical Office Building and garage facilities, which also sustained substantial damage from the flood.

TROPICAL STORM ALLISON

Tropical Storm Allison has been referred to as the “nation's most devastating flood event” ([5]) – losses from which are reported to reach the $5 billion damage estimate in the Houston region. The first storm of the Hurricane season, rainfall in the Rice University/Texas Medical Center area was unofficially recorded at 10.4 inches in a three hour period early on June 9th. As reported in a recent flood symposium by Philip Bedient (1) of Rice University, Tropical Storm Allison resulted in rainfall rates that “are some of the highest ever recorded” and “generated enormous overland flows to be directed towards the Texas Medical Center”. Final remarks from this conference note that the rainfall and runoff rates from Allison exceeded the flood protection devices installed “after the 1976 flood and could not have been predicted in advance.” (1) Regarding new strategies to protect this critical area it is noted that although numerous flood studies to the Brays watershed have occurred (the earliest noted in 1937), current Federal projects proposed to bring significant relieve to the TMC areas are not scheduled for completion until 2012 (3).

CASE REPORT

Recovery - June 9, 2001 – there was a unique calm at Hermann after the rains had subsided in the early morning hours. All utility systems had lost function hours earlier – the only system still in operation was bulk oxygen distribution since its storage vessels are at street level and hence were not impacted by the flooding. Communications was the first facility-related crisis as emergency power and battery backup systems had long since ceased operations. Cellular telephones were of minimal value as it was increasingly difficult to secure a connection with offsite facilities. The recovery process was clearly evident when viewing the results of the flooding; restoration of essential services would be a long and complex process requiring judgment, communication, organizational expertise and all of the resources Memorial Hermann could procure in the immediate days.

Figure 13

Figure 1: Actual number of work force in post flood period

Figure 2

Restoration of utility systems was immediately placed on a parallel path with patient evacuations and initial prioritization of tasks was as follows:

Establish incident command centers for both Utility and Patient Care management. Separate locations were utilized and the respective leadership teams communicated regularly on status of key issues. It was extremely important to think macro in the overall incident command structure as it is surprising how few people can stay focused on the big picture and instead focus on the immediate needs of individual issues.

RESOURCE SEARCH; PEOPLE, EQUIPMENT AND MATERIALS.

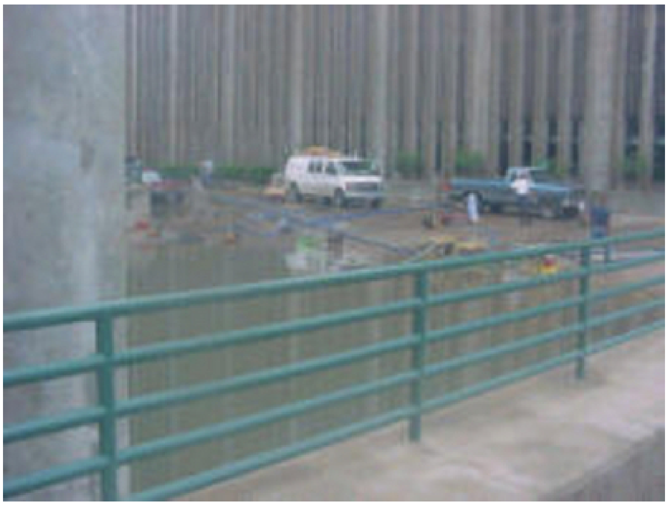
Key contractors and suppliers were contacted early in the morning of June 9th even as floodwaters prevented travel to the medical center. Key to Emergency Management is the ready availability of contact information; the importance of emergency contact lists for key vendors, suppliers, contractors and staff cannot be overemphasized. It is interesting to note that electronic call lists and other technology features were only marginally effective as paper still performs best without electricity.

WATER REMOVAL.

Key to the recovery process was removal of the floodwaters from the two lower levels and connecting tunnels of the campus. It is estimated that Hermann had been inundated with over 42 million gallons of water and water depths reached levels of 38 feet in two of the Pavilions. Thus, the water had to be removed before even a preliminary assessment of the damage could occur. Resources utilized for this task included oil field pumping equipment, large construction pumps and specialty pumps from the merchant marine industry. Note that this specialty equipment is not typically found in emergency preparedness supply depots. Also, due to great horizontal distances in a facility of this magnitude final pumping operations of remote stairwells, elevator shafts, and utility tunnels were accomplished by positive displacement pumps and vacuum trucks, as normal centrifugal pumps were limited in lift capabilities.

Figure 3

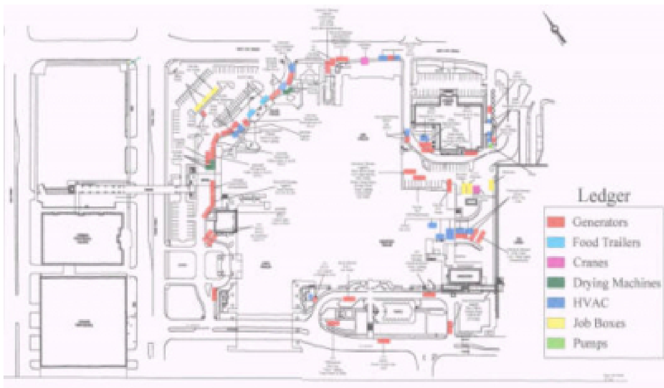
Figure 4



TEMPORARY LIGHTING AND POWER.

As the water systematically receded in the facility, temporary lighting and portable equipment power was installed first in main corridors and then in machine rooms to facilitate damage assessment and repair efforts. Thirty-six (36) portable diesel generators (ranging in size from 500 to 1400 kw) were placed around the perimeter of the Hermann campus and from these units, temporary feeders, distribution panels and circuits penetrated key areas of the campus. Statistics note that over 264,000 feet (50 miles) of temporary 480 volt, three phase feeders (500 kcmil wire size) were distributed through out the campus and 18,000 feet of temporary 120 volt lighting circuits were installed. During the peak of the 38-day recovery process, temporary generators and equipment consumed an estimated 10,000 gallons of diesel fuel each day. Priorities for utility restoration included egress lighting, air distribution systems and chilled water (air conditioning) systems to minimize further damage to the interior environment. Key distribution panels and bus risers in upper levels of the facility were back-fed with temporary generator power and electrically (physically) isolated from flood-damaged sections of the electrical distribution system.

Figure 5



Site plan; Equipment staging

As the lower levels of the facility were exposed and initial damage assessments completed it was clearly evident that additional issues had emerged requiring coordination and quick decision making to facilitate the re-opening of the hospital complex. Future disaster planning and rebuilding efforts will undoubtedly look to updated codes, standards and best practices as it is noted that "Natural disasters may be the ultimate barometer of a building code" (its design) "because they represent some of the most extreme conditions to which a structure will be subjected" (6). Some of the key issues in the Allison recovery process requiring additional coordination included:

DEMOLITION AND RECONSTRUCTION PLANNING.

Key to the recovery process were both short-term demolition activities and initiating a Master Planning effort to assist with decision making for the reconstruction phase of the project. Early in the recovery phase a key decision was made to demolish any flooded areas back to the concrete slab and as such minimize future issues with infection control and indoor air quality.

Figure 6

Figure 7

Although very controversial with insurance carriers, this decision proved beneficial to the recovery process as it clarified scope of work and simplified planning for re-building key features necessary for occupancy. Overall, 650,000 square feet of flood-damaged real estate was demolished at the Hermann complex within the first two weeks of the recovery process.

Figure 8

Figure 9

HAZARDOUS WASTE REMOVAL.

One operational issue that continued to hinder the recovery process was hazardous waste originating from the basement level Pathology Lab. This laboratory occupied 40,000 square feet immediately adjacent to both key utility service entrances and floodwater entry points. As such, the force of the water distributed hazardous waste over the entire basement level of the complex – some 110,000 square feet of real estate. Local resources that are typically utilized in disposing of hazardous materials were soon over burdened with the magnitude of the disaster and as such, planning and clean-up activities required support from as far away as Oregon, Illinois, and Virginia.

Figure 10

Figure 11

REGULATORY AGENCY NEGOTIATIONS.

One bright spot that emerged during the project was the teamwork displayed by local, state and federal code officials as the recovery process progressed. Early in the project, architects, engineers and life safety consultants provided feedback to governmental agencies – keeping them apprised of the progress at Hermann while planning for occupancy inspections for re-opening the facility. It is a rare sight to partner with building officials on nights, holidays, and weekends – the value of loyal consultants cannot be overstated.

INDOOR AIR QUALITY.

The propagation of mold and environmental contaminants has been well documented in hot humid climates. Early in the project protocols were established and processes initiated to minimize future indoor air quality issues in areas not subjected to flooding. Specific issues that were addressed include:

Figure 12

Flooded areas were separated from undamaged sections of the facility utilizing containment practices similar to those in the asbestos abatement industry. The goal was to isolate patient care areas both horizontally (at ground level) and vertically (elevator shafts and stairwells) to minimize the impact of environmental contamination.

Biocides were continually applied to the damaged lower levels to control microorganisms and facilitate cleanup.

Temporary heating, ventilation, and air conditioning (HVAC) systems were installed in key locations to minimize contamination, dehumidify flooded areas, and maintain negative pressure relationships in flood damaged spaces. Over 2000 tons of temporary chillers were installed during the first week of the recovery phase – many of which continued in operation for the remainder of the summer season.

Detailed re-commissioning processes were established while starting up permanent HVAC systems to minimize system contamination, document post-flood indoor air quality, and certify key areas for patient care activities.

It is highly likely that existing conditions in some sections of the complex were magnified by the flood event and as such, extensive efforts were undertaken replacing key HVAC equipment – thus certifying occupancy conditions.

CONSTRUCTION OF TEMPORARY SUPPORT AREAS.

One of the keys to re-opening the hospital facility was the design and construction of temporary support space for departments displaced by the flood. The magnitude of this scope of work required planning and constructing approximately 60,000 square feet of space for these critical services. Services requiring alternate operational strategies included:

RECOMMENDED KEY CONTACTS FOR EMERGENCY RESPONSE

In addition to emergency management personnel, key to recovery from a disaster of the scale caused by Tropical Storm Allison include resources that are able to provide rapid response and expertise in the following areas:

Utility suppliers – Note that this market segment is becoming more complicated as providers are de-regulated and markets opened up to competition.

Rental equipment suppliers – Houston is fortunate to be a world leader in the petro-chemical industry and as such has ready access to large pumps, portable generators, and mobile air-conditioning equipment. Many of the larger suppliers are national firms and should be in the key contacts list of any disaster plan.

General contractors - Again, the value-added of firms with a large regional or national focus cannot be over emphasized. Companies must also be financially stable, as cash flow becomes a critical issue with the speed and magnitude of large-scale recovery efforts.

Specialty trade contractors – Whether acting as prime or sub-contractors, experienced mechanical, electrical, and plumbing contractors (with ready access to personnel) are key to disaster recovery efforts. Facilities should cultivate relationships with firms as a normal course of business to facilitate response to disaster recovery. First response, clean-up contractors – There are several excellent local and national firms that specialize in first response clean-up efforts utilizing extensive levels of temporary manpower. These firms are also key vendors to include in disaster recovery plans.

{image:13}

LESSONS LEARNED

In addition to the physical challenges that must be overcome managing the disaster recovery process the impact of loyal, competent staff and support personnel cannot be overstated. The healthcare marketplace has forced many facilities to outsource departments and service lines that are not key components of the hospital's mission. Contracts for renovations are quite often evaluated purely from a first cost perspective and as such valuable relationships with contractors and consultants can be negatively impacted. Care must be exercised to maintain relationships within a facility's valuable human resource as financial margins continue to create change in support service areas. Many of these personnel and contract resources are often the only resource knowledgeable in the complicated operation of a health care facility and whose loyalty and knowledge is difficult to measure (value) during non-crisis conditions.

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