Tropical Storm Allison, June 2001

RMS Event Report

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SUMMARY

Tropical Storm Allison ravaged U.S. coastal areas with torrential rain and flooding for nearly two weeks in June 2001. Initially thought to be only a minor storm, Tropical Storm (TS) Allison caused 50 deaths, with damages topping $6 billion and insured losses of $2.5 billion, becoming the costliest tropical storm in U.S. history. This damage was caused by a storm that at its most intense point had maximum sustained winds of only 57 mph (92 km/hr).

Minimum Central Pressure	1002 mb
Maximum Wind Speed	57 mph (92 km/hr)
Maximum Hourly Rainfall Recorded	5.51 inches (14 cm)
Maximum Total Rainfall Recorded	35.7 inches (91 cm)
Percent of Average Annual Rainfall (Houston area)	80%
Percent of 500-year Rainfall Event (Houston area)	170% (USGS)

Table 1. Key storm parameters for Tropical Storm Allison

Allison hit Texas harder than any other state, with nearly 90% of the total losses for the storm occurring in the Houston metropolitan area. Louisiana, Mississippi, Florida, Georgia, South Carolina, North Carolina, Pennsylvania, and New Jersey were also impacted by flood losses. According to the Property Claims Service (PCS) of ISO, states with the largest losses after Texas were Pennsylvania with 9% ($215 million) and Louisiana with less than 3% ($65 million).

In the early morning hours of June 9, the storm dropped extreme rains in several critical areas of Houston, and 5-day rainfall measurements of more than 30 inches (76 cm) were recorded across the region. Flood control systems were overwhelmed, resulting in massive flooding in both residential and commercial properties. This report summarizes research into the causes of damage and loss associated with TS Allison, focusing on the Houston metropolitan area of Harris County, Texas where RMS conducted a week-long reconnaissance survey in August 2001.[1]

Total damage in the Houston region is estimated at $5 billion. The Texas Medical Center (TMC) and downtown Houston had particularly heavy losses. In the TMC, surface water entered underground parking garages and tunnels, flooding critical infrastructure within basement areas. Damage estimates for the TMC exceed $2 billion, of which $600 million in insurance claims are expected. In downtown Houston, the pedestrian tunnel system was inundated with floodwaters seeping in from the overflowing Buffalo Bayou. As a result, many downtown businesses operating in the tunnels or relying on the tunnel network for access to infrastructure and parking experienced interruptions for several months.

All sectors of the flood insurance market have been negatively affected by TS Allison. Changes in flood underwriting practices and standards are anticipated as a hardening market puts increased pressure on companies to institute more stringent flood underwriting controls. Insurers are also evaluating their appetite for flood coverage and reviewing their flood exposure evaluation methods. The Flood Insurance Rate Maps (FIRM) published by FEMA are essential tools for assessing flood risk, but it is becoming increasingly clear that a FIRM assessment needs to be supplemented with a thorough evaluation of all potential water entry points, including underground parking and tunnel connections.

[1] Published December 17, 2001.

STORM CHARACTERISTICS

Tropical Storm Allison, the first named storm of the 2001 Atlantic hurricane season, began as an eastward-moving tropical wave that stalled over the Gulf of Mexico. On the morning of June 5, a small low-level, low-pressure system formed and developed rapidly into a tropical storm during the afternoon with peak winds of 60 mph (97 km/hr). The first tropical storm warning was issued at 15:00 EDT (20:00 GMT) on June 5, and later that afternoon Allison came onshore near the west end of Galveston Island, Texas, with winds up to 50 mph (80 km/hr).

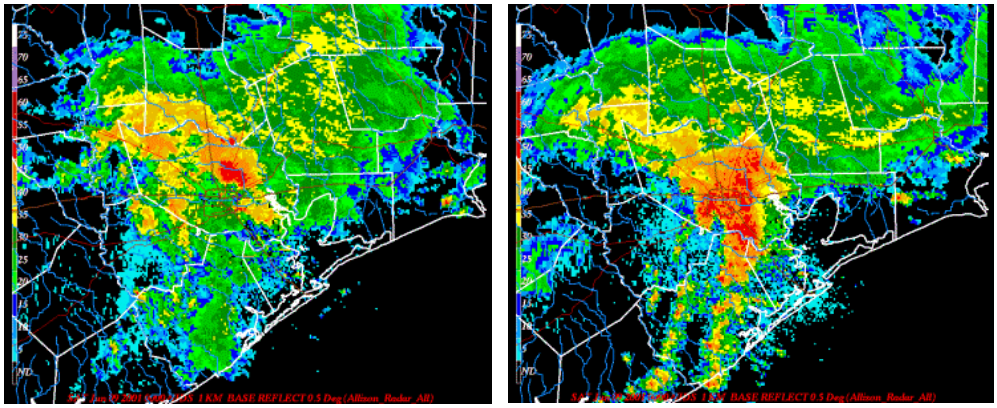

Figure 1. Two radar images (10-minute resolution) taken at approximately 22:45 on June 8 (left) and 01:10 on June 9 (right). Areas with up to 15 inches (38 cm) of rainfall per hour are shown in red, up to 2 inches (5 cm) per hour are shown in orange, and 0.3 inches (0.8 cm) per hour are shown in yellow (National Weather Service).

Once onshore, Allison rapidly weakened and stalled over the Houston metropolitan region, drawing in moisture-laden air off the warm Gulf of Mexico. This mechanism greatly facilitated the steady rains that fell over Houston for the next four days. On June 8, the storm's center drifted north about 100 miles (160 km) and the worst seemed to be over for Houston. However, Allison drifted back south during the late hours of June 8 and unleashed extreme rains over an 8-hour period into the early morning hours of June 9.

According to the Harris County Flood Control District (HCFCD), the vast majority of rainfall rates measured across the county exceeded 10 inches (25 cm) in 10 hours or less, and more than 1 million residents of the Houston area were impacted by the resulting flooding. Many Houston area weather-monitoring stations recorded more than 30 inches (76 cm) of rainfall over a 4-day period.

Time Period	*Rainfall Amount*
1 hour	6.3 inches (16 cm)
3 hour	13.5 inches (34.3 cm)
6 hour	21.5 inches (54.6 cm)
12 hour	28.5 inches (72.4 cm)
6 day	38.6 inches (98 cm)

Table 2.Maximum rainfall total recorded in the Houston area during TS Allison (National Weather Service).

A similar phenomenon occurred in the Houston area in 1979, when Tropical Storm Claudette came onshore near the Texas-Louisiana border on July 24 and then stalled. Forecasters expected Claudette to continue northward, but changes in upper atmospheric winds caused the system to loop over southeast Texas in a path similar to Allison's. Claudette still holds the U.S. record for the maximum 1-day rainfall of 43 inches (1.1 meters). Fortunately, Claudette's heavy rains fell mostly in rural areas south of Houston, and the losses from the storm were much lower than those observed in TS Allison.

Figure 2. TS Allison's path (red) across the U.S., along with TS Claudette's 1979 track (blue). Federally-declared disaster areas for TS Allison are shown in orange.

Once offshore, Allison regained some of its strength. It came onshore again in Louisiana on June 11, dropping up to 21 inches (53 cm) of rain. Fortunately, New Orleans recorded only 4.66 inches (12 cm) of rain the first day, and the storm avoided major urban areas. Allison then tracked through Mississippi, northwest Florida, Georgia, and the Carolinas, before passing through the Mid-Atlantic states. On June 16 and 17, Allison dropped 10 inches (25 cm) of rain in Pennsylvania and 7 inches (17 cm) in some parts of Connecticut, before finally exiting the northeast coast nearly two weeks after it formed. On the morning of June 18, the last report located Allison's remains moving out to sea, 35 miles (56 km) south-southwest of Nantucket Island, Massachusetts.

Since 1993, more than 77 significant flooding events have caused losses of more than $50 million in counties across the U.S. Texas and Florida have the greatest number of counties with heavy flood losses due to tropical cyclones. Like hurricanes Floyd (1999), Georges (1998), and Fran (1996), TS Allison caused severe flooding, but only minimal wind damage. While there is no clear meteorological evidence suggesting that the frequency of wet storms is increasing, at least 4 wet tropical cyclones have caused major losses in recent years.

Storm Name	*Year*	*Minimum Central Pressure*	*Maximum Sustained Winds*	*Maximum Rainfall*	*Total Insured Losses (U.S.)*
Fran	1996	946 mb	120 mph (193 km/hr)	12 in. (30.5 cm) in NC	$1.6 billion
Georges	1998	937 mb	155 mph (250 km/hr)	26 in. (66 cm) in MS	$2.5 billion
Floyd	1999	921 mb	155 mph (250 km/hr)	19 in. (48 cm) over 4 days	$1.8 billion
Allison	2001	1002 mb	57 mph (92 km/hr)	35.7 in. (91 cm) over 5 days	$2.5 billion

Table 3. Comparison of recent wet tropical cyclones (National Climatic Data Center)

FLOODING DAMAGE AND LOSSES

While only a tropical storm, Allison's path of destruction across the U.S. caused 50 deaths and damages in excess of $6 billion. PCS reports that as of October 30, 2001, more than 221,500 claims had been filed with total insurance losses estimated at $2.5 billion. Federal disaster declarations were issued for 70 counties in 5 states, and the National Flood Insurance Program (NFIP), as of September 30, 2001, expected to pay out an additional $900 million, primarily for residential claims.

About $5 billion of the total damage and 88% of the $3.4 billion in combined insurance and NFIP losses came from the Houston metropolitan region. Louisiana, Mississippi, Florida, Georgia, South Carolina, North Carolina, Pennsylvania, and New Jersey also had flood losses. Pennsylvania had the second highest insurance loss of $215 million, followed by Louisiana with $65 million in losses.

Houston Flooding

Settled on the banks of Buffalo Bayou in 1836, the city of Houston is home to more than 4.66 million people, and is the fourth largest city in the U.S. It is also an economic center for shipping, oil and gas production, and medical research. A complex system of 22 major bayous in 22 major watersheds meander through Houston's relatively flat terrain, and the region is also subject to heavy precipitation. Houston has some of the highest annual and 24-hour maximum precipitation rates of the major U.S. coastal cities vulnerable to tropical cyclones.

U.S. City	*100-Yr Precipitation Event (24-hour period)*	*Average Annual Precipitation*
New Orleans, LA	13 inches (33 cm)	59.7 inches (151.7 cm)
Miami, FL	14 inches (35.6 cm)	57.6 inches (146.2 cm)
Baton Rouge, LA	12 inches (30.5 cm)	55.8 inches (141.7 cm)
Houston, TX	12.5 inches (31.8 cm)	44.8 inches (113.7 cm)
Boston, MA	7 inches (17.8 cm)	43.8 inches (111.3 cm)
New York, NY	7 inches (17.8 cm)	42.8 inches (108.8 cm)
Philadelphia, PA	7 inches (17.8 cm)	41.4 inches (105.2 cm)
Washington, DC	8 inches (20.3 cm)	39.0 inches (99.1 cm)

Table 4. Rainfall statistics for several U.S. cities (National Weather Service).

Destructive flooding in Houston has been reported as far back as 1843. In 1937, recurrent flooding prompted formation of the Harris County Flood Control District (HCFCD), which constructs and maintains major flood control projects throughout the region's 2,500 miles (4,000 km) of waterways. The HCFCD works closely with the U.S. Army Corps of Engineers to plan, design, and construct flood damage reduction projects throughout Harris County.

Houston, like many other major coastal cities, has experienced unprecedented growth in the last half-century. The city nearly doubled its population during both decades of the 1950's and 1960's, and urbanization began to expand well beyond the city limits over this time period. Large-scale urbanization increases the amount of impervious surface and infrastructure, which can cause water to quickly accumulate in streets and fill flood control channels during heavy rainfall. Intense periods

of rainfall occur frequently in Houston, and the HCFCD reports that Harris County experiences flooding 5 to 8 times each year.

In just 5 days, Allison dropped 80% of the Houston region's total average annual rainfall, which was 170% of the 500-year rainfall event calculated for the region. Flood control systems and bayous were overwhelmed. The Harris County Office of Emergency Management recorded severe and record breaking flooding on 15 major bayous in central Harris County. Five of six major bayous running through central Houston overtopped their banks, and 4 of them (Greens, Buffalo, Halls, and White Oak bayous), exceeded their 100-year flood levels. Greens Bayou crested at nearly 20 feet (6 meters) above its banks. Surface water run-off was also excessive, and depths of 5 feet (1.6 meters) were recorded near the Texas Medical Center (TMC) and Rice University.

Figure 3. General overview of the extent and types of flooding in the Houston region caused by TS Allison.

Flooding in Houston caused 22 deaths and led to nearly 7,000 rescues. It also forced more than 30,000 people to seek alternative shelter, as thousands of homes and hundreds of roads were damaged, and 11,500 households lost power over the weekend of June 9 and 10. In all, flooding damaged more than 95,000 vehicles, 51,430 homes, and 1,700 businesses.

Airline flights and marine shipping and recreation in the Houston-Galveston region were also affected. More than 1,000 flights from the region's major hub, Bush Intercontinental Airport, were cancelled. The Houston Ship Channel, north of Baytown, Texas, was closed for several days after 26 barges and 3 ships broke away from their moorings and blocked the flooded waterways.

Oil spills and pollution in the channel were reported, and costs to remove storm debris and repair channel damage are estimated at $34 million.

Residential neighborhoods inside and to the north of Houston's Interstate loop 610 were hardest hit. They include: Pinewood Village, Houston Heights, Kashmere Gardens, Holiday Forest, Home Owned Estates, Downtown, Rice University/Texas Medical Center, and the University of Houston. To the south, near the City of Clear Lake, the neighborhoods of Gulf Meadows, Green Tee, and Friendswood also sustained heavy losses. The Harris County Appraisal District estimated total residential losses of $1.76 billion and 2,744 destroyed homes.

By November 13, nearly 118,000 Texans had registered for federal disaster assistance and more than $970 million of federal and state aid had been provided. According to the Federal Emergency Management Agency (FEMA), both Houston and surrounding Harris County are among the top 10 jurisdictions in the U.S. with the largest number of repetitive flood loss structures. Following Allison, more than 2,400 applications for FEMA's voluntary buyout program were submitted for substantially damaged homes located in floodplains.

Mold damage has been a major concern in facilities flooded by TS Allison. Mold growth typically starts 24 to 48 hours after a major flood event, and can only be stopped if the affected area is promptly cleaned. There is readily available food for mold growth in most residential and commercial buildings, including sheetrock paper, ceiling tiles, particleboard, and wood. Over the past few years, mold-related claims have escalated, primarily in the residential insurance sector, and especially in Texas. Mold damage is expected to drive claims higher in the aftermath of Allison.

While flooding damage extended across the region, the vast majority of losses were concentrated in two areas: the Texas Medical Center and downtown Houston. The following sections explore, in greater detail, the damage causes and resulting losses in these two areas.

Texas Medical Center

Known as the "city within a city" the TMC spreads across 695 acres (281 hectares) of south-central Houston, and is one of the largest medical research and care facilities in the world. The TMC employs 54,000 workers in 2 medical schools, 4 schools of nursing, and 13 hospitals. Over 4.8 million patients visit the TMC each year, and there are 6,170 patient beds and over 100 permanent structures in the complex.

Brays Bayou flows to the southwest of downtown Houston and passes through the TMC. Channelization and concrete lining of Brays Bayou was completed in 1968 and, based on flood data and urbanization modeling capabilities available at the time of construction, the channel was designed to accommodate a 100-year flood event. Subsequent investigations suggest that the impact of urbanization far exceeded initial calculations and the system was only sized to contain a 33-year flood event. Rapid development in the watershed continued and, prior to TS Allison, Rice University (1998) estimated that Brays Bayou's capacity had degenerated further and was likely to contain only a 5 to 10-year rainfall event.

In the north part of the TMC, streets drain into two primary underground pipes, known as the Harris Gully, which runs into Brays Bayou. The Harris Gully drainage system evolved in the late 1940s from a natural drainage way into an underground box culvert system. Currently, it consists of a pipe system that was originally designed in 1947 and expanded over the years. Recent engineering studies by Rice University suggest that Harris Gully can only contain a 2 to 3-year rainfall event. The combined lack of capacity in the bayou channel and the storm water drainage

system contributed to the TMC area's designation as a high-hazard flood zone on the FIRM maps published by FEMA.

In 1976, heavy rains caused more than $20 million in flood-related damage in the TMC. Subsequent flood mitigation efforts, particularly the installation of flood control devices such as floodgates, were designed to retain the 1976 flood level, generally considered to be about a 100-year event. The Rice/TMC Flood Alert System (FAS) was also developed the year following the 1976 floods. The FAS uses radar to estimate rainfall over the Brays Bayou watershed and predict flood conditions within the TMC.

Figure 4. Flooding in the TMC was almost entirely caused by inadequate storm water drainage and resulting surface water build-up on streets. As shown in this image, flood depths of more than 5 feet (1.6 meters) were recorded on TMC streets.

The FAS was fully operational during the week of Allison's strike, and many of the TMC institutions also installed floodgates as a precaution. At around 00:50 on June 8, the FAS went to full alert (red) status, and TMC institutions were contacted about the imminent flooding threat on Brays Bayou. In the storm's final 24 hours, only 5.1 inches (12.6 cm) of rain fell upstream of the TMC, and Brays Bayou did not overflow its banks. It did, however, stay at very high levels for about 8 to 9 hours, significantly impeding drainage through the Harris Gully.

The HCFCD estimates that Houston area storm water systems typically handle about 1.5 – 3 inches (3.8 – 7.5 cm) of rainfall per hour. In the TMC, 14.8 inches (37.6 cm) of rain fell during June 8 and 9, with more than 8.5 inches (21.6 cm) falling in an intense 2-hour period. The Harris Gully drainage system was soon filled, and water began to build up in the streets north of the TMC

and near Rice University. Floodwaters followed the topography downhill through the TMC toward Brays Bayou. Up to 5 feet (1.6 m) of water was measured on some streets within the TMC.

Floodwaters entered several subterranean parking garages, tunnels, air vents, loading docks, and utility chases within the TMC. Floodwaters were then conveyed across the TMC complex by connecting tunnel passages, and basements began to flood even in areas where there was little surface flooding. Subterranean flooding was particularly heavy in facilities connected to a major tunnel that runs parallel to Fannin Street. Institutions connected to this tunnel are commonly referred to as "tunnel dwellers."

As floodwaters continued to rise, water entered the ground floors of several TMC buildings. Floodgates were consistently overtopped, suggesting that flood depths far exceeded the 1976 flood levels. The basements and ground floors of several TMC institutions housed critical diagnostic equipment, medical research laboratories, electrical infrastructure (including back-up power generators and switchgear), and heating, ventilation, and air conditioning (HVAC) equipment.

The flooding quickly severed electricity running underground through the TMC. Many TMC facilities lost both primary and back-up power, including Memorial Hermann Hospital, a Level 1 trauma center. In the early morning hours of June 9, more than 1,000 patients were evacuated from TMC hospital rooms and intensive care units. Vehicular traffic in every direction within the entire TMC was cut-off for more than 9.5 hours, and the two Level 1 trauma centers in the TMC, Memorial Hermann and Ben Taub General, lacked any street access.

Nine of the 13 hospitals in the TMC were closed as a result of flood damage. Current damage estimates for the TMC complex exceed $2.0 billion, and more than $600 million of insured losses are expected. This is more than 30% of TS Allison's total gross damage. FEMA reports that 30 to 35 separate institutions are submitting requests for federal assistance, and a special 40-member task force has been established to assist in the recovery. Several of the larger hospitals estimate that full recovery will take 6 to 18 months.

Building Name	*Damage Description*	*Damage Estimate*	*Comments*
Baylor College of Medicine	Basements flooded. Primary and back-up power failed. Critical storage freezers stopped. Lost 90,000 research animals & 60,000 tumor samples.	$495 M	25 years of research data was destroyed. Facility was operational after a few weeks.
Memorial Hermann Hospital	Basements flooded to depths of 38 feet (11.6 meters) through underground connections with other buildings & parking garages. About 50% of water came from 1 tunnel connection. Lost electrical infrastructure, HVAC, diagnostic equipment, morgue, and laboratories.	$433 M	Insured for $150 million; FEMA granted $10.4 million. $60 million in cardiac care equipment damage. Took 4 days to pump water. Evacuated 540 patients; all returned after 8 days. 18 months estimated for full recovery.
The Methodist Hospital	Water entered the Neurosensory building. Flood depths of 40 feet (12 meters) in the basement damaged 300,000 sq. ft (27,871 sq. m) of space. Lost water, power, and air.	$360 M	Insured for $100 million. Discharged 400 patients, and did not fully reopen for 5 weeks. 6 months estimated for full recovery.
UT Houston Medical School	The force of floodwaters collapsed unreinforced walls. Lost 5,000 research animals.	$205 M	Insured for $50 million. Normal operations restored after 1 month. $68 million needed to retrofit and prevent future flood damage.
St. Luke's Hospital	Basement flooding in older structures. Lost primary and back-up power.	$91 M	Moved 60 critical patients to an unaffected building; another 230 patients evacuated. Full operations resumed in 2 weeks.
Texas Children's Hospital	Second basement level had 8 feet (2.4 m) of water in one area. Major flooding occurred in older buildings. Lost primary power. Flood doors installed at tunnel connection to reduce damage.	$20 M	Back-up power for essential services. Critical patients relocated from older, less protected buildings. Additional flood doors are being installed in basements near underground connections.
Texas Heart Institute	Research laboratories flooded. Pigs for artificial heart transplant tests drowned.	$16.6 M	Institute's main location is on the fifth floor of St. Luke's hospital.
M.D. Anderson Cancer Center	Lost primary power. Minor flooding.	$3 M	Back-up power functioned well.
Ben Taub General Hospital	Lost primary power, but undamaged by flooding.	Negligible	Operated on back-up power for several hours. The only Level 1 trauma center in Houston for several days.
TIRR	Lost primary power for a few hours. Basement had 2 inches of water as well as some flooding on the first floor.	Negligible	Adjacent to Ben Taub Hospital. Back-up power functioned well. Accepted patients from other hospitals.
Veterans Medical Center	Minimal flooding in the warehouse facility.	Negligible	Never lost power during the flooding.
St. Joseph's	Lost primary power. Little flood damage.	Negligible	Closed emergency room until full power was restored.

Table 5. Summary of damage to selected TMC institutions

Downtown Houston

Downtown Houston is the city center for commerce, entertainment, and cultural arts. Buffalo Bayou, flowing through the north end of downtown, has a long history of flooding. Although this bayou was one of the first to be channelized in the mid-1950s, many buildings still lie within its 100-year floodplain. On June 9, rainfall was particularly heavy to the north and west of downtown Houston, causing Buffalo Bayou to severely overflow its banks in several areas. Near its upstream junction with White Oak Bayou (northwest of downtown), Buffalo Bayou's flood heights exceeded channel banks by 10 feet (3 meters) – the highest flood level recorded in the bayou system. At several points, downtown buildings and parking garages located near Buffalo Bayou were inundated as floodwaters entered the ground floors through doors, air vents, and below grade windows.

Downtown Houston has the world's largest indoor pedestrian tunnel system connecting 81 buildings and housing numerous shops and restaurants. During the business week, the tunnels, located 20 feet (6 meters) below downtown streets, are traversed by thousands of workers and visitors looking to avoid street traffic and Houston's humid climate. Lacking engineered flood control devices, in the early morning hours of June 9 the pedestrian tunnels served as an effective conduit for floodwaters. The force of floodwaters destroyed unreinforced concrete block walls, metal doors, and partition walls. Water quickly filled the basements of several high-rise office structures, theaters, and commercial structures. Ultimately, 16 square blocks of downtown Houston were flooded below grade. The FEMA-designated flood zones indicated some risk of surface flooding in areas nearest Buffalo Bayou. However, the maps were not designed to reflect all possible water entry modes, such as the pedestrian tunnels, that could result in more extensive flooding below grade as observed in this event.

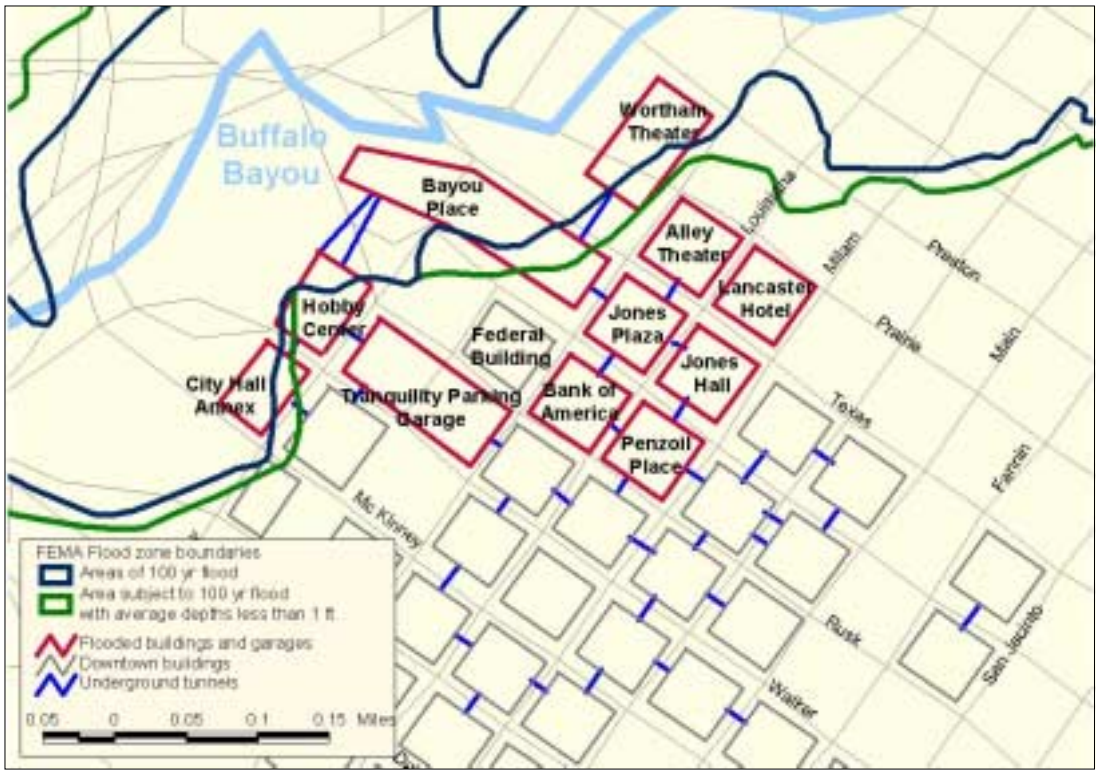

Figure 5: Buildings damaged by flooding from tunnels in downtown Houston. Note the buildings situated within the 100-year flood plain.

The Federal Building was the only building in close proximity to the bayou that did not flood. This facility did not have any connection to the underground pedestrian tunnel system for security purposes.

Building Name	*Damage Description*	*Comments*
Hobby Center	Building under renovation at the time of the flood. Water filled the parking garage and basement.	Flood damage had little long-term effects. This building is located in the 100-year flood plain.
City Hall Annex	Basement parking area flooded. Water entered the tunnel system through this building.	Estimated loss of $1 million. The facility is within the 100-year flood plain.
Tranquility Park/Theater Area Garages	Water filled all three parking garages. Major damage to the entire garage infrastructure (i.e. electrical, ventilation, lighting, drainage).	Estimated loss of $15 million. 250 million gallons of water pumped out over 50 days. 150 cars had to be towed out. 3,700 parking spaces unusable for 3 ½ months. Asbestos abated, ventilation and electrical system completely replaced. Alligators, fish, and turtles were found during reconstruction. City shuttles operated until garages reopened on September 21. FEMA funded $7.8 million for repairs.
Wortham Theater Center	Basement flooded through the pedestrian tunnel system.	Estimated loss of $3.1 million. Damage primarily to costumes, musical instruments, and backstage equipment. Building is located in the 100-year flood plain. A reinforced concrete wall withstood floodwaters on the side of the building adjacent to the bayou reducing flood damage to some extent. FEMA approved its portion of $1.5 million repair cost.
Jones Hall	Estimated 8 feet of water in the basement. Electrical and computer infrastructure destroyed. Historic instruments and sheet music ruined.	Estimated loss of $8 million. Houston Symphony Orchestra still started the season on time.
Alley Theater and Garage	Basement flooded with 10 feet of water.	Estimated loss of $10 million.
Bank of America	One death in an elevator in the underground parking area. Basement flooded.	56-story office tower.
Pennzoil Place	Basement flooded.	42-story twin office towers.
Bob Casey Federal Building	No flooding.	Not connected to the pedestrian tunnel system. No surface water build-up around the facility.

Table 6. Summary of the types of damage to selected downtown Houston buildings

LESSONS AND CONSEQUENCES

Tropical Storm Allison was clearly a high-return period, extreme rainfall event, and the tremendous concentration of exposure in flood-prone regions of Houston caused devastating levels of damage and loss. While there is no clear meteorological evidence suggesting that the frequency of wet storms such as TS Allison is increasing, flood-related insurance losses from these kinds of storms have been significant in recent years. In the wake of TS Allison, changes in all sectors of the U.S. flood insurance market are expected, as insurers reevaluate coverages, underwriting practices, and exposure evaluation methods.

Mitigating Flood Exposures

TS Allison highlighted several important issues for flood risk underwriting, particularly for commercial lines. In the wake of Allison, insurers are re-focusing attention on risk assessment and mitigation measures that can reduce flood losses, such as:

- Requiring installation of gas-powered pumps in lower levels of buildings to reduce flood depths and mitigate flood losses. While typically unable to keep up with rapid inundation, these pumps can effectively handle minor flooding.
- Mitigating potential power disruptions with a systems-based approach to protection. In particular, back-up generators and additional electrical infrastructure, like wiring and switchgear, should be elevated above potential flood levels.
- Raising locations for storage, raw materials, works in process, and finished goods in flood-prone areas.
- Requiring back-up copies of blueprints for buildings in which the office of the building engineer is located in the basement. Blueprints, essential to building repair, are often kept in these areas.
- Including flood scenarios in disaster recovery/contingency plans for facilities.
- Constructing and/or repairing buildings with materials that inhibit or limit mold growth in areas susceptible to flood damage.

Improving Flood Underwriting Standards and Practices

TS Allison painfully illustrated the vulnerability of buildings to subterranean flooding, even when no surface level flooding has occurred. While FEMA Flood Insurance Rate Maps (FIRMs) are essential risk analysis tools for insurers, they do not assess all the possible modes of water entry into a given building. Therefore, a FIRM assessment should be supplemented with a thorough evaluation of potential entry points for floodwaters, such as underground parking and tunnel connections, return air louvers, loading docks, utility chases, and below-grade windows and doors.

In some cases, insurers are also rewording flood policy language in hopes of limiting below-grade liabilities for both property and business interruption exposures. The extensive amount of interior damage in TS Allison may also lead to new exclusions for mold-related claims for personal lines, as well as commercial and health care risks.

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