Greens Bayou Watershed Analysis

Overview of the Greens Bayou Watershed

The Greens Bayou watershed, in northeastern Houston, has faced substantial flood losses in the last two decades. According to Harris County (HCFCD), 24,730 homes were flooded during Harvey (2017) and 970 structures were flooded during Tax Day flood (2016). Though flooded several times, compared to other watersheds, Greens has not seen adequate investment in flood mitigation projects.

Compounding the challenges, the watershed is home to a large population near or below the poverty line, with many multi-family properties deep in the floodplain. With the aim to develop a comprehensive flood management plan, the SSPEED Center at Rice University, in partnership with the Community Design Resource Center (CDRC) at the University of Houston, conducted a floodplain analysis and mitigation study focusing on four neighborhoods within Greens Bayou watershed: Greater Greenspoint, East Aldine, Eastex-Jensen, and East Houston.

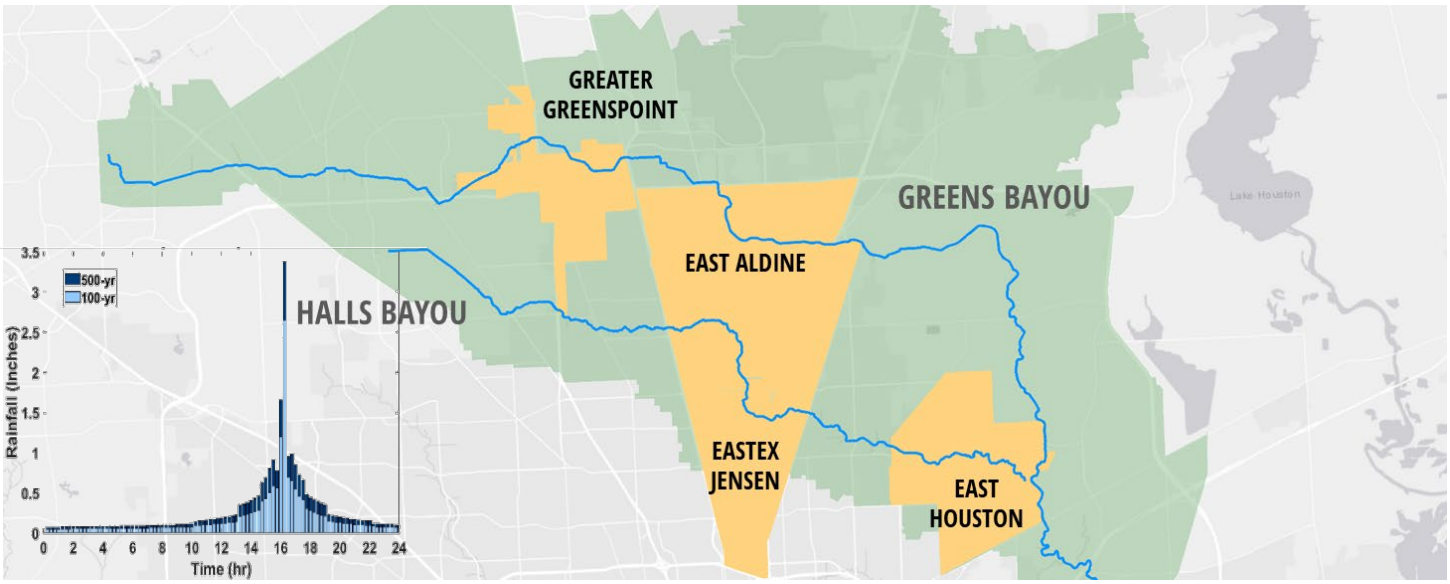

Figure 1 Map of Greens Bayou Watershed and Four Neighborhoods Selected for the Study including New NOAA 100-yr & 500-yr Rainfall Graph

Watershed Characteristics

- Main bayou channels: Greens Bayou & Halls Bayou
- Drainage Area: 212 Sq. Miles
- Open stream length: 308 Miles
- Population according to 2010 Census: 528,720

Study Objectives

- Perform a flood hazard analysis of the new 100-year and 500-year storms focusing on four neighborhoods: Greater Greenspoint, East Aldine, Eastex/Jensen, & East Houston
- Identify inundation hotspots and consider potential mitigation options
- Evaluate the impacts of selected mitigation options for each neighborhood under the new 100-year and 500-year storms
- Provide transportation network accessibility maps
- Involve neighborhood community leaders for input on the favorable mitigation strategies

Study Methodology

INPUT
- Rainfall (new NOAA rainfall, 2018)
- Topography (LiDAR, 2018)
- Land Use

ANALYSIS
- Hydraulic model (HEC-RAS): Flood Depths
- Model Validation: Gage Information & High Water Marks

MITIGATION PLANNING
- Identify Flood Vulnerable Areas
- Evaluate Feasible Mitigation Strategies (Detention)

Figure 2 Methodology for Hydrologic and Hydraulic (H&H) Modeling

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Community Engagement

Community involvement was a critical piece of the Greens Bayou Watershed Analysis. In order to share H&H modeling results and findings on potential resilient development strategies with the community leaders, planners and designers, the Community Design Resource Center (CDRC) and SSPEED Center, in collaboration with Greater Houston Flood Mitigation Consortium (GHFMC), organized two community meetings at the University of Houston's College of Architecture. Participants included Kinder Institute for Urban Research, neighborhood stakeholders, community-based organizations, designers, planners, and government representatives.

Figure 3 Dr. Bedient presenting at the first Greens Bayou Watershed Community Meeting at the University of Houston's College of Architecture

Overview

On January 26, 2019, preliminary H&H modeling results, such as new 100-yr and 500-yr floodplain maps for each study neighborhood, were presented to the attendees. Briefing books created by CDRC for each neighborhoods were also shared, to provide a base for demographic and other characteristic conditions in the neighborhoods. The preliminary results and potential solutions were discussed in four groups divided by neighborhood.

Based on the discussion in the first meeting, mitigation strategies for the different neighborhoods were identified and modeled using H&H models. During the July 11th meeting, updated floodplain maps, created using 2018 LiDAR and 2018 Land Use information, were shared along with the analysis of impacts of suggested detention ponds on flooding.

Moreover, resiliency strategies other than detention ponds were also presented. The presentations were followed by the discussion among the attendees to get comments and suggestion on the favorable community planning approaches for flood-reduction purposes.

In conclusion, through these workshops, both planners and modelers got better understanding about community needs, and on the other hand, community leaders and other attendees got to see the changing floodplains in the watershed and express their opinions on better mitigation measures.

Figure 4 Flooding in Greenspoint during Tax Day

Greens Bayou Watershed Analysis

Neighborhood Focus: Greater Greenspoint

Overview

- Located in upstream of the watershed
- Area: over 7 square miles
- Population in 2016: 33,549
- 43% of area families with incomes below the federal poverty line
- Current detention ponds near Greenspoint: Cutten road detention basin, Antoine detention basin, Glen forest Detention basin and Kuykendahl stormwater detention basin

Findings

The flood hazard analysis highlighted the shortage of flood storage at various locations within the Greater Greenspoint neighborhood, in particular at the northeastern edge of the neighborhood along Greens Bayou. Both Greens Bayou and Halls Bayou are shown to overtop their channel banks, indicating that these channels do not have sufficient capacity to withstand the 100-yr (and the 500-yr) storm. Increasing capacity by channel widening is infeasible due to the presence of major highways and railroad. Instead, Greater Greenspoint could consider buyouts and detention to increase flood storage and reduce flood hazard within the neighborhood.

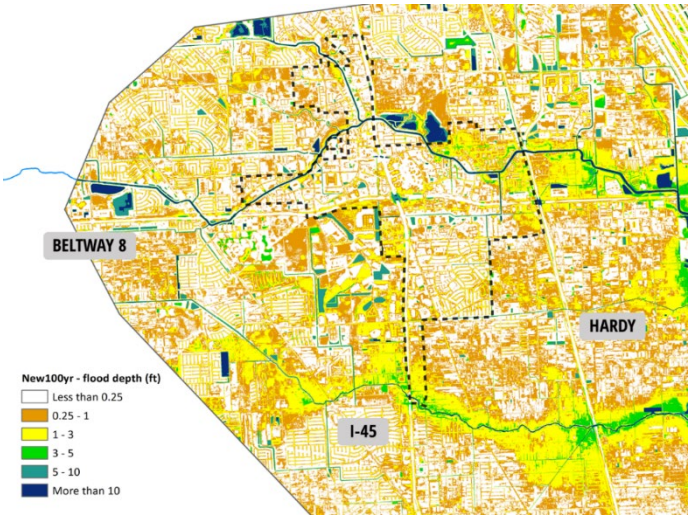

Figure 5 100-yr floodplain map for Greater Greenspoint based on latest NOAA rainfall statistic

Evaluation of Mitigation Strategies

- Figure 6 shows the GHFMC-proposed ponds range between 200 and 430 acres, and are assumed to have an average depth of 15 ft.
- A total 6 watchpoints were selected in Greenspoint to measure the reduction in flood depth after construction of suggested detention basins.
- The results show that only watchpoints located downstream of the proposed basins and within the riverine floodplain would benefit from additional detention (e.g., 3, 4, and 7).
- Watchpoints far removed from the riverine floodplain would most likely see no benefit from the additional detention, as evidenced by Watchpoint 5's results.

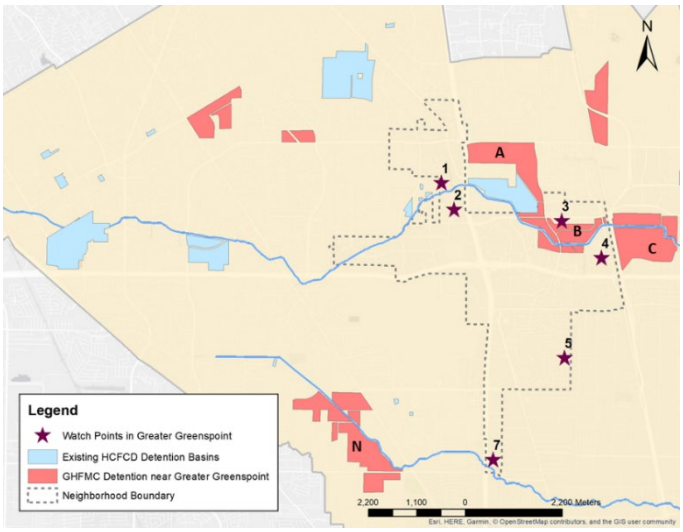

Figure 6 Proposed detention within Greater Greenspoint

Figure 7 Flooding in Greenspoint during Harvey

Greens Bayou Watershed Analysis

1D vs 2D Modeling and Pump Storage

1D vs 2D HEC-RAS Modeling

Type of modeling	1D HEC-RAS	2D HEC-RAS
Flow Direction	One-directional flow	Multi-directional flow
Area of Modeling	Alongside river (~2 miles wide)	Entire watershed
Flow type	Riverine flow	Riverine+Shallow Floodplain Flow
Output	Tables, floodplains	Can include Animated floodplain

Table 1 A comparison of 1D vs. 2D HEC-RAS Modeling

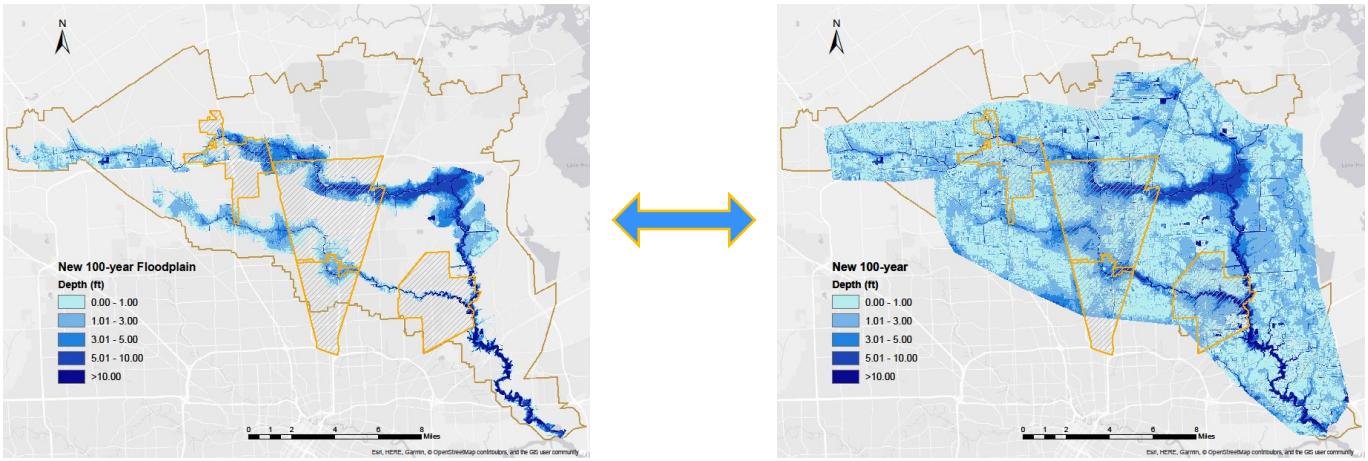

Figure 8 ATLAS 14 100-yr floodplain map for Greens Bayou, 1D vs. 2D HEC-RAS Modeling

Evaluating the Effectiveness of the Pump Storage Detention in Greenspoint

- The proposed pump storage and buyout location is near the Greenspoint Mall, East of I-45.
- Pump storage reduces an additional 2000 cfs peak flow on the Greens Bayou for a 100-year rain event (ATLAS 14).
- Minimum size of the pump: 10,000 gallons of water per minute (gpm).
- Cost ranges from $100,000~$225,000 for a self-priming pump.

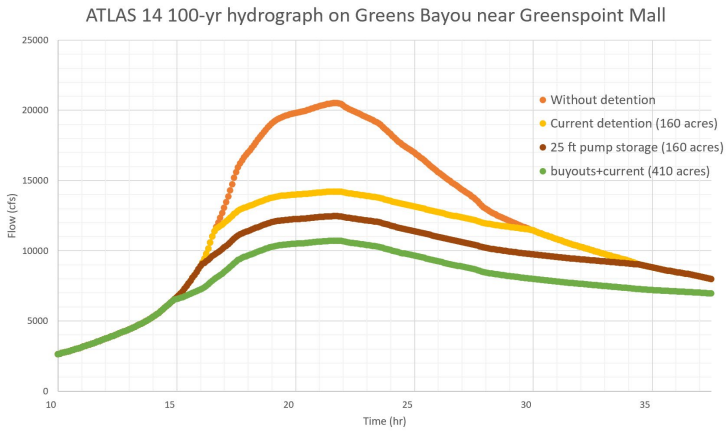

Figure 9 Detention/pump stoage scenarios' effect on an ATLAS 14 100-yr hydrograph

Figure 10 Location of the proposed pump storage