Galveston County
Multi-Jurisdictional
Hazard Mitigation Plan

Bayou Vista
Clear Lake Shores
Friendswood
Galveston County
Hitchcock
Jamaica Beach
Kemah
La Marque
League City
Santa Fe
Tiki Island

DRAFT

2016

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1.0 Introduction

1.1 Background

Galveston County is susceptible to a wide range of hazards, including hurricanes and tropical storms, thunderstorms, flooding, tornadoes and wildfires. These life-threatening hazards can destroy property, disrupt the economy and lower the overall quality of life for individuals. This was evident with the destruction and devastation caused by Hurricane Ike, which made landfall on September 13, 2008.[1]

While it is impossible to prevent a hazard event from occurring, the impact of hazards can be lessened in terms of their effect on people and property. This concept is known as hazard mitigation, which is defined by the Federal Emergency Management Agency (FEMA) as *sustained actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects.*[2] Communities participate in hazard mitigation by developing hazard mitigation plans. The Texas Division of Emergency Management (TDEM) and FEMA have authority to review and approve hazard mitigation plans through the Disaster Mitigation Act of 2000. Galveston County has been involved in mitigation planning since 2006. The evolution of the original plan development and subsequent updates are provided in Table 1.1.

Table 1.1: Hazard Mitigation Plan Development and Update Process

Plan Year	Funding	Developed by
2006-2010		Houston-Galveston Area Council of Governments (HGAC)
2011-2016	Pre-Disaster Mitigation Program (PDM)	H2O Partners, Inc.
2016-2020		True North Emergency Management, LLC

1 Hurricane Ike is discussed in further detail in Section 5
2 www.fema.gov

1.2 Scope

The focus of the plan update is to mitigate hazards as determined through a detailed hazard risk assessment conducted for Galveston County. Hazards that pose a "low" or "negligible" risk will continue to be evaluated during future updates to the plan. This enables the county and its participating jurisdictions and partners to prioritize mitigation actions based on hazards which are understood to present the greatest risk to lives and property.

This plan update includes changes in which jurisdictions chose to participate in the multi-jurisdiction planning process. Galveston, Dickinson, and Texas City opted not to join and Friendswood, Santa Fe, and League City were added as participants. Table 1.2 includes a listing of those included in the update to the 2011-2016 plan who are seeking approval.

Table 1.2: Participating Jurisdictions Seeking Approval

Jurisdictions	
Galveston County (including unincorporated areas)	City of Kemah
City of Bayou Vista	City of La Marque
City of Clear Lake Shores	City of League City
City of Friendswood	City of Santa Fe
City of Hitchcock	Village of Tiki Island
City of Jamaica Beach	

1.3 Purpose

The overarching goal of the update is to minimize or eliminate long-term risks to human life and property from known hazards by identifying and implementing cost-effective mitigation actions. The purpose of the update is twofold: to protect people and structures, and to minimize the costs of disaster response and recovery. This multi-jurisdiction plan was developed to:

- Identify hazards
- Review past disasters
- Assess county and municipal hazard risk and vulnerability
- Identify and promote mitigation efforts

1.4 Authority

The updated plan is tailored specifically for Galveston County and the participating jurisdictions seeking approval therein, and reflects conditions that have changed since the completion of the 2011 to 2016 plan. When complete, the 2016 to 2020 plan will comply with the requirements promulgated by the TDEM and all applicable provisions of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Section 104 of the Disaster Mitigation Act of 2000 (DMA 2000) (P.L. 106-390), and the Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004 (P.L. 108–264), which amended the National Flood Insurance Act (NFIA) of 1968 (42 U.S.C. 4001, et al). It also complies with FEMA's February 26, 2002 Interim Final Rule ("the Rule") at 44 CFR Part 201 which specifies the criteria for approval of mitigation plans required in Section 322 of the DMA 2000. The updated plan will also be developed in accordance with FEMA's Community Rating System (CRS) Floodplain Management Plan standards and policies. In 2012, FEMA revised the crosswalk review process and developed the Local Mitigation Plan Review Tool.[3] The improved tool provides constructive recommendations from FEMA on areas that could be explored, with future updates added to strengthen the jurisdiction's plan for effective mitigation strategies. A copy of the completed Local Mitigation Plan Tool is provided in Appendix A-1 along with the formal approval letter from FEMA.

1.5 Summary of Sections

Section 2: ***Planning Process*** is a complete account of the planning committee and public/stakeholder meetings held during the planning process. Information provided includes meeting summaries of information presented and discussions made, sign in sheets, and communication used to gather data and advertise for public input. This section also includes the ***Plan Maintenance Process*** and how the GCHMC and their respective officials will integrate this plan with all other planning initiatives, regulations and ordinances. Procedures are also defined within this section to evaluate the effectiveness of this plan through a review of the progress made towards implementation of mitigation actions, public/stakeholder involvement and identification of additional risks that may surface following the development and approval of this plan update.

Section 3: ***Community Profile*** provides a general description of the participating jurisdictions within the Galveston County planning area with their respective demographic, geographic and economic characteristics. This section also addresses land use, housing and infrastructure for the planning area.

[3] Local Mitigation Planning Handbook (March 2013)

Sections 4 to 22: The ***Hazard Identification and Risk Assessment*** outlines hazards that are prone to the planning area and the process used to identify hazards for this plan. Relevant background data, location/extent, historical occurrences, probability of future impacts, estimating future losses, and mitigation strategies are also provided.

Section 23: ***Capability Assessment*** provides the ability of the participating jurisdictions to implement mitigation strategies and identify and areas where improvements/enhancements should be considered to further advance mitigation strategies.

Section 24: ***Mitigation Strategy*** provides a summary of the accomplishments and needs into a systematic approach to achieving the planning area's goals. This section includes an update of the goals and actions from the previous approved plans and the process used to redefine the goals into a multi-jurisdictional approach. Detailed 2016-2020 mitigation action plans by participating jurisdiction are also provided in this section.

Section 25: ***Repetitive Flood Properties*** documents each participating jurisdictions participation and compliance with the National Flood Insurance Program (NFIP) and Community Rating System (CRS). A summary of the number of repetitive loss properties listed in the NFIP and progress made on mitigating these structures is also provided.

1.6 Plan Adoption

The Galveston County Multi-Jurisdictional Hazard Mitigation Plan has been developed in accordance with 44 CRF §201.6 and has been adopted by each participating jurisdiction. Table 1.3 provides a summary of the dates each plan was formally adopted and copies of the executed adoption resolutions are provided in Appendix A.

Table 1.3: Participating Jurisdiction's Plan Adoption Process

Jurisdiction	Adoption Date
Galveston County	
Bayou Vista	
Clear Lake Shores	
Friendswood	
Hitchcock	
Jamaica Beach	
Kemah	
La Marque	
League City	
Santa Fe	
Tiki Island	

2.0 Planning Process and Plan Maintenance

2.1 Planning Process Overview

According to the Federal Emergency Management Agency (FEMA), any successful planning activity, such as the development of a hazard mitigation plan, involves bringing together a cross-section of stakeholders to reach a consensus in achieving a desired outcome or resolve a community problem.

The jurisdictions participating in this plan support this initiative through daily interaction with residents, officials and business leaders in local and surrounding communities and participate in various planning initiatives including the development of the Galveston County Multi-Jurisdictional Hazard Mitigation Plan. By fostering these relationships, mitigation planning will move closer to achieving its objective of saving lives and reducing future losses resulting from natural disasters

In developing the Plan update, the consultant team used the March 2013 "Local Mitigation Planning Handbook" to meet the Interim Final Rule for Local Mitigation Planning found in §44 CFR 201.6.

Meetings were held throughout the planning process and are described herein. The following factors used in updating the 2011 plan were taken into consideration for this plan update:

- Whether the goals address current and expected conditions;
- If the nature/magnitude of risks have changed;
- If there are current resources appropriate for implementing the Plan;
- Whether implementation problems, such as technical, political, legal or coordination issues hinder development;
- If outcomes have occurred as expected; and
- How communities, agencies, and partners participated in the implementation process.

2.2 Galveston County Hazard Mitigation Council and Planning Team

The Galveston County Hazard Mitigation Council (GCHMC) members identified in Table 2.1 were selected by county/city officials to serve as their designated representative. These individuals were given the responsibility to guide the decision-making process throughout the planning process, assist with the identification of data and needs for inclusion in the plan, and review the draft plan before submittal to the TDEM and FEMA for state and federal approval. The GCHMC members will present the approved, pending adoption plan to their respective county/city officials for formal

adoption; and on behalf of their jurisdiction, assist with the integration of the goals and plan maintenance procedures outlined in this plan with other planning initiatives and actions.

To facilitate effective communication and consensus with decisions, Galveston County's Emergency Management Coordinator and Deputy Emergency Management Coordinator served as chairmen of the GCHMC.

Table 2.1: Members of the Galveston County Hazard Mitigation Council

Jurisdiction	Representative and Title
Bayou Vista	Larry Whittington, Sr., Police Chief
Clear Lake Shores	Kenny Cook, Emergency Management Coordinator
Galveston County	Garrett Foskit, Emergency Management Coordinator Meaghan Kennedy, Deputy Emergency Management Coordinator
Friendswood	Terry Byrd, Emergency Management Coordinator
Hitchcock	John Hamm, Emergency Management Coordinator
Jamaica Beach	John Brick, Emergency Management Coordinator
Kemah	Brent Hahn, Assistant Emergency Management Coordinator
La Marque	Charlene Warren, Emergency Management Coordinator
League City	Ryan Edghill, Emergency Management Coordinator
Santa Fe	Kenneth Campbell, Emergency Management Coordinator
Tiki Island	Bryan Springer, Emergency Management Coordinator

True North Emergency Management provided two planners, A. "Ryan" Williams and Rebecca Boone to work alongside the GCHMC members and develop the 2016 updated plan and present to TDEM and FEMA for approval.

Raymond Mejia, CPP, Hazard Mitigation Planner from TDEM's Mitigation Section provided technical assistance throughout the planning process.

2.3 GCHMC Plan Development Meetings

The GCHMC met three times during the planning process to systematically review data and planning documents, prioritize and rank hazards and mitigation actions, and provide input on jurisdictional needs and changes for inclusion in the plan update. Also, six mitigation strategy workshops were held throughout the planning area to solidify the mitigation goals, objectives, and actions for each participating jurisdiction. The GCHMC members were encouraged to invite officials and stakeholders to participate in these meetings.

Each of these planning steps resulted in critical work products and outcomes that collectively make up the updated plan. These events are described below and supporting documentation (agendas, sign-in sheets, presentations, etc. are provided in Appendix B.1.

Meeting 1	Agenda
Date: October 19, 2015 Time: 3-5:00 p.m. Location: Doyle Center, 2010 5th Avenue, Texas City	Introduction Plan Update Overview Community Report Hazard Identification and Risk Assessment Mitigation Strategies Schedule Questions and Dismissal

Meeting Summary

Meaghan Kennedy, Deputy EMC, Galveston County welcomed the meeting participants and introduced True North Emergency Management as the consultant hired to update the county, and participating jurisdictions, 2011-2016 hazard mitigation plan. Rebecca Boone, representing True North, opened the meeting with introductions from the planning team and then provided a brief overview of what this mitigation plan update entails and the importance of working together to develop an updated plan that will meet the participating jurisdictions' needs for the next five years were discussed. Projects and mitigation efforts outlined in the plan will assist with the development of grant applications and obtaining potential funding.

Rebecca invited the represented jurisdictions to share what their mitigation opportunities and challenges are. In general, funding and improving drainage have been a challenge for the majority of the planning area. Opportunities noted included enhancing outreach to the public (social media and reaching non-English speaking communities); continuance of elevation and buyout programs, having the support of officials and the public have led to many successes.

Ryan Williams, True North, reviewed the list of hazards profiled in the current hazard mitigation plan as compared to the current State of Texas plan, and FEMA guidance. Additional hazards will be brought forward for possible inclusion in this plan update: coastal erosion and retreat, land subsidence, expansive soils, tsunami, and lightning. Based on this analysis, the GCHMC selected the following hazards for inclusion in the plan update:

- Coastal Erosion and Retreat
- Dam/Levee Failure
- Drought
- Earthquake
- Expansive Soils
- Extreme Heat
- Flood (Coastal and Inland)
- Hailstorms
- Hurricane/Tropical Storm
- Land Subsidence
- Lightning
- Severe Winter Weather
- Tornado
- Tsunami
- Windstorms
- Wildfire (Urban and Rural)
- Pipeline failure
- Hazardous Material Incidents

Next the meeting participants received an overview of the mitigation strategy section of the plan and a list of the mitigation goals and objectives identified by the participating jurisdictions in their previous plans. Rebecca suggested the GCHMC representatives to download and review the FEMA Mitigation Ideas Handbook and the HMA Unified Guidance to help them identify new mitigation actions for inclusion in the plan update. The planning team will work with each jurisdiction over the course of the next few months to determine changes and additions to their mitigation strategy section of the plan.

Meeting 2	Agenda
Date: November 17, 2015 Time: 2:00-3:30 p.m. Location: Doyle Center, 2010 5th Avenue, Texas City	Introduction Approval of Previous Meeting Minutes Plan Update Overview Review of Capability Assessment Public Online Survey Results Hazard List and Summarize Findings Hazard Ranking Next Steps

Meeting Summary

The main purpose of this meeting was to evaluate the hazard data trends and complete the hazard ranking process to determine the risk level of each jurisdiction. Ryan Williams presented an overview of the data obtained from the National Climatic Data Center (NCDC) to assist the GCHMC members to relate the impacts of previous events to the ranking methodology exercise.

The hazard ranking methodology analyzed hazard impacts based on the following criteria: area impacted, health/safety consequences, property damage, environmental damage, and economic disruption. These characteristics were evaluated along with the likelihood of occurrence to determine the overall vulnerability for each participating jurisdiction. See Section 4 – Hazard Identification and Risk Assessment Overview for details of this process.

Mitigation Strategy Workshops			
Date	Time	Location/Jurisdiction	Agenda
Jan. 5, 2016	9-11:00	1111 Bayou Road, La Marque	Review Mitigation Goals and Objectives Review Previous Plan's Mitigation Actions Review and Prioritize 2016 Mitigation Actions Identify Additional Mitigation Actions Review Critical Facilities/Infrastructure Lists
	1-3:00	3950 FM 646 North, Santa Fe	
	3:45-5:00	1600 Whitaker Drive, Friendswood	
Jan. 6, 2016	8:30-10:30	783c Marlin, Bayou Vista Bayou Vista, Hitchcock, Tiki Island, and Jamaica Beach	
	3:00-5:00	555 W. Walker, League City League City, Clear Lake Shores, and Kemah	
Jan. 7, 2016	10-11:00	1301 FM 646 Rd W, Dickinson Galveston County	

Rebecca Boone, True North, scheduled a mitigation workshop with each jurisdiction to conduct a formal review of the mitigation actions selected for inclusion in the plan, address any missing data, and provide a final review of their critical facilities and infrastructure lists. The GCHMC was asked to invite officials, stakeholders, and any other interested parties that have an interest in assisting with implementing mitigation strategies to this workshop. Tiki Island and Hitchcock were not able to attend the scheduled meeting, so their discussions were held on a conference call on January 20 and 22, 2016 respectively.

In summary, the following items were addressed:

- Review of how the previously approved plan's mitigation goals and objectives tie into the revised goals and objectives for the 2016-2020 plan update. (See Section 24 and Appendix D-1 for details)
- Review previous mitigation action tables and addressed missing data or provide clarification as to the progress made. (See Section 24, Tables 24.1 to 24.10)
- Review and prioritized 2016 mitigation action tables. Each action was reviewed, and missing data or clarification was provided. To further strengthen the mitigation strategies for each jurisdiction, a list of suggested mitigation actions was provided, and those applicable to the jurisdictions were incorporated into their final mitigation action plans. (See Section 24, Tables 24.11 to 24.21)
- Next, each jurisdiction walked through an evaluation process to determine the priority level (low, moderate, or high). (See Section 24, Subsection 24.3 for details)
- Lastly, a copy of the critical facilities and infrastructure locations was provided to each jurisdiction to look over to determine if all relevant facilities were included

In closing each workshop session, Rebecca provided an overview of the status of the draft plan and how the review process will be conducted. She also opened the floor for questions and comments related to the plan and ensuring that each jurisdiction's needs have been made known to the planning team for inclusion in the plan update.

Meeting 4	Agenda
Date: January 20, 2016	Welcome
Time: 10:00 a.m. to 12:-00 p.m.	Approval of Previous Meeting Minutes
Location: Bayou Vista Community Center, 783C Marlin, Bayou Vista	Plan Update Overview
	Review of Hazard Analysis
	Review of Repetitive Flood Loss
	Next Steps

Meeting Summary

This meeting was hosted by Bayou Vista in their community center. Meaghan Kennedy, Deputy EMC, Galveston County welcomed the meeting participants and introduced Ryan Williams, True North. Subsequently, attendees introduced themselves by name, agency, and jurisdiction. The previous meeting minutes had been distributed with the meeting invitation and were approved by the group.

Natural hazards data compiled from the National Climatic Data Center (NCDC) and information from additional reference sources was presented. PowerPoint and hand out materials added depth to the quantitative analysis of risks through identified losses and number of occurrences and also solidified descriptions of individual hazards. Participating jurisdictions were asked to review their previous rankings and ensure they were in final form. Some minor revisions to the hazard list including the breakout of lightning, hailstorm, and windstorm took place; this brought the plan into better alignment with the State of Texas's Hazard Mitigation Plan.

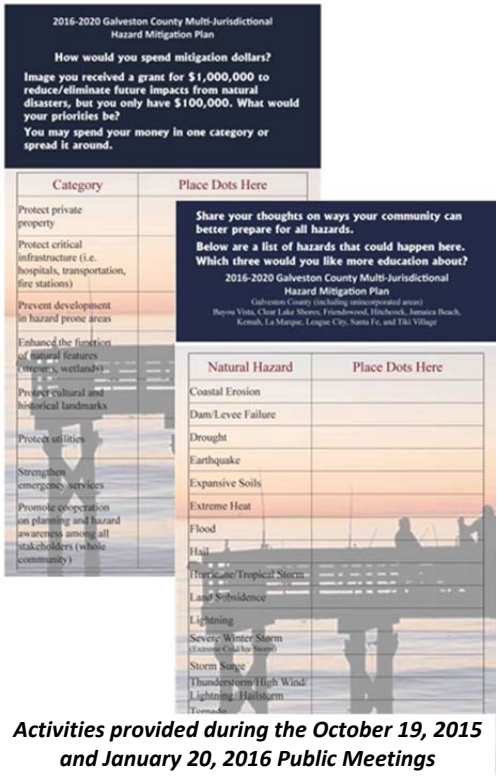
Concluding discussions on the hazards and some team collaboration on historical events such as Hurricane Ike ensued. Participants were informed the repetitive flood loss properties list was under final review and that it would be distributed to each community via email.

The meeting was then opened to questions and final comments. Before adjournment, special thanks were expressed to Bayou Vista for hosting the meeting and providing the facility.

2.4 Public and Stakeholder Engagement

An important component of mitigation planning is public participation and stakeholder involvement. Input from residents, business owners, etc. as a whole provides the planning team with a greater understanding of local concerns and increases the likelihood of successfully implementing mitigation actions. If citizens and stakeholders, such as local businesses, non-profits, hospitals, and schools, are involved, the more likely they are to gain a greater appreciation of the hazards present in their community and take steps to reduce their impact.

To allow for all interested individuals and stakeholders in the planning area to provide their input for the development and review of this plan, an online survey and public/stakeholder meetings were provided. These opportunities for engagement were advertised in local/statewide newspapers, Facebook, and the participating jurisdictions web pages (where available).



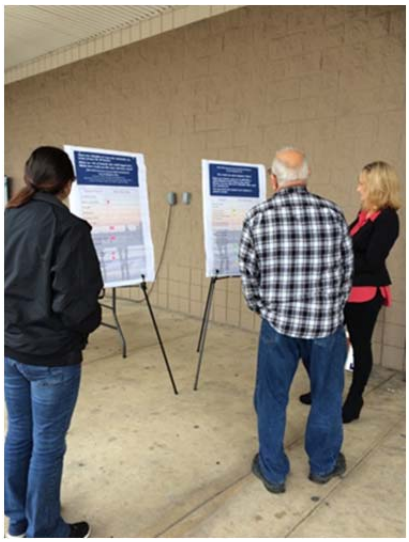
Activities provided during the October 19, 2015 and January 20, 2016 Public Meetings

Public/Stakeholder Participation

Public involvement, in the development of the Galveston County Hazard Mitigation Plan Update, was sought at two separate periods of the planning process: (1) the first five months of the plan development; and (2) upon completion of a final draft Plan but prior to official plan approval and adoption. Meeting formats were varied in an effort to appease to residents and stakeholders in the planning area. Three formats were used: (1) open public meetings; (2) online survey instruments; and (3) making copies of draft Plan deliverables available for public review on the county's website. These events are described below and supporting documentation (advertisements, social media, flyers, sign in sheets, survey questions and results, etc. are provided in Appendix B.2.

Input Meetings

The first series of open public meetings were held on October 19, 2015 following the GCHMC kickoff meeting at the Doyle Center in Texas City. This meeting provided an opportunity for the public/stakeholders to meet with their officials and the planning team to learn why hazard mitigation planning is necessary and how they can help. Two activities were made available to solicit input on which hazards more education is needed to prepare better for future events, and how they would like to see officials spend mitigation dollars to reduce/eliminate future impacts in their communities. Although there were no outside participants, several officials remained to meet the public and did complete the activities.



Participants completing activities at January 20, 2016 Public Meeting

An additional opportunity for the public/stakeholders to learn about the importance of a hazard mitigation plan for their community and provide their input was scheduled on January 6, 2016 at Lowe's in Texas City. This format and location was selected to make it convenient to obtain comments from shoppers as they departed the store. This meeting was successful in the fact that 12 people interacted with the planning team and GCOEM representative and participated in the two activities made available. The same activities as the October 20th meeting were made available. Provided below is a summary of the results provided on the activities at each public meeting:

Allocation of Mitigation Dollars		
Category	October 19, 2015	January 20, 2016
Protect private property	$0	$125,000
Protect critical infrastructure (i.e. hospitals, transportation, fire stations)	$75,000	$275,000
Prevent development in hazard prone areas	$75,000	$0
Enhance the function of natural features (streams, wetlands)	$30,000	$250,000
Protect cultural and historical landmarks	$10,000	$0
Protect utilities	$100,000	$250,000
Strengthen emergency services	$70,000	$150,000
Promote cooperation on planning and hazard awareness among all stakeholders (whole community)	$30,000	$75,000

Participant's selection of which hazards they would like more education on.	
October 19, 2015	January 20, 2016
• Dam/Levee Failure • Flood • Hurricane/Tropical Storm • Thunderstorm, High Wind, Lightning, and Hailstorm	• Coastal Erosion • Dam/Levee Failure • Drought • Earthquake • Extreme Heat • Flood • Hurricane/Tropical Storm • Land Subsidence • Severe Winter Storm • Storm Surge • Thunderstorm, High Wind, Lightning, and Hailstorm • Tsunami • Wildfire

Online Survey

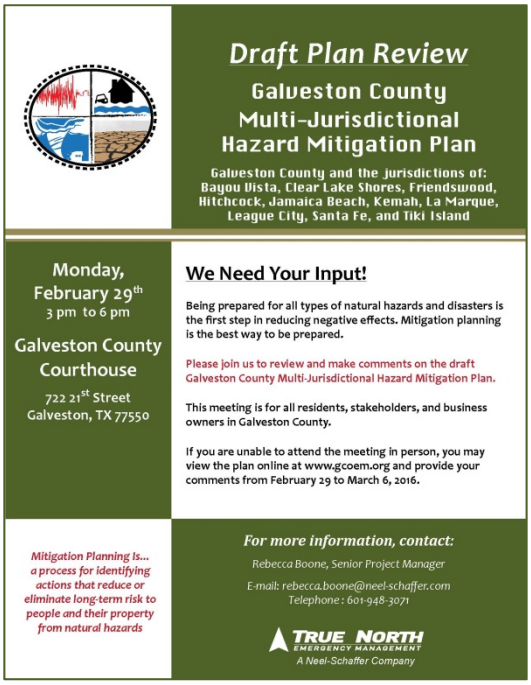
In addition to the open public meeting, the participating jurisdictions were able to solicit input from residents and stakeholders through the use of a public survey conducted via Survey Monkey and linked to available web pages and social media. The desire of this survey was to capture the interest of those who are not available to attend traditional-style meetings and increase awareness through the contact distribution lists provided through social media.

The survey provided multi-choice and open-ended questions. The questionnaire consisted of 11 questions designed to solicit information about respondent's concerns and experience in dealing with hazards. The survey was launched on October 19, 2015 and concluded on November 22, 2015. During this time, a total of 315 residents completed the survey. Below is a summary of the number of respondents per jurisdiction.

Community	No. of Responses	Community	No. of Responses
Unincorporated Galveston County	29	La Marque	9
Bayou Vista	4	League City	41
Clear Lakes Shores	1	Santa Fe	11
Friendswood	176	Village of Tiki Island	2
Hitchcock	1	Other	35
Jamaica Beach	2	Skipped Question	1
Kemah	3	Total Responses	315

Draft Plan Review Meeting

As sections of the plan were completed, an electronic copy was emailed to each member of the GCHMC with instructions to thoroughly review the information presented and provide any changes to the Planning Team. This allowed for three weeks of review time for the GCHMC and their officials prior to releasing to the public for their comments.



The public and stakeholders were provided an opportunity to review the draft Plan on February 29, 2016 at the Galveston County Courthouse. The event was advertised in the Galveston County newspaper, *The Daily News*. Flyers, as shown on the right, were posted on public bulletin boards and distributed to stakeholders identified by the GCHMC representatives within their jurisdiction, and social media and web pages also helped promote the opportunity to review the draft plan.

The draft plan was made available online at www.gcoem.org for review and comment from February 29 to March 7, 2016.

2.5 Review and Incorporation of Existing Plans

Review

A variety of existing studies, plans, reports, and technical information were reviewed as part of the planning process. Sources of the information included FEMA, the United States Army Corps of Engineers (USACE), the U.S. Fire Administration, National Oceanic and Atmospheric Administration (NOAA), the Texas Water Development Board (TWDB), the TCEQ, Texas Forest Service, the Texas Division of Emergency Management (TDEM), and local hazard assessments and plans.

Sections 4-22 summarize the findings from these information sources. Some of these documents, including those from NOAA, provided histories of disasters in the area. The USACE studies were reviewed for their assessment of risk and potential projects in the region. Census data were used to obtain population and housing statistics. Materials from FEMA and TDEM were reviewed for guidance on plan development requirements. Jurisdictions included actions from other plans, such as Floodplain Management Plans and developed actions to implement and incorporate other plans such as Stormwater Management Plans.

Incorporation

Current projects and studies from numerous sources were utilized as a starting point for discussing mitigation actions among the jurisdictions. Previous hazard events, occurrences, and descriptions were identified through NOAA's National Climatic Data Center (NCDC). Results of past hazard events were found through searching the NCDC and included in hazard sections (5-20) of this update. This data was also presented at the meeting held January 20th in order to facilitate a discussion on risk to help participants verify their hazard rankings for their jurisdiction. The State of Texas Mitigation Plan (2013), developed by TDEM, was reviewed in initial planning meetings in order to develop a specific group of hazards to address in the planning effort. The State Plan was also used as a guidance document, along with FEMA materials, in the development of the Plan Update.

2.6 Plan Maintenance Procedures

The jurisdictions who sought approval in this planning initiative will implement the strategies outlined within this plan and update and maintain the plan according to the guidelines below. The jurisdictions will use the plan's goals, as well as continued analysis of hazard risks and capabilities, to weigh the available resources against the costs and benefits for each mitigation action. The participating jurisdictions understand the value of this plan and its positive impact on mitigating hazards and intend to continue updating this plan and implementing the plan's strategies.

Four key methods of keeping this plan current are monitoring, evaluating and updating the plan. FEMA defines these the following way[1]

1. Incorporation
2. Monitoring: Tracking the implementation of the plan over time.
3. Evaluating: Assessing the effectiveness of the plan at achieving its stated purpose and goals.
4. Updating: Reviewing and revising the plan at least once every five years.

Incorporation

Each participating jurisdiction will be responsible for further development and/or implementation of their mitigation action plans. The following describes the process by which the participating jurisdictions will incorporate elements of the mitigation plan into other planning mechanisms and how information was incorporated where appropriate over the past five years.

Process of Incorporation

Once the plan update is adopted, each jurisdiction will implement actions based on priority and the availability of funding. The participating jurisdictions already implement policies and programs to reduce losses to life and property from hazards as described in the Capability Assessment found in Section 23. The mitigation actions developed for this plan update build upon that effort and will be implemented through other program mechanisms where possible.

Participating jurisdictions will integrate implementation of their mitigation actions with other existing jurisdiction plans such as capital improvement, comprehensive, land use, design and construction standards, and emergency management plans as identified in the Capability Assessment in Section 23.

[1] Local Mitigation Planning Handbook, FEMA March 2013.p.7-1

Each participating jurisdiction will review their existing plans in light of this plan update and incorporate any mitigation policies and actions into these plans, as appropriate. The jurisdictions will ensure the actions in the mitigation plans are reflected in other planning efforts. The additional planning efforts, as identified in Section 23, will be used to advance mitigation strategies in participating jurisdictions.

Upon formal adoption of the updated plan, GCHMC members will work with officials to integrate the updated hazard mitigation strategies into existing plans as indicated in Table 2.2 below.

Table 2.2: Process of Incorporation by Planning Mechanism

Planning Mechanism	Incorporation of Plan Update
Grant Applications	The plan update will be consulted by GCHMC for each jurisdiction whenever grant funding is sought for mitigation projects. If a project is not in the plan update, an amendment may be necessary to include the action in the plan.
Annual Budget Review	Each participating jurisdiction representative that participated in the planning process (as indicated in Table 2.1) will review the update and mitigation actions therein when conducting their annual budget review. Allowances will be made in accordance with grant applications sought or mitigation actions that will be undertaken according to the implementation schedule of the specific action.
Regulatory Plans	All of the participating jurisdictions currently have regulatory plans in place, such as Emergency Management Plans, Continuity of Operations Plans, Disaster Recovery Plans, Economic Development or Evacuation Plans as indicated in Section 23. The plan update will be consulted when participating jurisdictions review or revise their current regulatory planning mechanisms, or in the development of regulatory plans that are not currently in place.
Capital Improvement Plans	Seven of the jurisdictions, including the county, have a Capital Improvement Plan (CIP) in place (See Table 23-1 in Section 23). Before any updates to the CIP are conducted, jurisdictions with CIPs will review the risk assessment and mitigation strategy sections of this plan update, as limiting public spending in hazardous zones is one of the most effective long-term mitigation actions available to local governments. In addition, the plan update will be consulted if a CIP is developed for Clear Lake Shores, Hitchcock, Jamaica Beach, or Kemah.
Comprehensive Plans	According to Table 23-1, which contains the results of the capability assessment, eight jurisdictions have a Comprehensive Plan in place. Since comprehensive plans involve developing a unified vision for a community, the mitigation vision and goals of the plan update will be reviewed in the development or revision of a Comprehensive Plan.
Floodplain Management Plans	Floodplain management plans include preventative and corrective actions to address the flood hazard. All of the jurisdictions developed mitigation actions to address vulnerabilities to inland and coastal flooding. Therefore the actions for flooding, and information found in Section 6 of this plan discussing the people and property at risk to flood, will be reviewed in revised when jurisdictions update their management plans or develop new plans. All of the jurisdictions currently have a plan in place except Friendswood and Hitchcock as shown in Section 23, Table 23-1.

Monitoring

The Galveston County EMC serves as Chairman of the Galveston County Hazard Mitigation Council and is responsible for ensuring the plan is monitored for effectiveness. When necessary, the Chairman will collect information from the participating jurisdictions to update the plan. The Chairman is responsible for the plan's general upkeep and oversight as it relates to compliance with the hazard mitigation grant program requirements, all files, and necessary documentation, as well as conducting routine plan reviews. Each participating jurisdiction's designated representative will be responsible for coordinating the administrative decisions and plan integration with future planning initiatives with their appropriate officials.

Each of the jurisdictions will independently implement their own jurisdiction-specific mitigation actions. Each mitigation action in this plan is prioritized and assigned to a specific department for implementation when opportunities and funding become available. Estimated timelines are given for each mitigation action where appropriate.

The role of the chairman includes the following tasks:

- Schedule, at a minimum, a biannual meeting with the GCHMC;
- Develop meeting agendas;
- Invite other agencies/departments to participate in meetings;
- Schedule post-disaster event meetings with the GCHMC for federally and/or state-declared disasters if significant damage was sustained or the hazard disclosed vulnerabilities within the planning area that need to be addressed;
- Coordinate updates to the public with participating jurisdictions when applicable (this may include but is not limited to plan amendments, completion of mitigation actions, notification of programs available to the public for mitigation, etc.).

During annual meetings, the GCHMC will address any issues that may have occurred since the last plan update, assess events impacting the planning area to determine if changes in the plan are required, and complete the evaluation and project implementation worksheets for documentation purposes.

If significant changes, updates, or amendments to the plan are suggested by the GCHMC, they will inform TDEM's Mitigation Section to determine the appropriate action that should be taken.

Evaluation

The Galveston County Hazard Mitigation Chairman and the members of the GCHMC will use the Plan Evaluation Checklist provided in Appendix B-3 to evaluate this plan and make recommendations for future plan updates and enhancements. The worksheet will be completed annually.

The Plan Evaluation Checklist includes the following components:

- Evaluate the goals and objectives ensuring they address current and expected conditions;
- Determine any changes in the nature or magnitude of risks identified in the plan;
- Evaluate current resources for adequacy in implementing the plan;
- Document any implementation problems with other agencies, including technical, political, legal or coordination issues;
- Evaluate the effectiveness of the GCHMC;
- Evaluate the effectiveness of the participating jurisdiction's capabilities.

To further support the Plan Evaluation Checklist, three worksheets were developed and are also provided in Appendix B-3.

- Mitigation Action Implementation Worksheet (listing of mitigation actions identified by each jurisdiction);
- Mitigation Planning Team Worksheet (FEMA's Local Mitigation Planning Handbook, Worksheet 2.1);
- GCHMC Meetings and Public Involvement Activities.

The Plan Evaluation Checklist and Mitigation Action Implementation Worksheet are completed annually and stored in Appendix G. The Mitigation Planning Team Worksheet is completed only if a change is recommended by the Chairman and/or the GCHMC.

Updating

At any time, minor technical changes may be made to the plan to keep it updated. However, any material changes to the mitigation actions or major changes in the overall direction of the plan or the policies contained within it must be subject to formal adoption by the Governing Bodies of participating jurisdictions. Any amendment to the plan must undergo an open public process. Participating jurisdictions will seek public input on any material change to the plan during a formal review and comment period.

At the end of the comment period, the proposed amendment and all comments will be forwarded to the Governing Bodies of each participating jurisdiction. If no comments are received from the reviewing parties within the specified review period, this will also be noted. The Governing Bodies will then review the proposed amendment and comments received and vote to accept, reject, or amend the proposed change. Upon ratification, the amendment will be transmitted to TDEM.

In determining whether to recommend approval or denial of a plan amendment request, the following factors will be considered:

- Errors or omissions made in the identification of issues or needs during the preparation of the plan;
- New issues or needs that were not adequately addressed in the plan; and
- Changes in information, data, or assumptions from those on which the plan was based.

Five Year Review

The plan will be thoroughly reviewed by the GCHMC every five years to determine whether there have been any significant changes in the area that may necessitate changes in the types of mitigation actions proposed.

As with the development of this plan update, the Office of Emergency Management for Galveston County will oversee the review process. Specifically, the EMC and Deputy EMC will act as Chairpersons for the GCHMC.

New development in identified hazard areas, an increased exposure to hazards, disaster declarations, the increase or decrease in capability to address hazards, and changes in federal or state legislation are examples of factors that may affect the content of the updated plan.

The plan review provides Galveston County and the participating jurisdictions with an opportunity to evaluate those actions that have been successful and to explore documenting potential losses avoided due to the implementation of specific mitigation measures. The plan review also provides the opportunity to address mitigation actions that may not have been successfully implemented as assigned.

Following the five-year review, any revisions deemed necessary will be summarized and utilized according to the reporting procedures and plan amendment process outlined herein. Upon

completion of the review and update/amendment process, the revised plan will be submitted to TDEM for final review and approval in coordination with FEMA.

2.7 Continued Public Involvement

Input from the public was an integral part of the preparation of this updated plan and will continue to be essential as the plan grows and changes. As noted above, a significant change to this plan will require opportunities for the public to make its views known. Recommendations for continued public involvement are also included as mitigation actions for public education and awareness campaigns.

This plan will be posted on the GCOEM website, www.gcoem.org, where officials and the public are invited to provide ongoing feedback. Copies of the updated plan also will be kept for public review in the offices of each participating jurisdiction.

Further, if necessary, the county can designate voluntary citizens or willing members of the private sectors as members of the Planning Team as well as utilize local media to notify the public of any maintenance or periodic review activities taking place.

3.0 Community Profile

3.1 Overview

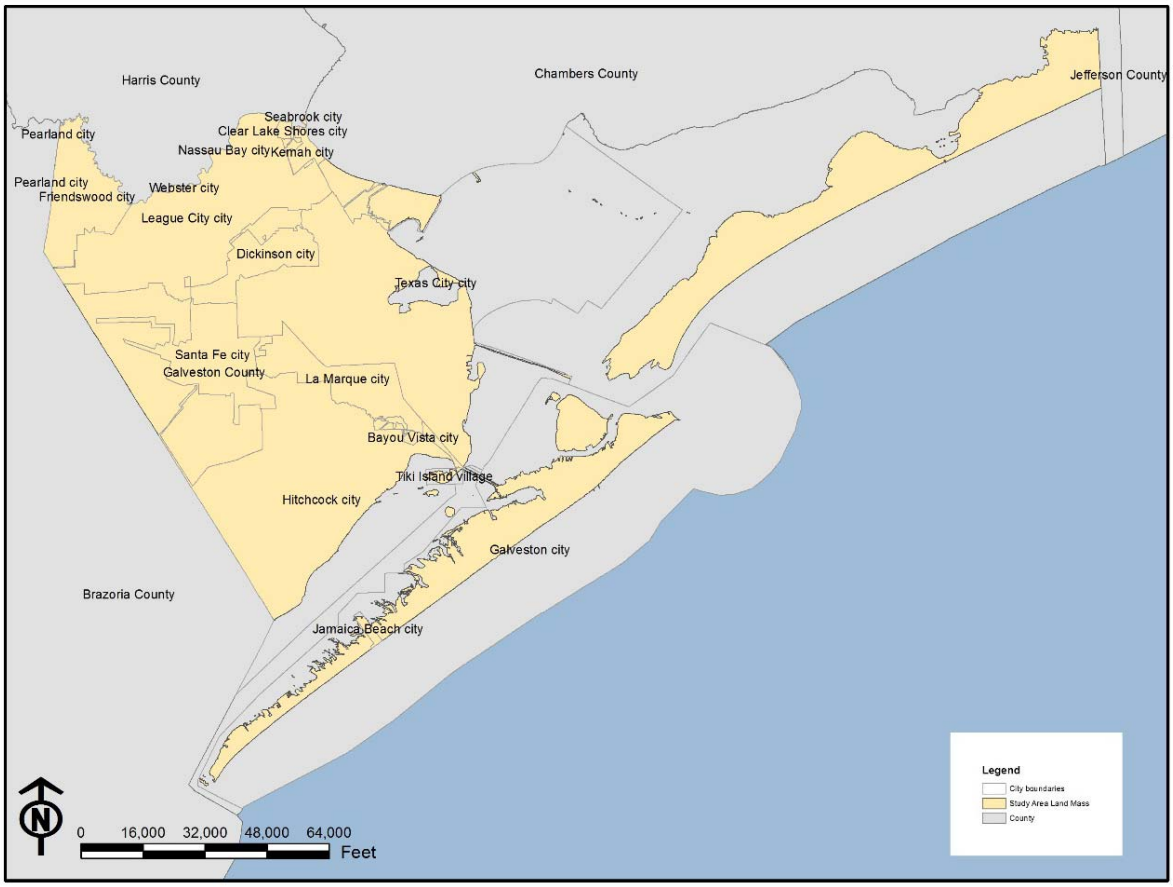
Galveston County is located on the Gulf Coast of Texas, east of Brazoria County, and west of Chambers County (Figure 3.1). The county is a 399 square mile area[1] bound by Clear Creek and Trinity Bay, where the county line crosses Galveston Bay to the eastern reaches of High Island. West Galveston County extends inland to the unincorporated community of Algoa and San Luis Pass on the coast. The Gulf of Mexico makes up the boundary on the southeast.

Galveston County was formally established in 1839 under the Republic of Texas and is comprised of the cities of: Bayou Vista, Clear Lake Shores, Dickinson, Friendswood, Galveston, Hitchcock, Jamaica Beach, Kemah, La Marque, League City, Santa Fe, Texas City, and the Village of Tiki Island. The City of Galveston is the county seat. As discussed in Section 1, all of the cities and unincorporated areas are participating in this Plan Update with the exception of Dickinson, Galveston, and Texas City. The participating jurisdictions range from larger urbanized areas to small residential beach communities nestled in the marshes, and although the area is diverse, each community faces the natural and man-caused hazards discussed in Sections 5-17 of this update. This section looks at a general profile of the county as a whole, providing data were available for each jurisdiction, including:

- Population and Demographics;
- Housing and Household Income;
- Economy and Industry; and
- Land Use and Development Trends

[1] United States Census Bureau

Figure 3.1: Overview of Galveston County

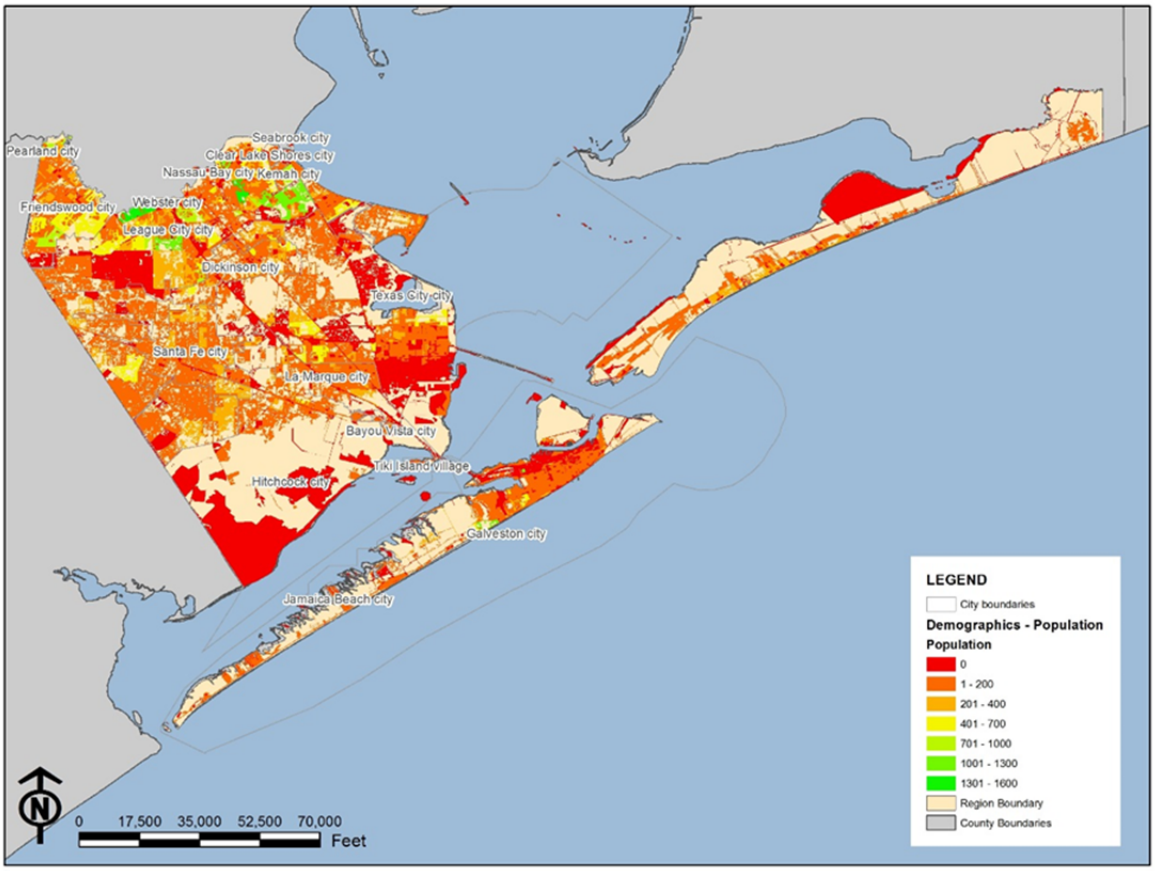


Source: HAZUS-MH 2010

3.2 Population and Demographics

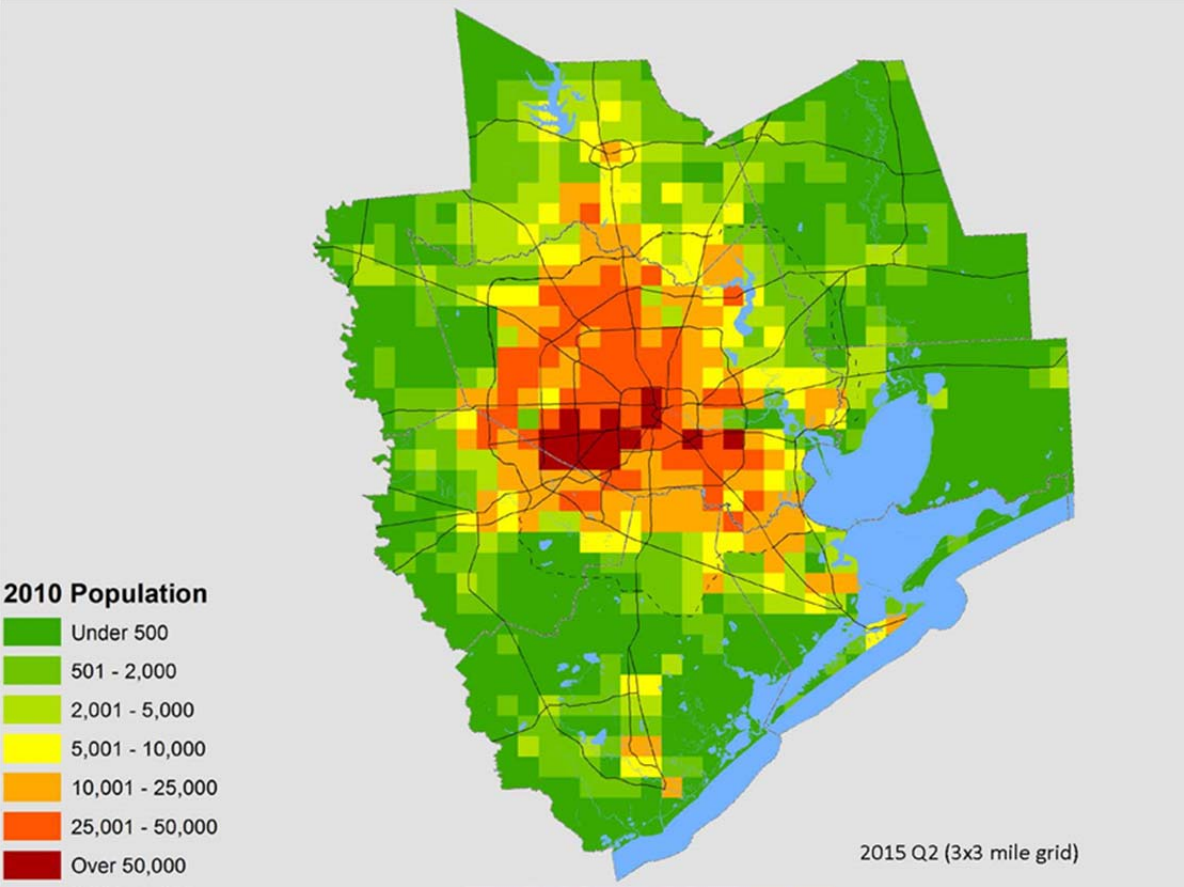
The population distribution (based on the United States Census Bureau for 2010) for Galveston County is depicted in Figures 3.2 and 3.3, which displays the county as a whole and as a part of the region, including unincorporated areas as well as the 10 participating jurisdictions. Census 2010 data was used to determine population distribution.

Figure 3.2: 2010 Population Distribution Map for Galveston County



Source: HAZUS, 2010 Census

Figure 3.3: 2010 Population Distribution Map for Galveston County Region



Source: Houston Galveston Area Council

Tables 3.1, 3.2, 3.3 and 3.4 provide a numeric breakdown of the population by jurisdiction. Several of the jurisdictions are tourist destinations and therefore experience seasonal population, an increased number of people at peak travel times in the summer months. The jurisdictions that experience seasonally-based population during the summer are listed in Table 3.1. A breakdown of the special needs population (elderly and low income) follows in Table 3.2.

Table 3.1: Participating Jurisdictions with Seasonal Population

Jurisdiction	Population Increase
Bayou Vista	50%
Tiki Island	80%
Jamaica Beach	120%
Bolivar (unincorporated)	5,000 additional/100,000 on major holidays

Source: Unknown

Table 3.2: Population Distribution by Jurisdiction

Jurisdiction	Total Population (2010 Census)	Total Number of Households (2009 ACS)	Special Needs Population		
			Elderly (Over 65)	Below Poverty	Low Income Households (>/= $20K)
Bayou Vista	1537	1,537	342	229	96
Clear Lake Shores	1063	1,063	164	237	26
Friendswood	35,805	35,805	4,198	7,001	891
Hitchcock	6961	6,961	957	95	683
Jamaica Beach	983	525	192	226	3
Kemah	1,773	760	171	430	85
La Marque	14,509	14,509	2,006	62	683
League City	83,560	31,239	6,117	528	2,090
Santa Fe	12,222	4,468	1,742	238	499
Village of Tiki Island	968	433	243	26	17
Galveston County	291,309	110,032	32,804	38,856	17,264

Source: US Census 2010, Summary File, U.S Census ACS 5 year estimates 2009-2013

Population estimates from 1970 to 2015 and population projections from 2020 to 2040 are listed in Table 3.3 and illustrated in Figure 3-4 respectively, as provided by the U.S. Census Bureau. Over the past four decades Galveston County has become increasingly more developed and urbanized, with 93.9 percent of the population urban as of 2010. The county's total population in 1970 was 169,812 and increased by 47 percent to 291,309 by 2000. Between 2000 and 2010, the population increased another 16 percent to 291,309. By 2040, the county's population is projected to nearly double the 1970 population, for a projected population count of 321,886. Household population projections are included in Table 3-3 for each participating jurisdiction. Data limitations preclude inclusion of projections for total population at this time. All populations are expected to increase with the exception of Bayou Vista which is expected to maintain current population levels.

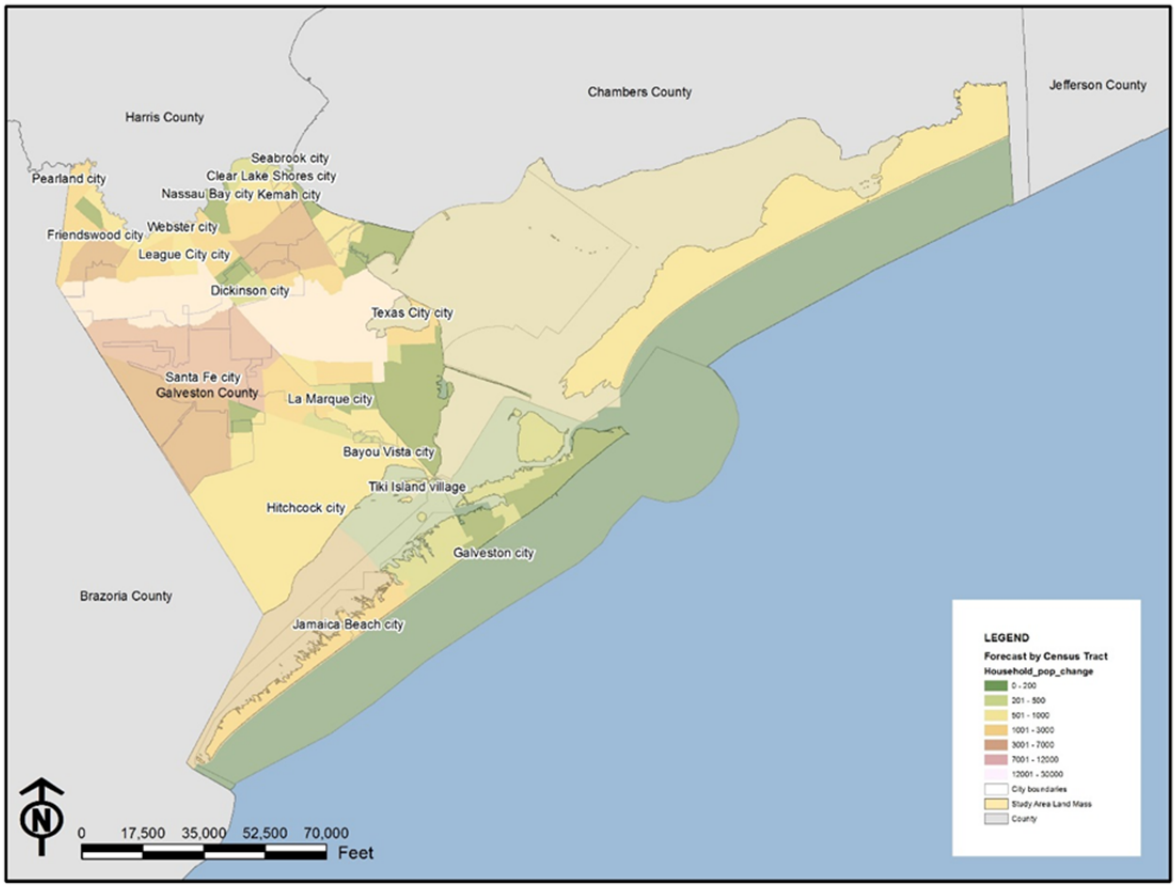
Table 3.3: Galveston County Household Population Projections and Estimates[2]

Jurisdiction	Year								% increase 2010-2050
	1970	1990	2000	2010	2015	2020	2030	2040	
Bayou Vista	-	-	-	1,537	1,537	1,537	1,537	1,537	0%
Clear Lake Shores	-	-	-	1,063	1,065	1,067	1,067	1,241	17%
Friendswood	-	-	-	35,598	41,177	45,813	55,704	63,065	77%
Hitchcock	-	-	-	6,960	8,038	8,999	9,706	10,273	48%
Jamaica Beach	-	-	-	983	1,002	1,017	1,017	1,017	3%
Kemah	-	-	-	1,773	1,995	2,173	2,368	2,569	45%
La Marque	-	-	-	14,370	16,327	17,029	17,693	22,300	55%
League City	-	-	-	83,089	108,713	128,471	159,236	162,135	95%
Santa Fe	-	-	-	12,217	13,380	14,245	15,596	19,139	57%
Village of Tiki Island	-	-	-	968	1,120	1,173	1,173	1,173	21%
Galveston County (Unincorporated)	-	-	-	32,259	35,420	38,091	49,636	69,195	114%
Galveston County (Household Population)*				286,922	-	375,527	478,819	568,159	98%
Galveston County (Total Population)*	169,812	217,396	250,158	291,309	299,971	307,372	318,459	321,886	10%

Source: Texas State Data Center; HGAC Regional Growth Forecast 2015 Q2; household population excludes population enumerated in institutional households such as national/provincial/municipal/city jails/detention centers, military camps, tuberculosis pavilions, mental hospitals, leprosaria/leper colonies or drug rehabilitation centers

[2] (p) = population projection based on no migration

Figure 3.4: Population Projections and Estimates by Census Tract



Source: Houston Galveston Area Council 2015 Q2 estimates based on US Census Data

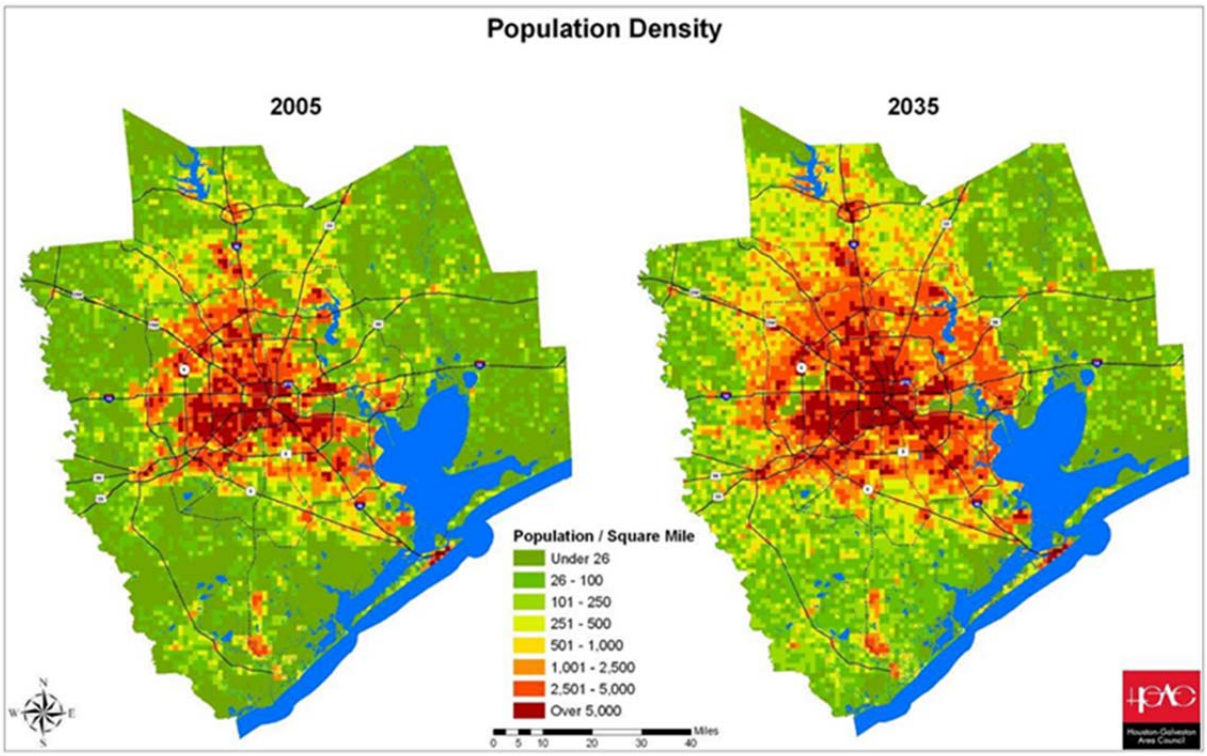
Table 3.4 provides the estimated population density by square mile during 1970 to 2010, and projected population density from 2020 to 2040, as tabulated by the U.S. Census Bureau and the Texas State Data Center. As of 2010, the population density in Galveston County was 770 people per square mile. By 2040, the population density is projected to increase to 1,056 people per square mile, which is nearly double that of 1990. Figure 3-5 geographically illustrates population density changes projected to occur during 2005 to 2035 in the Houston-Galveston region.

Table 3.4: Galveston County Estimated and Projected Population Density

Year	Population	Population Density (Per Sq. Mile)
1970	169,812	426
1990	217,396	545
2000	250,158	627
2010	291,309	770
2020 (p)	344,010	862
2030 (p)	386,888	970
2035 (p)	404,471	1,014
2040 (p)	421,361	1,056

Source: Texas State Data Center

Figure 3.5: Houston-Galveston Population Density Change (2005 – 2035)



Source: Houston Galveston Area Council

3.3 Ethnicity

The ethnic makeup of Galveston County according to estimates for 2014 by the United States Census Bureau is shown in Table 3.5 below.

Table 3.5: 2014 Ethnicity - Galveston County

Jurisdiction	Description						
	Hispanic or Latino alone	White Alone	Black African American Alone	American Indian and Alaska Native	Asian Alone	Native Hawaiian/ Pacific Islander	Two or More Races
Bayou Vista	9.10%	87.50%	0.40%	0.00%	1.00%	0.00%	1.70%
Clear Lake Shores	6.10%	90.30%	0.00%	0.00%	1.20%	0.00%	2.50%
Friendswood	14.90%	75.80%	3.00%	0.20%	4.80%	0.00%	1.30%
Hitchcock	23.80%	45.00%	29.70%	0.00%	0.30%	0.00%	1.20%
Jamaica Beach	12.50%	84.40%	0.90%	2.20%	0.00%	0.00%	0.00%
Kemah	14.90%	77.10%	1.70%	0.00%	5.40%	0.00%	0.90%
La Marque	24.20%	34.70%	37.40%	0.10%	1.30%	0.00%	2.20%
League City	18.90%	65.90%	7.40%	0.10%	5.60%	0.00%	1.90%
Santa Fe	12.70%	85.40%	0.20%	0.60%	0.30%	0.00%	0.80%
Village of Tiki Island	3.10%	91.00%	1.70%	0.00%	2.80%	0.00%	1.50%
Galveston County	23.7%	80.1%	13.6%	0.8%	3.4%	0.1%	1.9%

Source: Projections based on US Census 2010 data

Table 3.6 depicts numerical and percent change among ethnic and racial groups for Galveston County. From 2010 to 2050 it is estimated that the anglo population in Galveston County will increase by 7.0 percent, compared to a decrease by 6.8 percent statewide. The Hispanic population is projected to increase by 47.9 percent in the county. African-Americans and other racial and ethnic groups are also projected to increase for both state and county estimates.

Table 3.6: Present and Projected Ethnic and Racial Composition of Galveston County, 2010-2050

Ethnicity	2010	2020	2030	2040	2050	Numerical Change	Percentage Change
White	172,652	175,987	174,997	168,923	160,545	12,107	7.0
African American	39,229	40,842	41,919	41,950	41,433	2204	5.6
Hispanic	65,270	74,335	83,609	91,518	97,512	31,242	47.9
Other	14,158	16,208	17,934	19,495	20,645	6487	45.8
All	291,309	307,372	318,459	321,886	320,135	28,826	9.9

Source: Texas State Data Center and Office of State Demographer, Institute for Demographic and Socioeconomic Research (IDSER)

3.4 Age

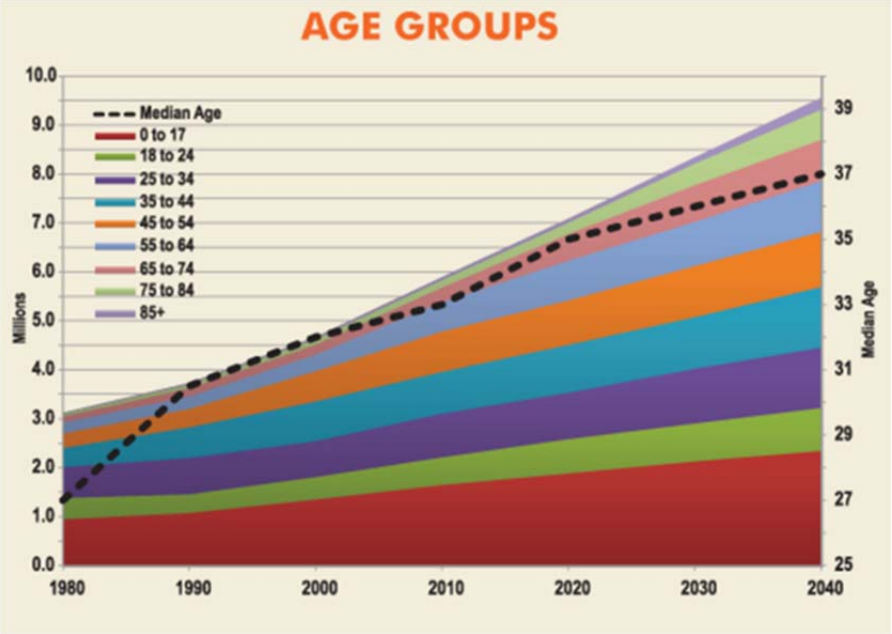
According to US Census 2010 data, the median age for persons living in Galveston County is 37, with 28.23 percent of the population at 19 or under and 16.66 percent 65 and older. The 2010 Census results for age for Galveston County are depicted in Table 3.7 below. Figure 3-5 illustrates the projected change in age composition of the population in Galveston County from 1980 to 2040. The median age is expected to increase.

Table 3.7: Age Composition in County and State

Age	Galveston County			Texas	
	Number	Percent		Number	Percent
Under 19 years	82,211	28.23		7,621,714	31.30
19 to 24 years	41,673	14.31		3,765,007	15.60
25 to 34 years	36,317	12.47		3,670,118	14.70
35 to 44 years	38,658	13.17		3,524,021	14.10
45 to 54 years	42,725	14.66		3,455,262	13.70
55 to 64 years	43,131	14.81		3,097,793	11.00
65 to 74 years	26,936	9.24		2,027,867	8.90
70 to 79 years	13,558	4.65		1,096,401	4.40
80 years and over	8,079	2.77		652,385	2.50

Source: US Census 2010

Figure 3-5: Age Projections for Galveston County



Source: Galveston 2040 Regional Transportation Plan

3.5 Education

School districts in Galveston County include the following: Clear Creek ISD, Dickinson, ISD, Friendswood ISD, Galveston ISD, High Island ISD, Hitchcock ISD, La Marque ISD, Santa Fe ISD and Texas City ISD. The county is also home to two community colleges, College of the Mainland and Galveston College and two major universities, Texas A&M University at Galveston and the University of Texas Medical Branch at Galveston. Table 3.8 depicts level education by jurisdiction.

Table 3.8: Level of Education 2013

Jurisdiction	High School Diploma or higher (%)	Bachelor's Degree or higher (%)
Bayou Vista	92.8%	22.5%
Clear Lake Shores	91.3%	42.4%
Friendswood	95.8%	49.1%
Hitchcock	82.5%	8.5%
Jamaica Beach	92.9%	36.7%
Kemah	84.8%	28.1%
La Marque	83.9%	14.9%
League City	94.9%	42.8%
Santa Fe	90.9%	14.2%
Village of Tiki Island	96.3%	40.0%
Galveston County	80.9%	22.7%
Texas	75.7%	23.2%

Source: U.S Census ACS 5 year estimates 2009-2013

3.6 Housing and Household Income

According to the 2010 U.S. Census, there were 94,782 total households in Galveston County. Of these, 33.8 percent had children under the age of 18 living with them, and 52.4 percent of the total number of households was comprised of married couples. Over 25 percent of all households were made up of individuals, with a total of 30.2 percent of non-families. In 2010 the average household size was 2.6, while the average family size was 3.12 persons per household.

Table 3.9 provides a summary of the housing units by type. Table 3.10 and Figure 3.6 depict the estimated and projected number of households based on Census estimates. In 2014, there are an estimated 136,160 households in Galveston County. Previous population projections showed the number of households increasing to 176,982 by 2040. These projections should be updated to reflect higher growth rates. The 2014 Census estimates are on track to exceed the 2020 projected number of household units, 139,329.

Table 3.9: Housing Unit Type

Jurisdiction	Units In Structure					
	Total housing units	1-unit, detached	1-unit, attached	2 units	3 units or more	Mobile home
Bayou Vista	1,252	1,221	4	27	0	0
Clear Lake Shores	617	542	7	0	68	0
Friendswood	13,593	11,087	357	91	1986	72
Hitchcock	3,273	2,315	8	76	521	353
Jamaica Beach	1,213	1,154	0	0	27	0
Kemah	886	696	62	46	71	0
La Marque	6,341	5,684	56	12	401	182
League City	33,098	25,041	1,038	245	6265	435
Santa Fe	5,261	4,345	52	175	259	396
Tiki Island	964	898	10	7	49	0
Galveston County	136,160	82,061	2,462	2,351	19,703	5,486

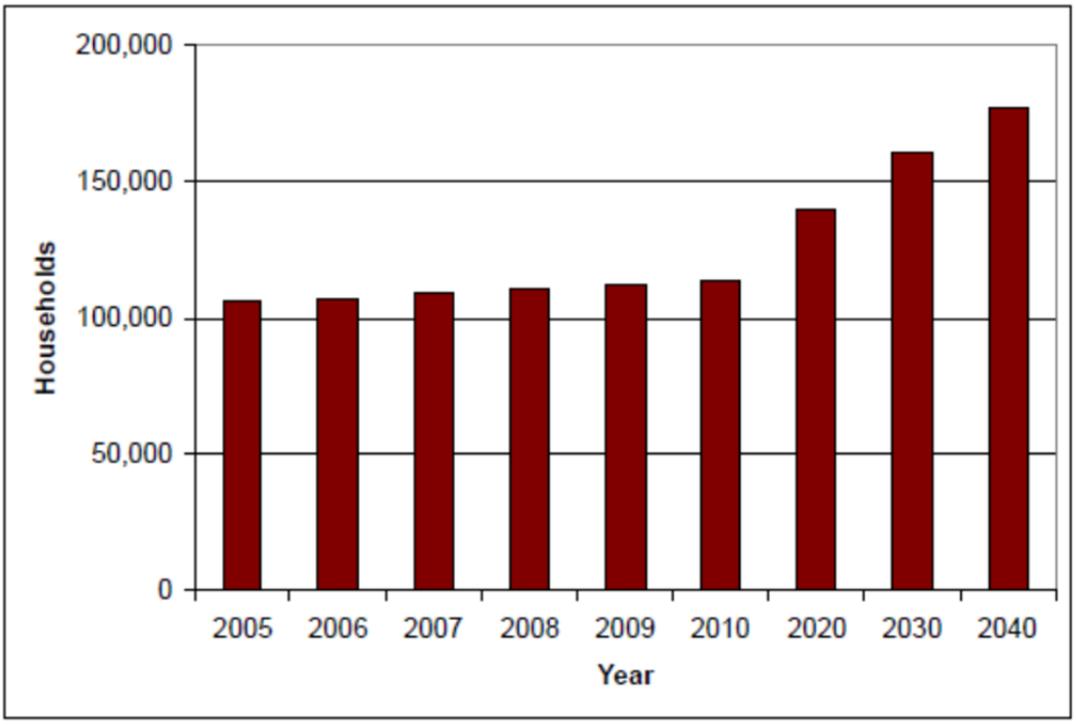
Source: US Census ACS 2010-2014; The ACS estimate of 10 was updated to reflect the specific number obtained in local counts. The updated information is within the margin of error of +/- 16 units of the ACS estimate.

Table 3.10: Estimated and Projected Number of Households in Galveston County

Year	Households
2005	105,619
2010	113,708
2020	139,329
2030	160,111
2040	176,982

Source: Galveston 2011-2016 Mitigation Plan Update

Figure 3.6: Estimated and Projected Number of Households in Galveston County



Source: Galveston 2011-2016 Mitigation Plan Update

The median household income for the county was $61,744 in 2014. The median income for non-family households was $35,044 dollars and $77,015 for family households. Males employed full-time year round received a much higher income at $58,240 versus $42,847 for females according to the Census.

3.7 Economy and Industry

The economy and industry of Galveston County continued to develop during the national recession and after the devastation caused by Hurricane Ike in 2008 and are now showing signs of economic recovery. Unemployment has decreased significantly, job growth in the region is higher than both state and national averages and the number of people and jobs are projected to increase steadily over the next decade.

Unemployment rates for the county increased from 4.9 percent in 2000 to 5.8 percent in 2008 and with estimates as high as 8.2 percent in 2009[3] during the height of the recession. The increase in unemployment was due not only to a downturn in the national economy, but the lasting effects of Hurricane Ike which devastated the County's economy in 2008. The economy has recovered with only 4.4 percent currently unemployed.

Gulf Coast regional indicators also show signs of recovery.[4] Per Capita person income growth increased 48 percent in the region between 2003 and 2013 and personal income rose from 181 billion to 334 billion in the same time frame. Job growth increased 23 percent in the region. This was slightly higher than the state increase of 19.6 percent and the U.S. increase of 4.7 percent.

The US Census (2009) reported the largest industry in the county was health care/social assistance; however, industries for the area vary by each jurisdiction. Table 3.12 lists main local industries in order of prominence for each community, as well as median income.

3 Texas Workforce Commission
[4] Texasahead.org regional profiles, 2014

142 *Table 3.12: Industry and Median Income by Jurisdiction*
143

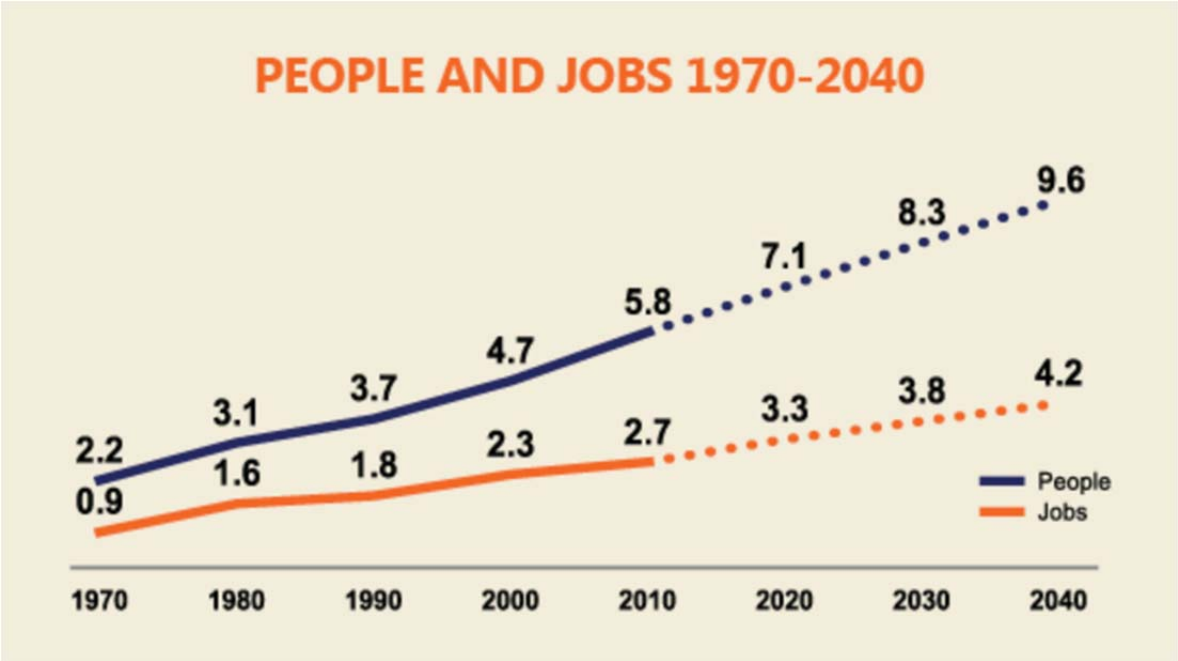
Jurisdiction	Median Income	Industries
Bayou Vista	$83,811	Educational Services, Health Care/Social Assistance, Construction, Retail Trade, Finance and Insurance
Clear Lake Shores	$98,289	Educational Services, Construction, Manufacturing, Health Care/Social Assistance, Professional Sci-Tech Services
Friendswood	$99,365	Manufacturing, Educational Services, Health Care/Social Assistance, Professional Sci-Tech Services, Retail
Hitchcock	$44,907	Construction, Health Care/Social Assistance, Retail, Educational Services, Manufacturing
Jamaica Beach	$79,125	Construction, Health Care/Social Assistance, Real Estate/ Rent/ Lease, Arts/ Entertainment/ Recreation, Accommodation/ Food Service
Kemah	$70,208	Manufacturing, Accommodation/ Food Services, Educational Services, Transportation/ Warehouse, Public Administration
La Marque	$42,369	Health Care/Social Assistance, Educational Services, Accommodation/ Food Services, Construction, Retail
League City	$89,339	Manufacturing, Health Care/Social Assistance, Educational Services, Retail, Professional Sci-Tech Services,
Santa Fe	$62,394	Health Care/Social Assistance, Manufacturing, Construction, Educational Services, Retail
Village of Tiki Island	$114,688	Health Care/Social Assistance, Manufacturing, Wholesale, Professional/Scientific/Technical Services, Educational Services, Construction
Galveston County	$61,877	Health Care/Social Assistance, Manufacturing, Educational Services, Retail Trade, Construction

144 Source: US Census, 2009-2013 ACS 5 Year Summary File, Table C24030

145

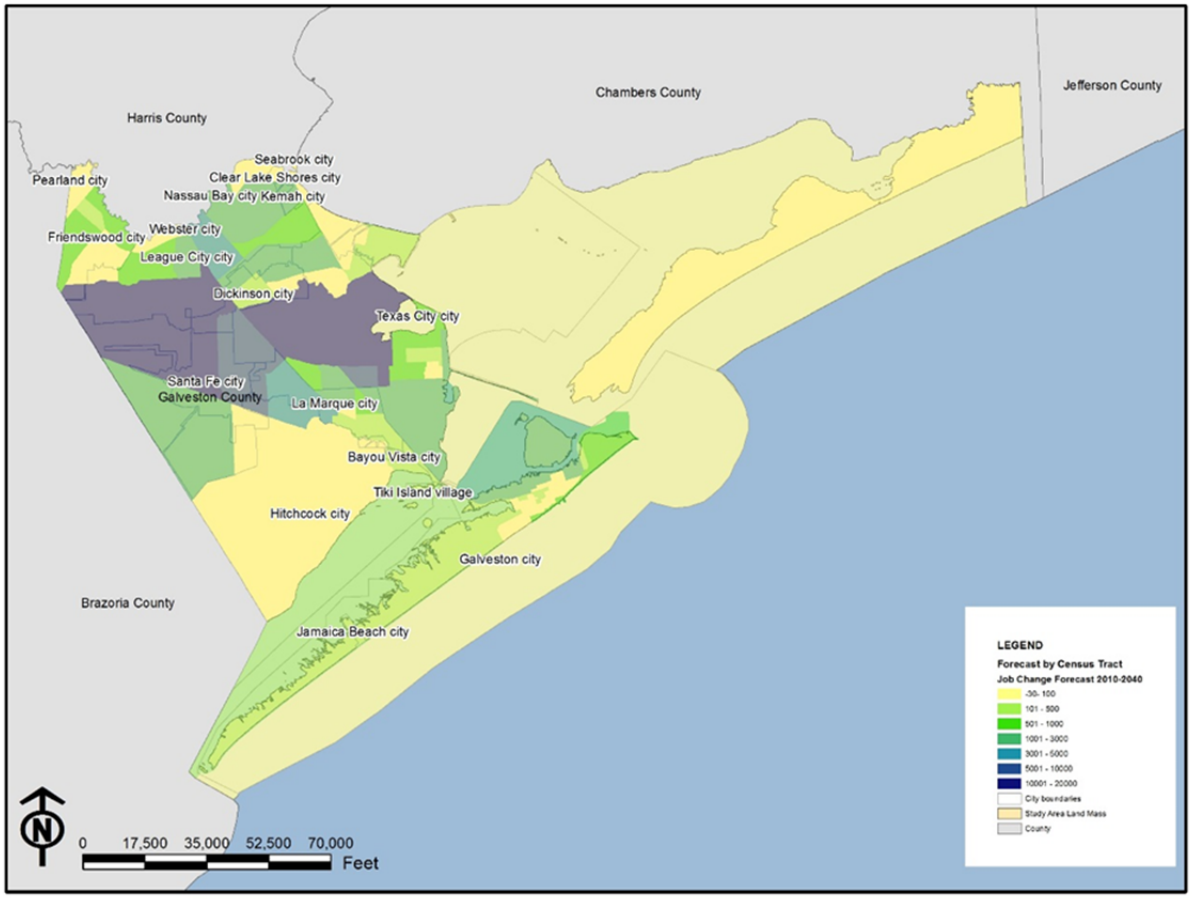
Data distributed by the Houston Galveston Area Council based on the 2010 Census illustrates positive growth in the County. The region is expected to grow to 9.6 million people and 4.2 million jobs by 2040 (Figure 3.7). 2040 job projections, illustrated in Figure 3.8, predict the highest numbers of job growth in the vicinity of Texas City, Dickinson, and Santa Fe. The increased purchasing power and tax revenue will lead to growth in 5 key areas: light vehicle fleet, real state gross domestic product, number of households, state vehicle miles traveled, and motor fuel taxes. Notably, the Real State Gross domestic product is expected to double from its 2009 rate (Figure 3.9).

Figure 3.7: People and Jobs 1970-2040



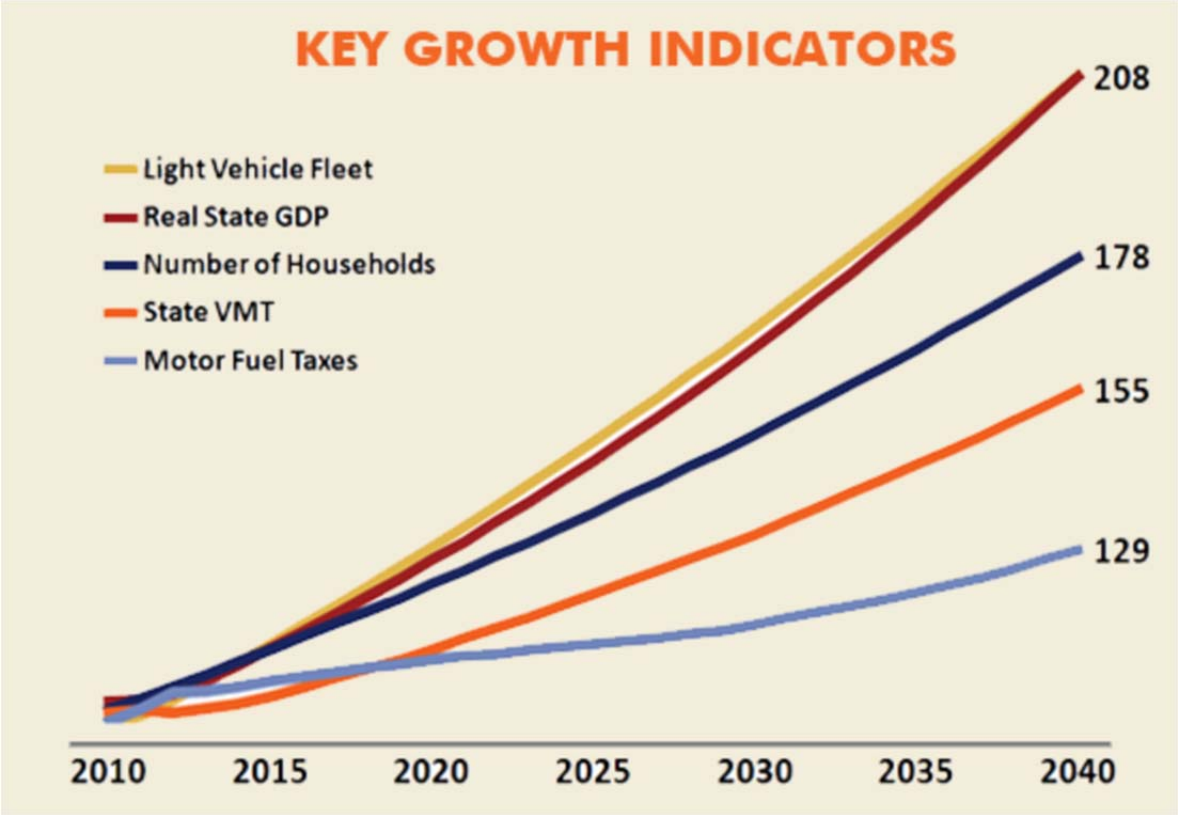
Source: Houston Galveston Area Council 2040 Galveston Regional Transportation Plan

155 *Figure 3.8: 2010-2040 Job Change Estimates*



156 Source: Houston Galveston Area Council 2010 Job Estimate and 2040 Job Projection

157 *Figure 3.9: Key Growth Indicators*



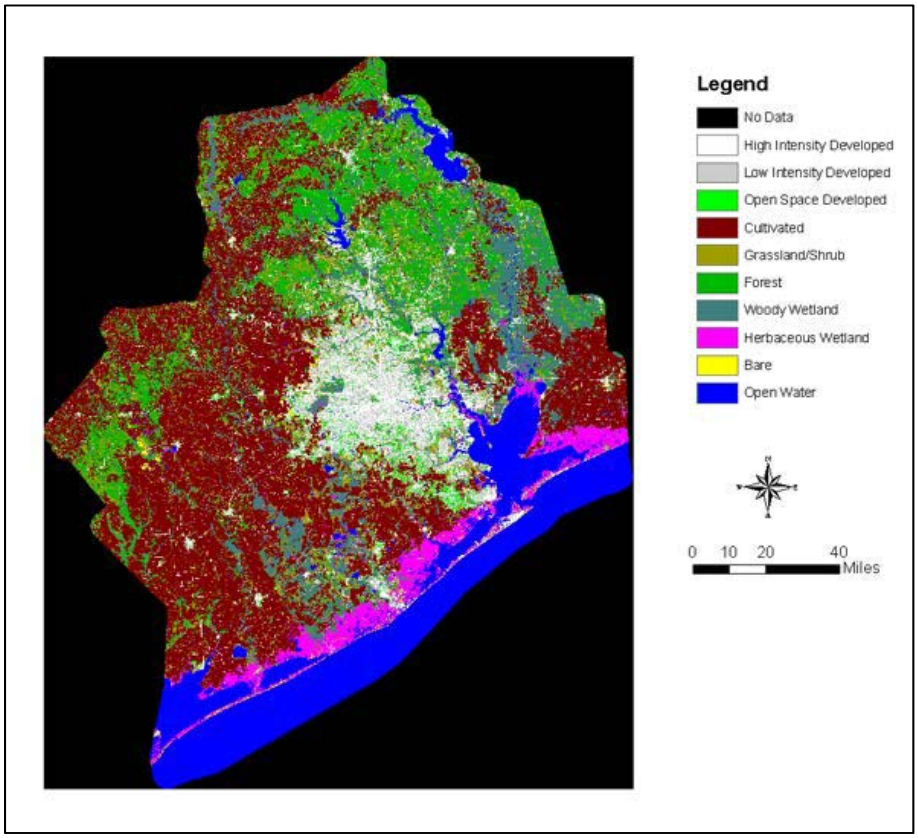
158 Source: Houston Galveston Area Council Data for 2040 Galveston Regional Transportation Plan

3.8 Land Use and Development Trends

Galveston County is located on the Texas Gulf Coast plains in the southeastern plains, bounded on the northeast by Galveston Bay and on the northwest by Clear Creek and Clear Lake. Most of the county covers Galveston Bay and is bounded to the south by the Galveston Seawall and Gulf of Mexico beaches. League City is the largest city in the county in terms of population, reaching 100,000 residents in 2015.[5]

Galveston County has a total land area of 399 square miles and total water area of 478 square miles. Generally, the land surface can be characterized as broad and nearly level. Elevation ranges from sea level to about 45 feet in the northwest part of the county (NRCS soils survey, 1985). Land use countywide supports the leading industries which include agriculture, oil and gas, shipping, and tourism. Figure 3.10 depicts land cover for the county.

Figure 3.10: Types of Land Cover (2010)



Source: Houston Galveston Area Council

[5] http://tx-leaguecity.civicplus.com/CivicAlerts.aspx?AID=1689

Agricultural land use of the 399 square miles of land (255,360 acres) comprises almost 1 percent of the state's cultivated land. The US Department of Agriculture Census (2012) reported that 89,554 acres were in cultivation in 2012 (See Table 3.13). Rice, hay, and grain are the major agriculture commodities grown. Countywide, rainfall averages 50.76 inches annually, and the growing season is 320 days a year.

Table 3.13: Agricultural Land Use 2012

	Number of farms	Land in farms (acres)	Harvested cropland (acres)	Irrigated land (acres)
Galveston County	612	89,554	7,713*	87,507*
State of Texas	248,809	130,153,438	29,147,537	4,489,153

Source: US Department of Agriculture Census (*2008, 2012)

There is one major drinking water reservoir that serves Galveston County. The Gulf Coast Water Authority operates and maintains the dam and reservoir and also oversees distribution to area Municipal Utility Districts (MUD) and Water Control Improvement Districts (WCID). Surveyed by the Texas Water Development Board (TWDB), the reservoir surface area is 859 acres, storage capacity is 7,360 acre feet and it is fed by the San Jacinto River. Other fresh water lakes and reservoirs in Galveston County are minor; each having storage capacities less than 5,000 acre feet making them below the threshold that the TWDB surveys.

The cities of Friendswood and League City purchase water from the City of Houston from the following sources:

- Lake Houston (Coastal water Authority)
- Lake Conroe (San Jacinto River Authority)
- Lake Livingston (Trinity River Authority)
- Future Allen's Creek Reservoir (Brazos River Authority)-70 percent owned by Houston

In order to better understand how growth development trends might affect hazard vulnerability, it is useful to consider population growth, occupied and vacant land, the potential for future development in hazard areas, and current planning and growth management efforts. Currently, land use planning is not required by the State of Texas, and Galveston County does not engage in land use planning, zoning or code enforcement. However, the county does enforce floodplain management ordinances, and individual jurisdictions have the authority to use zoning and land use planning.

4.0 Hazard Identification and Risk Assessment Overview

4.1 Identify Hazards and Inventory Assets

Hazard identification consists of defining the study area regarding scale and coverage, and collecting and compiling a list of prevalent hazards in the study area to help narrow the focus of the analysis.

Study Area Definition

Figure 4.1 shows the extent of the Galveston County study area, as well as the population distribution. There are ten incorporated jurisdictions participating in the study area (Bayou Vista, Clear Lake Shores, Friendswood, Hitchcock, Jamaica Beach, Kemah, La Marque, League City, Santa Fe, and the Village of Tiki Island) and all unincorporated areas are covered together in the risk assessments. Census data for 2014 was used to determine population distribution.

Figure 4.1: Population Distribution Map for Galveston County

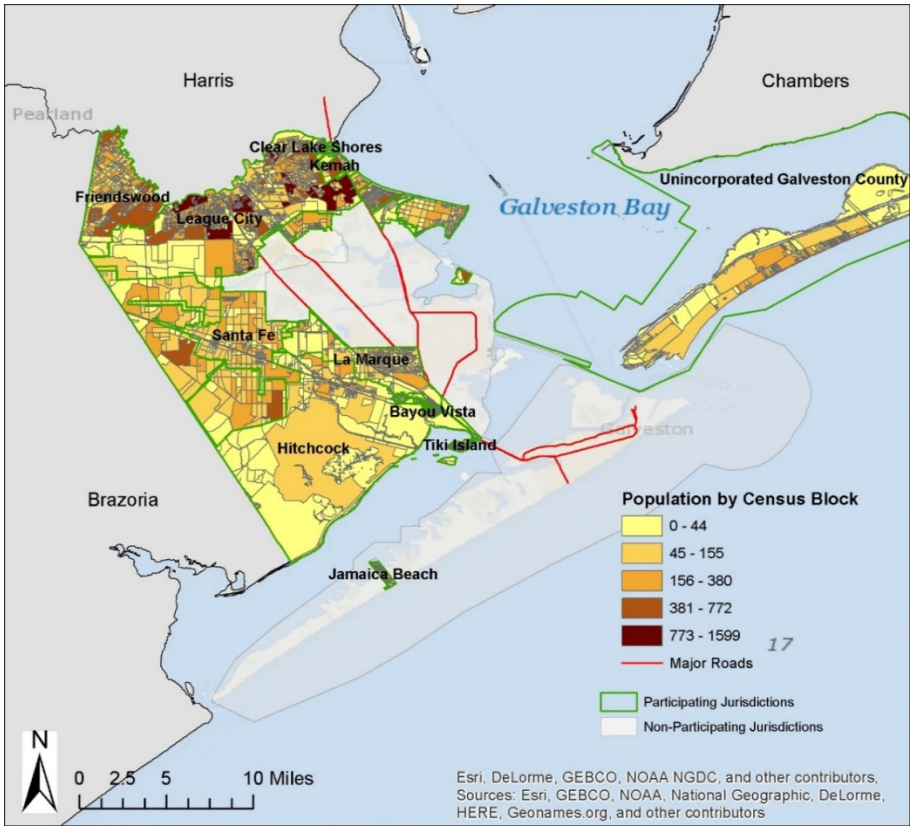


Table 4.1 provides parcel count and the total estimated improved value of the parcels. The parcel data was based on the current property appraisals provided by the Galveston County Central Appraisal District. Replacement costs could likely exceed the assessed parcel values for several reasons: (1) replacement costs are typically 50 percent higher than the assessed value (per Galveston County), (2) replacement costs often include additional expense for building code and National Flood Insurance Program compliance, and (3) costs are typically higher after a disaster due to the higher demand and lower supply of skilled contractors.

Table 4.1: Parcel Inventory by Jurisdiction

Jurisdiction	Total Estimated Number of Parcels	Total Improved Value of Parcels
Bayou Vista	1,324	$225,154,990
Clear Lake Shores	1,051	$243,448,194
Friendswood	14,761	$3,825,963,372
Hitchcock	6,337	$460,075,283
Jamaica Beach	1,590	$338,227,637
Kemah	1,221	$294,986,165
La Marque	8,972	$827,263,553
League City	36,314	$8,329,031,559
Santa Fe	6,457	$845,974,919
Village of Tiki Island	1,254	$445,402,231
Galveston County	30,438	$1,022,613,438
Total	88,210	$7,046,438,427

Source: Galveston Central Appraisal District (October 2015)

Table 4.2 provides the number and estimated values of critical facilities based on HAZUS-MH and additional layers for airports, ports, and ferries. Appendix F provides a comprehensive list of the critical facilities in the area as identified by each jurisdiction.

Table 4.2: Critical Facilities by Jurisdiction

Jurisdiction	Critical facilities[1]	
	Number	Value
Bayou Vista	1	$1,246,000
Clear Lake Shores	1	$1,246,000
Friendswood	16	$108,937,004
Hitchcock	11	$24,656,002
Jamaica Beach	2	$1,246,000
Kemah	3	$8,740,000
La Marque	11	$68,064,005
League City	25	$234,215,010
Santa Fe	14	$72,536,002
Village of Tiki Island	2	$1,246,000
Galveston County Unincorporated	15	$17,207,002
Total	123	$539,339,028

[1] Comprised of fire stations, hospitals, police stations, schools, emergency operation centers, ferry facilities, airport facilities and port facilities as listed and valued in default HAZUS-MH inventory.

Table 4.3 includes the amount (in kilometers) of oil and gas pipelines, highways and railways, and the number of hazardous materials sites (i.e., includes georeferenced TRI and Tier 2 sites) in the study region. This demographic and building stock data were the basis of the risk assessment presented in this report.

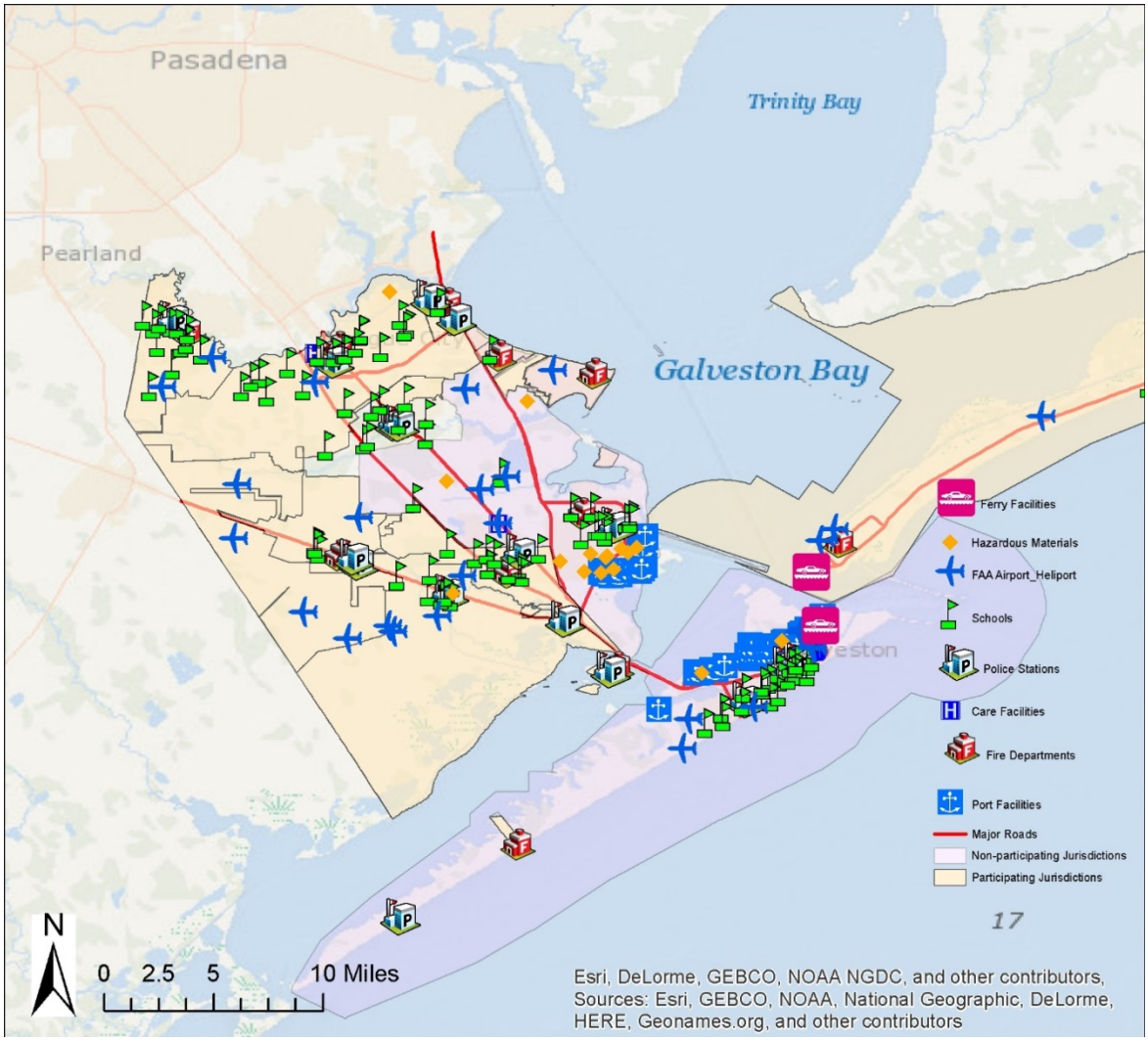
Table 4.3: Infrastructure, Lifelines, and Hazardous Materials by Jurisdiction

Jurisdiction	Infrastructure and Lifelines				No. of Hazardous Material Facilities***
	Oil Pipe (km)*	Gas Pipe (km)*	Highway (km)**	Railroad (km)**	
Bayou Vista	0.00	0.00	0.00	0.00	0
Clear Lake Shores	0.00	0.00.	.22	.19	1
Friendswood	23.15	41.73	0.00	0.00	7
Hitchcock	20.98	47.62	10.20	15.74	18
Jamaica Beach	0.00	0.00	0.00	0.00	1
Kemah	0.00	2.02.	5.11	1.47.	5
La Marque	11.49	1.01	20.71	7.04	15
League City	35.65	64.05	19.12	5.46	23
Santa Fe	19.39	24.53	6.35	4.49	8
Tiki Island	0.00	0.00	0.00	0.00	0
Galveston County Unincorporated	47.24	90.44	34.57	13.33	17
Total	157.90	271.40	96.28	47.72	95

Source: *Railroad Commission of Texas
**Galveston County
*** TRI and Tier 2 lists

Figure 4.2 shows the location of critical facilities in Galveston County as presented in the 2011 plan. This illustration shows all airports, ferry facilities, port facilities, fire stations, police stations, medical facilities, and schools within the county, including jurisdictions not participating in this risk assessment.[2] Individual hazard analyses utilize HAZUS-MH 3.0 critical facility building stock identified for the participating jurisdictions.

Figure 4.2: Critical Facilities in Galveston County



[2] The logic in displaying all critical facilities in Galveston County in this generalized figure is based on the idea that proximity of essential facilities may be relevant for reference and general planning purposes and a better understanding of critical facilities placement within the overall study region and surrounding areas.

Identification of Hazards

Hazard identification is recognizing risk-related events threatening a jurisdiction. Events are described as natural or human-caused hazards inflicting harm on people or property, or interfering with commerce or human activities. Such events would include, but are not limited to, hurricanes/tropical storms, floods, severe storms (hail, lightning, high wind), and other incidents affecting populated or built areas.

The GCHMC considered all hazards prone to the Texas Gulf Coast in accordance with 44 CFR 201.6 (c)(2)(i). Information from the National Climatic Data Center (NCDC), the United States Geologic Service (USGS), the online public survey, and other sources were reviewed to determine the type, location, and extent of natural hazards that may affect the planning area. A review of natural and technological hazards prone to Texas Gulf Coast was conducted by comparing the hazards identified in the following plans: Galveston County (2011), Friendswood (2015), League City (2009), and the State of Texas (2013). Table 4.5 reflects the crosswalk of hazards identified in these plans and includes the revised list of hazards to be presented in the 2015 plan update. Although technological hazards are not a requirement of FEMA, the GCHMC determined it beneficial to include pipeline and hazardous material incidents into this plan update.

Justification for Limited and Non-Profiled Hazards

The following hazards are considered a potential occurrence on the Texas Gulf Coast, but not deemed a threat or are limited to specific geographic areas.

- Coastal Erosion and Retreat – Coastal erosion applies only to jurisdictions that border the Gulf or tidal waterway. This includes Clear Lake Shores, Hitchcock, Jamaica Beach, Kemah, Tiki Island, and unincorporated areas of Galveston County.
- Dam/Levee Failure – According to the National Inventory of Dams, there is one high hazard dam, Galveston County Water Reservoir Dam, located in Dickinson Bayou in Texas City. The Galveston County Hurricane Flood Protection Levee, also located in Texas City and provides 17 miles of protection, and there are additional flood gates located near Clear Lake Shores and Kemah and a and berm near Bayou Park. If these systems were to fail, La Marque, Kemah, and Clear Lake Shores could be impacted. Only these jurisdictions and the county, decided to include mitigation strategies to address potential threats.
- Earthquake – The State of Texas included earthquake as a potential hazard for Region 1 only. The GCHMC considered this hazard with a majority of the participating jurisdictions agreeing the probability of a future impact is highly unlikely. However the jurisdictions of Bayou Vista, Clear Lake Shores, Kemah, La Marque, Santa Fe, and Tiki Island ranked

earthquake as a low hazard and felt it should be recognized in this plan without the development of mitigation strategies.

- Expansive Soils –According to generalized soil surveys from USGS, there are clay soils with swelling potential in Galveston County; however, no specific occurrences were identified.
- Land Subsidence - There is no current historical documentation of an incident however; Bayou Vista, Clear Lake Shores, Hitchcock, Kemah, and the unincorporated areas of Galveston County considered this as a potential risk.
- Tsunami - Galveston County is not at a high risk from tsunami due to the local rarity of the geologic events that most often generate these dangerous waves. However, the jurisdictions of Bayou Vista, Clear Lake Shores, Jamaica Beach, Kemah, Tiki Island, and the unincorporated areas of Galveston County considered this as a potential risk

Table 4.5: Hazard Identification

Natural Hazards	2011 Galveston County	2015 Friendswood	2009 League City	2013 State of Texas	2015 Plan Update
Coastal Erosion and Retreat				X	Limited
Dam/Levee Failure	X			X	Limited
Drought	X	X		X	Profiled
Earthquake				X	Non-Profiled
Expansive Soils				X	Non-Profiled
Extreme Heat	X		X	X	Profiled
Flood (Coastal and Inland)	X	X	X	X	Profiled
Hailstorm	X	X	X	X	Profiled
Hurricane/ Tropical Storm	X	X	X	X	Profiled
Land Subsidence		X		X	Limited
Lightning		X	X	X	Profiled
Severe Winter Storm	X	X		X	Profiled
Tornado	X	X	X	X	Profiled
Tsunami	X				Limited
Wildfire (Urban and Rural)	X			X	Profiled
Windstorm		X	X	X	Profiled
Technological Hazards					
Pipeline Failure	X	X			Profiled
Hazard Material Incidents	X	X			Profiled

4.2 Overview of Hazard Analysis

This multi-jurisdictional risk assessment was conducted with three distinct methodologies, utilizing GIS- based analysis, HAZUS-MH software, and a statistical risk assessment methodology. Each hazard analysis is based on both qualitative and quantitative information, and each approach provides estimates of the potential impact of hazards by using a common, systematic framework for evaluation, including historical occurrence information. The results of the multi-jurisdictional risk assessment are provided as appropriate for each hazard profiled. Following are brief descriptions of the approaches used for the analysis.

GIS-Based Analysis

For GIS-based assessment, digital data was collected from local, state and national sources. ESRI® ArcGIS™ was used to assess risk utilizing digital data including local tax records for individual parcels and geo-referenced point locations for critical facilities. Using these data layers, the risks were evaluated by estimating the assessed building value associated with parcels determined to be located in identified hazard areas.

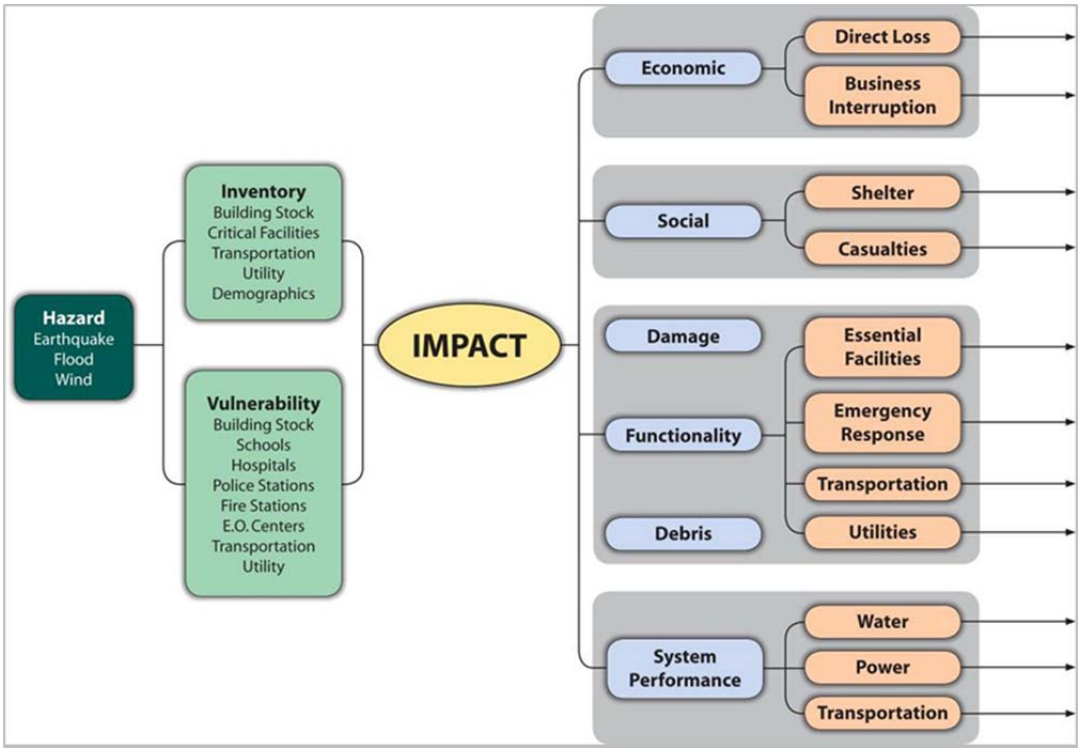
The objective of the GIS-based analysis was to determine the estimated vulnerability of people, buildings and critical facilities to the identified hazards for the participating jurisdictions using best available geospatial data. In so doing, local databases made available through Galveston County such as local tax assessor records, parcel boundaries, building footprints and critical facilities data, were used in combination with digital hazard data. The results of the analysis provided an estimated number of people, as well as the numbers and values of buildings and critical facilities determined to be potentially at risk of those hazards with delineable geographic hazard boundaries. GIS analysis was used on the following hazards: flood (coastal and inland), hurricane/tropical storm, dam/levee failure, wildfire (urban and rural), and technological hazards.

HAZUS-MH Analysis

HAZUS-MH is FEMA's standardized loss estimation software program built upon an integrated GIS platform (Figure 4.3) to conduct analysis at a regional level (i.e., not on a structure-by-structure basis). The HAZUS-MH risk assessment methodology is parametric, in that distinct hazard and inventory parameters (e.g., wind speed and building types) were modeled using the HAZUS-MH software to determine the impact (i.e., damages and losses) on the built environment. This risk assessment applied HAZUS-MH to produce countywide profiles and estimate losses for flood and hurricane/tropical storm at the jurisdictional level. At the time this analysis was completed, HAZUS-MH 3.0 was used to estimate potential losses using HAZUS-MH default building stock inventory data and flood.

The results of the HAZUS-MH model analysis include annualized loss estimates for each participating jurisdiction so that potential loss values may be compared to one another throughout the county.

Figure 4.3: Conceptual Model of HAZUS-MH Methodology



Statistical Risk Assessment Methodology

The statistical risk assessment methodology was primarily applied to analyze hazards of concern that were outside the scope of HAZUS-MH and the GIS-based risk assessment. This methodology uses a statistical approach and mathematical modeling of risk to predict a hazard's frequency of occurrence and estimated impacts based on recorded or historic damage information. This methodology was explicitly used to assess the risk to the following hazards: hailstorm, windstorm, lightning, and tornado. Flooding, hurricane winds, and storm surge also incorporate statistical elements into their analysis. Available historical data for each hazard was used, and statistical evaluations were performed using manual calculations. The general steps used in the statistical risk assessment methodology are summarized below:

- Compile data from local, state and national sources, etc.
- Clean up data, including removal of duplicate records

- Identify patterns in frequency, intensity, vulnerability and loss
- Statistically and probabilistically extrapolate the patterns
- Produce meaningful results, including the development of annualized loss estimates

Loss Estimates

The economic loss results are presented here using two interrelated riskindicators:

1. The Annualized Loss (AL), which is the estimated long-term weighted average value of losses to property in any single year in a specified geographic area (i.e., county).
2. The Annualized Loss Ratio (ALR), which expresses estimated annualized loss normalized by property value.

The estimated AL addresses the key idea of risk: the probability of the loss occurring in the study area (largely a function of building construction type and quality). By annualizing estimated losses, the AL factors in historic patterns of frequent smaller events with infrequent but larger events to provide a balanced presentation of the risk. The ALR represents the AL as a fraction of the replacement value of the local inventory. This ratio is calculated using the following formula: ALR = Annualized Losses/Total Exposure

The ALR gauges the relationship between average annualized loss and replacement value. This ratio can be used as a measure of vulnerability in the areas, and since it is normalized by replacement value, it can be directly compared across different geographic units such as metropolitan areas or counties.

Risk (Vulnerability) Assessment is presented in terms of AL, whenever possible. In general, presenting results in the annualized form very useful on threefronts:

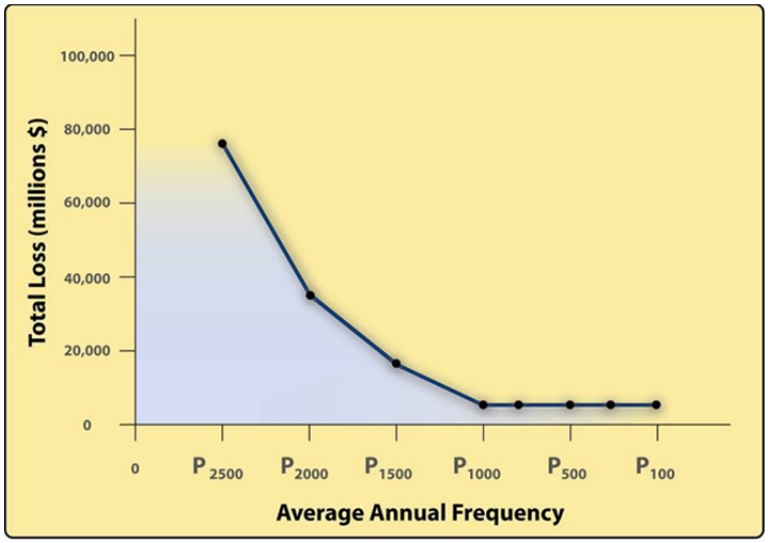
1. Contribution of potential losses from all future disasters is accounted for with this approach.
2. Results in this form from different hazards are readily comparable and hence easier to rank.
3. When evaluating mitigation alternatives, use of annualized losses is the most objective approach for this purpose.

Annualized Losses for the hazards where the parametric approach is utilized are computed in a three- step process:

1. Compute/estimate losses for a number of scenario events with different return periods (e.g., 10-year, 100-year, 200-year, 500-year, etc.).
2. Approximate the probability versus loss curve through curve fitting.
3. Calculate the area under the fitted curve to obtain annualized losses.

This approach is illustrated graphically in Figure 4.5. For other hazards where the statistical approach was used, the computations are based primarily on the observed historical losses.

Figure 4.5: Graphical Representation of the Annualized Loss Methodology



Economic Impact

Using the previously described methodology, results were obtained for the different hazards profiled earlier. The economic results are summarized in Table 4.6.

The economic loss results are presented here using AL, which is the estimated long- term value of losses to the general building stock in any single year in a specified geographic area (i.e., county). The estimated AL addresses the two key components of risk: the probability of a hazard occurring in the study area and the consequences of the hazard, largely a function of building construction type and quality, and of the intensity of the hazard event. By annualizing estimated losses, the AL factors in historic patterns of frequent smaller events with infrequent but larger events to provide a

183 balanced presentation of the risk. Specific information for individual jurisdictions is provided in the
184 applicable hazard sections.

185 *Table 4.6: Summary of Annualized Loss (AL) Estimates*

Flood (Surge)	Hurricane (Wind)	Windstorm	Tornado	Flooding	Hail
*$702,705,416	$78,126,283	$783,885	$510,866	$86,850	$28,386

186 Note: *Countywide Estimate from HAZUS-MH

187 A summary of the ALR results is presented in Table 4.7. The ALR represents the AL as a fraction of
188 the replacement value of the local inventory. The ALR gauges the relationship between average
189 annualized loss and replacement value. This ratio can be used as a measure of vulnerability in the
190 areas, and since it is normalized by replacement value, it can be directly compared across different
191 jurisdictions. Specific information for individual jurisdictions is provided in the applicable hazard
192 sections.

193 *Table 4.7: Summary of the Annualized Loss Ratios (ALR)*

Flood (Surge)	Hurricane (Wind)	Windstorm	Tornado	Flooding	Hail
*1.9%	0.44%	0.00%	0.00%	0.00%	0.00%

194 Note: *Countywide Estimate from HAZUS-MH

195 4.3 Risk Ranking

196 The GCHMC reviewed a hazard ranking process presented by the planning team as shown in Table
197 4.8. This methodology evaluates five risk characteristics against a scoring factor to establish a level
198 of vulnerability and a process to establish the level for future occurrence.

199

Table 4.8 - Natural Hazard Identification Methodology

Risk Characteristic (Vulnerability)		Score
Area Impacted (The % of the jurisdiction at risk to an impact from each hazard)	No area in the jurisdiction directly impacted	0
	Less than 25% of the jurisdiction impacted	1
	Less than 50% of the jurisdiction impacted	2
	Less than 75% of the jurisdiction impacted	3
	Over 75% of the jurisdiction impacted	4
Health And Safety Consequences (The health and safety consequences that can occur)	No health and safety impact	0
	Few injuries or illnesses	2
	Few fatalities but many injuries or illnesses	3
	Numerous fatalities	4
Property Damage (The amount of property damage that can occur)	No property damage	0
	Few properties destroyed or damaged	1
	Few destroyed but many damaged	2
	Few damaged and many destroyed	3
	Many properties destroyed and damaged	4
Environmental Damage (The environmental damage that can occur)	Little or no environmental damage	0
	Resources damaged with short-term recovery	1
	Resources damaged with long term recovery	2
	Resources destroyed beyond recovery	4
Economic Disruption (The economic disruption that can occur)	No economic impact	0
	Low direct and/or indirect costs	1
	High direct and low indirect costs	2
	Low direct and high indirect costs	3
	High direct and high indirect costs	4
Future Occurrence		
Probability Of Future Occurrence (The probability of a future occurrence)	Unknown/less than 1 occurrence (anticipate rare occurrence)	1
	1 - 4 documented occurrences over last 10 years	2
	5 - 7 documented occurrences over last 10 years	3
	8 – 10 documented occurrences over last 10 years	4
	More than 10 occurrences over last 10 years	5
Risk Level	**Total Rating Score**	
Low	0-33	
A low risk rating is expected to have little to no impact upon the jurisdiction. The hazard poses minimal health and safety consequences to the state's residences and is expected to cause little to no property damage. *The occurrence of a hazard with a low risk rating is rare; however, due to other factors such as geographical location, it is still possible for such a hazard to occur and even cause significant damage based upon the magnitude of the event.*		
Medium	34-67	
A medium risk rating is expected to have a moderate impact upon the jurisdiction. The hazard poses minor health and safety consequences with minor injuries expected and few to no fatalities. The hazard may cause some properties to be damaged or destroyed. *The occurrence of a hazard with a medium risk rating is likely at least once within the next 25 years.*		
High	68 to 100	
A high risk rating is expected to have a significant impact upon the jurisdiction. The hazard poses high health and safety consequences with numerous injuries and fatalities possible. The hazard may even cause some properties to be damaged or destroyed. *A hazard with a high risk rating is expected to occur at least once within a 12 month period, but can occur multiple times within a year.*		

To ensure a base line of understanding of each hazard and to assist with the process of risk rankings, information was gathered from the 2011 plan; the public survey; the NCDC storm data base; and TDEM and presented to the GCHMC prior to completion of the risk ranking exercise.

Once the risk characterization was completed for each identified natural hazard, the sum of the risk characteristics were added together and multiplied by the probability of occurrence to determine each hazard's total risk rating score. The maximum score possible was 100. Table 4.9 provides a recap of the risk level attained for each hazard. The completed scoring sheets for each jurisdiction are provided in Appendix C.

Table 4.9: Summary of Hazard Ranking

Jurisdiction	Flood (Coastal and Inland)	Hurricane/Tropical Storm	Tsunami	Tornado	Windstorm	Hailstorm	Lightning	Winter storm	Drought	Extreme Heat	Wildfire (Urban and Rural)	Coast Erosion and Retreat	Land Subsidence	Earthquake	Dam/Levee Failure	Expansive Soils	Pipeline Failure	Hazardous Material Incents
Bayou Vista	H	H	L	H	H	H	M	L	L	M	L	L	L	L	L	L	M	M
Clear Lake Shores	L	M	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Friendswood	H	L	L	L	L	L	M	L	L	L	L	L	L	L	L	L	L	L
Hitchcock	L	L	L	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L
Jamaica Beach	M	H	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Kemah	H	H	L	H	H	H	H	M	H	H	M	H	M	M	M	M	H	H
La Marque	M	M	L	L	H	M	H	L	L	L	L	L	L	L	M	L	M	M
League City	M	L	L	L	M	M	L	L	L	L	L	L	L	L	L	L	L	L
Santa Fe	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Tiki Island	H	H	L	M	M	M	M	L	L	L	L	L	L	L	L	L	L	L
Galveston County	L	M	L	L	H	L	L	L	L	L	L	L	L	L	L	L	M	M

4.4 Conclusions

The results of this study are useful in following ways:

- Improving our understanding of the risk associated with the natural hazards in Galveston County through a better understanding of the complexities and dynamics of risk, how levels of risk can be measured and compared, and the myriad factors that influence risk. An understanding of these relationships is critical for making balanced and informed decisions on managing the risk.
- Providing a baseline for policy development and comparison of mitigation alternatives. The data used for this analysis present a current picture of risk in Galveston County. Updating this risk "snapshot" with future data will enable comparison of the changes in risk with time. Baselines of this type can support the objective analysis of policy and program options for risk reduction in the region.
- Comparing the risk among the natural hazards addressed. The ability to quantify the risk to all these hazards relative to one another helps in a balanced, multi-hazard approach to risk management at each level of governing authority. This ranking provides a systematic framework to compare and prioritize the very disparate natural hazards that are present in Galveston County. This final step in the risk assessment provides the necessary information for the GCHMC to craft a mitigation strategy to focus resources on only those hazards that pose the most threat to the region.

5.0 Hurricane/Tropical Storm

5.1 Description

By far the most severe, common and geographically extensive impact on the Galveston County planning area from a natural hazard is caused by hurricanes, coastal storms and the associated wind and storm surge.

Hurricanes and tropical storms are naturally occurring events that produce damaging high winds, generate dangerous storm surge flooding, cause pounding storm surf, spawn tornadoes, and produce torrential rainfall that can cause inland flooding.

On a recurring basis, hurricanes are the strongest natural hazard threat to human life and property. Tropical storms and hurricanes threaten the Galveston County planning area with high winds, rain, and storm surge. Galveston County and the participating jurisdictions participate with local media in educating the public about the dangers of hurricanes. Due to the size of hurricanes and tropical storms, the entire planning area can be impacted by these storms.

The Atlantic hurricane season begins June 1 and ends November 30, but hurricanes have developed outside of the designated season.

The following terms are used to describe tropical storms / hurricanes:

Tropical Wave: A trough or cyclonic curvature maximum in the trade-wind easterlies. The wave may reach maximum amplitude in the lower middle troposphere.

Tropical Depression: A tropical cyclone with maximum sustained surface wind speeds (using the U.S. 1-minute average) of 33 kts (38 mph or 62 km/hr) or less.

Tropical Storm: A tropical cyclone with maximum sustained surface wind speed (using the U.S. 1-minute average) ranges from 34 kts (39 mph or 63 km/hr) to 63 kts (73 mph or 118 km/hr).

Hurricane: A tropical cyclone with maximum sustained surface winds (using the U.S. 1-minute average) of 64 kts (74 mph or 119 km/hr) or more.

Storm Surge

According to the National Hurricane Center, along the coast, the greatest potential for loss of life related to a hurricane is from storm surge. Low pressure and strong circular winds "pile" the water into a dome shape that can be 50-100 miles wide. The surge travels with the storm and is most severe in the right quadrant of the storm; relative to the direction the storm travels. Surge can be 15 feet deep, topped by waves, and make landfall ahead of the center or "eye" of the hurricane. Wind-driven waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with normal high tides.

Because much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 10 feet above mean sea level, the danger from storm tides is tremendous. For example, Hurricane Ike produced storm surges up to 8 feet above the normal tide- level.

Hurricane Wind

Hurricane wind intensity is measured with the Saffir-Simpson Scale based on a 1-5 rating of a sustained wind speed at the time of measurement. This is used to estimate the potential property damage expected along the coast from a hurricane landfall. Hurricanes reaching Category 3 and higher are considered major hurricanes because of potential significant loss of life and damage. Category 1 and 2 storms are still dangerous, however, and require preventative measures. Wind speed is the determining factor in the scale. All winds are described using the U.S. 1-minute average. Previously, storm surge was described by the Saffir-Simpson Scale but is no longer included.

The following excerpt from the National Hurricane Center explains the revised definition of the Saffir-Simpson Hurricane Scale and the separation of storm surge from storm category followed by an explanation of the need to change the new range of wind speeds:

> *Earlier versions of the Saffir-Simpson Hurricane Scale incorporated central pressure and storm surge as components of the categories. The central pressure was used during the 1970s and 1980s as a proxy for the winds as accurate wind speed intensity measurements from aircraft reconnaissance were not routinely available for hurricanes until 1990. Storm surge was also quantified by category in the earliest published versions of the scale dating back to 1972. However, hurricane size (extent of hurricane-force winds), local bathymetry (depth of near-shore waters), topography, the hurricane's forward speed and angle to the coast also affect the surge that is produced. For example, the very large Hurricane Ike (with hurricane force winds extending as much as 125 mi from the center) in 2008 made landfall in Texas as a Category 2 hurricane and had peak storm surge values of about 20 feet. In contrast, tiny Hurricane Charley (with hurricane force winds extending at most 25 mi from the center) struck Florida in 2004 as a Category 4 hurricane and produced a peak storm surge of only about 7 feet These storm surge values were substantially outside of the ranges suggested in the original scale. Thus*

to help reduce public confusion about the impacts associated with the various hurricane categories as well as to provide a more scientifically defensible scale, the storm surge ranges, flooding impact and central pressure statements are removed from the Saffir-Simpson Hurricane Scale and only peak winds are employed in this revised version.

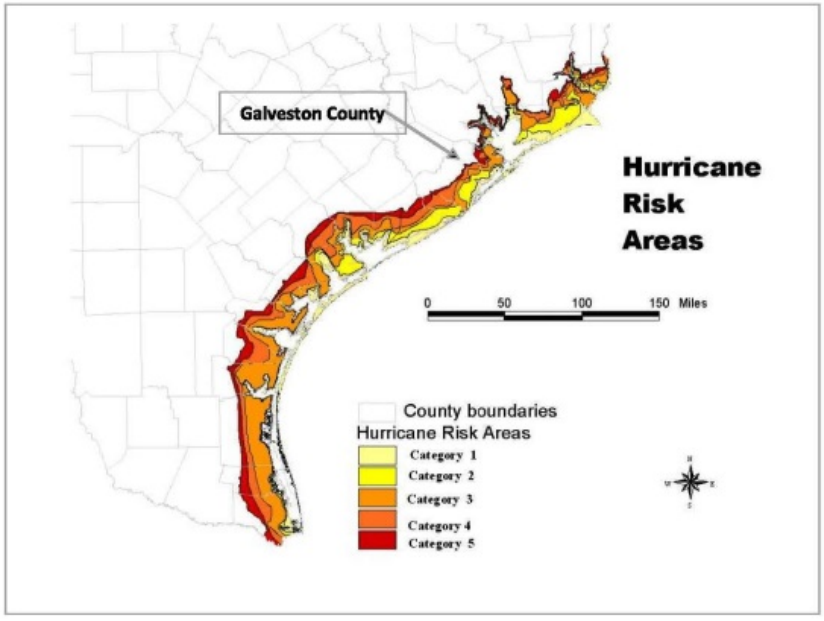
The Saffir-Simpson Hurricane Wind Scale (SSHWS) has undergone a minor modification for 2012 in order to resolve awkwardness associated with conversions among the various units used for wind speed in advisory products. The change broadens the Category 4 wind speed range by one mile per hour (mph) at each end of the range, yielding a new range of 130-156 mph. This change does not alter the category assignments of any storms in the historical record, nor will it change the category assignments for future storms.

5.2 Location

As a coastal community, Galveston County is vulnerable to threats directly and indirectly related to a hurricane event, such as high winds, storm surge, and flooding. Beachfront communities, including Jamaica Beach, face the primary impact of hurricane winds; however hurricanes and their secondary hazards can affect the entire county.

Although all areas of the county are impacted during a hurricane, the low-lying coastal areas receive the most flooding, and communities along rivers, bays and estuaries, including Tiki Island, Bayou Vista, Hitchcock, Clear Lake Shores and Kemah, experience flooding earlier. The effects of a hurricane begin to diminish as it moves inland; although no single area of the county is free of risk. For example, the winds alone from Hurricane Ike covered 120 miles, stretching across the county, but all areas were impacted by high winds and flooding. Figure 5.1 displays the location of hurricane risk by storm category along the Texas Gulf Coast.

Figure 5.1: Hurricane Risk Areas



5.3 Extent

Hurricanes are categorized according to the strength and intensity of their winds using the Saffir-Simpson Hurricane Scale (See Table 5.1 on the next page). A Category 1 storm has the lowest wind speeds while a Category 5 hurricane has the highest. This scale only ranks wind speed, but lower category storms can inflict greater damage than higher category storms depending on where they strike, other weather they interact with and how slow they move. As a prime example, Hurricane Ike, which struck Galveston in 2008 and is discussed herein, was classified as a Category 2 storm, yet was one of the costliest natural disasters in Texas history.[1]

The ingredients for a hurricane include a pre-existing weather disturbance, warm tropical oceans, moisture and relatively light winds aloft. Persistent, favorable conditions can produce violent winds, destructive waves, torrential rains and powerful floods. In an average three-year period, roughly five hurricanes strike the US coastline, killing approximately 50 to 100 people anywhere from Texas to Maine. Of these, two are typically "major" or "intense" hurricanes (a Category 3 or higher storm on the Saffir-Simpson Hurricane Scale).

The Saffir-Simpson Hurricane Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential. Wind, pressure and surge are combined to estimate potential damage. Categories 3, 4 and 5 are classified as “major” hurricanes. Major hurricanes comprise only 20 percent of total tropical cyclone landfalls, but they account for over 70 percent of the damage in the United States. Damage from hurricanes can result from spawned tornadoes, coastal flooding from storm surge, and inland flooding from heavy rainfall.

[1] FEMA. 2008. Hurricane Ike Impact Report. Department of Homeland Security, Federal Emergency Management Agency, Mitigation Division. Washington, D.C.

Table 5.1: Saffir-Simpson Hurricane Wind Scale (revised 2012)

Category	Previous Range	New Range	Effects on Land
1	74-95 mph	No change	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days
2	96-110 mph	No Change	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111-130 mph	111-129 mph	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable several days to weeks after the storm passes
4	131-155 mph	130-156 mph	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	Greater than 155 mph	Greater than 157 mph	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: National Hurricane Center

Hurricane-force winds can easily destroy poorly constructed buildings and mobile homes. Debris such as signs, roofing material, and small items left outside become extremely hazardous in hurricanes. Extensive damage to trees, towers, water and underground utility lines (from uprooted trees), and fallen poles cause considerable civic disruption.

The extent for hurricane wind in Galveston County is large, with more than 50 percent of the area covered. Table 5.2 profiles the potential winds speeds in miles per hour (MPH) that could be expected in Galveston County during a hurricane event for various return periods.

Table 5.2: Average Hurricane Wind Speeds in Galveston County

Jurisdiction	Wind Speed (mph) Verses Return Period (year)						
	10	20	50	100	200	500	1000
Bayou Vista	69	97	111	119	125	134	129
Clear Lake Shores	70	92	114	128	135	142	138
Friendswood	65	85	110	115	128	133	144
Hitchcock	69	95	111	116	123	133	134
Jamaica Beach	71	95	113	104	119	134	133
Kemah	69	92	113	127	133	141	140
Le Marque	69	96	111	120	125	134	139
League City	67	89	111	121	129	135	143
Santa Fe	67	93	110	114	123	132	132
Village of Tiki Island	71	97	113	119	124	136	136
Galveston County Unincorporated	66-75	89-99	110-117	104-132	119-138	130-147	116-150

Source: HAZUS-MH

5.4 Historical Occurrences

It is significant to note that the deadliest hurricane disaster in U.S. history, known as "the Galveston Hurricane of 1900," made landfall and inundated the entire island city of Galveston, Texas, around September 8, 1900. More than 8,000 people died when hurricane storm tides (the surge plus the astronomical tide) of 8 to 15 feet covered the city. More than half of all the homes and buildings were destroyed. Property damage has been estimated at $700 million (in today's dollars).

Path of Hurricane Ike

Even though only a Category 2 Storm at landfall, Hurricane Ike, which hit Galveston on September 13, 2008, is ranked as the third most destructive ever to make landfall in the United States.[2] Maximum sustained winds were 100 mph, with hurricane-force winds extending outward up to 120 miles from the center and tropical storm force winds extending outward up to 275 miles.

The majority of the housing damage in the Galveston Bay area was to buildings constructed in the 1960s and 1970s. Hurricane Ike demonstrated that enforced modern building and floodplain codes work well to reduce damage to the built environment. Many homes that were built since the 1990s that were properly elevated did not sustain serious damages, whereas winds devastated homes on Galveston Island that were built under older building codes. Modern homes that were constructed to 130 mph wind codes required by the International Residential Building Code were still standing the morning after Ike.

Other significant historical hurricane events that have impacted Galveston County include a large and violent hurricane on August 16, 1915 and Hurricane Alicia on August 18, 1983, which moved over the Texas coast about 25 miles southwest of Galveston causing a total of over $2.4 billion in damages (in today's dollars).[3] Table 5.3 provides a summary of hurricane/tropical storms from 1998 to 2015 as recorded by the NCDC.

Table 5.3: Galveston County Hurricane/Tropical Storm Events 1998-June 2015

Date	Event Type/Name	Deaths	Injuries	Property Damage	Event Summary
8/21/1998	Tropical Storm Charley	0	0	$ 5,000	Damage was minimal across the area, with beach erosion accounting for the damage estimates.
9/7/1998	Tropical Storm Frances	2	0	$200,000,000	Impact and resultant damage occurred in Galveston, Harris, Brazoria and Matagorda counties of Texas. All four of these counties received a Presidential Disaster Declaration to help in the relief and recovery efforts. In these four counties, total damage exceeded $286 million dollars. Most of this damage was along the coast and around Galveston Bay where high tides and winds destroyed dunes and personal property.
6/5/2001	Tropical Storm Allison	0	0	$31,740,000	Major flooding across the county.

[2] FEMA. 2008. Hurricane Ike Impact Report. Department of Homeland Security, Federal Emergency Management Agency, Mitigation Division. Washington, D.C.
[3] Hurricane history based on National Hurricane Center summaries.

Date	Event Type/Name	Deaths	Injuries	Property Damage	Event Summary
9/5/2002	Tropical Storm	0	0	$0-	No details provided
7/14/2003	Hurricane (Typhoon) Claudette	0	0	$8,300,000	In Galveston County, 38 single family homes were destroyed, 25 received major damage, and 964 received minor damage. 33 businesses were affected with damage costs of an estimated $970,000. Total damage, including beach erosion, was estimated at $8.3 million. The highest recorded tide level, 7.56 feet above mean low-lower water, was recorded at Pleasure Pier.
8/30/2003	Tropical Storm Grace	0	0	$7,000	Heavy rainfall between 6 and 12 inches was observed from extreme eastern Galveston County to across the Bolivar Peninsula. Beach erosion was minor. Some of the higher rainfall amounts (August 30th to August 31st) included 6.19 inches in League City, and 2.09 inches at Jamaica Beach.
9/1/2003	Tropical Storm Grace	0	0	$7,000	Storm tide damage on the Bolivar Peninsula was confined to the Gilchrist area. Ten single family homes experienced flooding up to eighteen inches deep inside the home. Fifteen single family homes and two mobile homes experienced flooding up to six inches deep inside the home.
9/23/2005	Hurricane (Typhoon) Rita	0	3	$15,000,000	In Galveston County, tropical storm force sustained winds with gusts to hurricane force were reported across the county, especially on the Bolivar Peninsula. Numerous power poles and road signs were blown down on Bolivar. Many of the beach homes received roof damage. Numerous trees were down with small structure damage on High Island. Power was out to most of the county on Saturday. Total damage across the county was around $15 million.
8/5/2008	Tropical Storm Edouard and Storm Surge/Tide	0	0	$95,000	Storm tide damage on the Bolivar Peninsula was confined to the Gilchrist area. Ten single family homes experienced flooding up to eighteen inches deep inside the home. Fifteen single family homes and two mobile homes experienced flooding up to six inches deep inside the home.
9/12/2008	Storm	12	0	$4,000,000,000	Storm tide ranged from 10 to 15 feet above

Date	Event Type/Name	Deaths	Injuries	Property Damage	Event Summary
	Surge/Tide Ike				mean sea level along the Galveston Bay, Clear Lake and associated tributaries which caused major flooding of coastal areas. Some higher surge levels up to 17 feet were indicated on the Bolivar Peninsula. At least 10 direct fatalities occurred in Galveston County. Number of injuries unknown. Some towns hit hard by surge include Galveston, San Leon, Kemah, and all towns on Galveston Island and the Bolivar Peninsula.
6/15/2015	Tropical Storm Bill	0	0	$0-	There was minor coastal flooding on the Bolivar peninsula with some debris removal required off of State Highway 87. High surf caused erosion of Galveston Island beaches. Sand and debris washed up on the streets of various west end island communities. There was minor flooding damage to downstairs garages in Jamaica Beach with two temporarily closed roads.
Total		14	3	$4,255,154,000	

Source NCDC

5.5 Probability of Future Events

The return period in years for a hurricane passing within 50 nautical miles of Galveston County planning area is 9 years. Taking into account the previous occurrences and return period, a hurricane event for Galveston County is likely, meaning an event is probable within the next three years.

5.6 Vulnerability Assessment

HAZUS-MH wind speed data, inventory and damage functions, and methodology were used to determine the annual expected loss at the county level. Table 5.4 shows annualized property losses, and annualized percent loss ratios by jurisdiction and Table 5.5 shows the expected damage to critical facilities by jurisdiction.

Table 5.4: Potential Annualized Losses by Jurisdiction (Hurricane Wind)

Jurisdiction	Total Exposure*	Annualized Losses for Residential Buildings at Risk	Annualized Losses for Commercial Buildings at Risk	Total Annualized Expected Property Losses	Annualized Percent Loss Ratio
Bayou Vista	$225,154,990	$1,041,508	$14,910	$1,056,418	0.47%
Clear Lake Shores	$243,448,194	$485,036	$48,550	$533,586	0.22%
Friendswood	$3,085,164,965	$10,400,291	$471,560	$10,871,851	0.35%
Hitchcock	$460,075,283	$2,352,932	$38,611	$2,391,543	0.52%
Jamaica Beach	$338,227,637	$2,322,548	$16,854	$2,339,402	0.69%
Kemah	$294,986,165	$708,720	$58,603	$767,323	0.26%
La Marque	$827,263,553	$5,305,660	$330,607	$5,636,267	0.68%
League City	$8,164,064,546	$30,257,633	$1,125,524	$31,383,157	0.38%
Santa Fe	$845,974,919	$5,700,942	$250,454	$5,951,396	0.70%
Tiki Island	$445,402,231	$2,253,333	$48,071	$2,301,404	0.52%
Galveston County Unincorporated	$2,931,109,729	$14,319,250	$574,686	$14,893,936	0.51%
Total	$17,860,872,212	$75,147,853	$2,978,430	$78,126,283	0.44%

Source: HAZUS-MH
Note: *Total Exposure is improved value of parcels in Galveston County

Table 5.5: Critical Facilities Potentially Damaged by Hurricane Wind

Jurisdiction	Total No. of Critical Facilities	100-Year Hurricane Wind			500-Year Hurricane Wind		
		Loss of Function	Partially Functional	Fully Functional	Loss of Function	Partially Functional	Fully Functional
Bayou Vista	0	0	0	0	0	0	0
Clear Lake Shores	1	0	1	1	2	0	0
Friendswood	14	0	7	7	12	2	0
Hitchcock	11	3	8	0	11	0	0
Jamaica Beach	1	0	0	0	0	0	0
Kemah	3	0	0	3	3	0	0
La Marque	13	0	13	0	12	1	0
League City	28	0	28	0	25	3	0
Santa Fe	9	0	9	0	8	1	0
Tiki Island	2	2	0	0	2	0	0
Galveston County Unincorporated	14	0	7	7	14	0	0
Total	96	5	73	18	89	7	0

Source: HAZUS-MH

5.7 Impact

According to the State of Texas Hazard Mitigation Plan (2013), the State Threat and Hazard Identification and Risk Assessment (THIRA) identified a Category 5 hurricane landfall at Galveston Island on Labor Day Weekend as one of the worst case scenarios for the State. Even though warning time for hurricanes has lengthened due to modern and early warning technology, the impact is substantial because it could result in multiple fatalities, a complete shutdown of facilities for 30 days or more, or leave more than 60 percent of property destroyed or severely damaged.

The Texas Gulf Coast has not suffered a direct hit from a Category 4 hurricane since August 1915 hurricane. According to the NWS, if a similar storm were to hit the area today, storm surge would start at 15 feet on the Island and reach 20 to more than 25 feet on the west side of Galveston Bay, flooding most of Galveston County east of I-45, all of Clear Lake Shores and into areas of Harris County. Sustained winds of 130 mph or more lasting for up to several hours would impact houses and businesses "built to code" which are designed to withstand winds less than 100 mph. The impacted number of homes would be substantial as over 600,000 people live in the Category 4 surge zone, which also includes petrochemical plants, the Johnson Space Center and several key industries along Galveston Bay. Unlike rainwater flooding, where the vast majority of people impacted are relatively safe in their homes, the combined surge and wind impact would require an evacuation of as many as 600,000 citizens in the surge zone in order to save lives.

Mitigation Strategy

Table 5.6 provides a summary of the mitigation actions identified by each jurisdiction to address hurricane/tropical storm. Details for these actions are provided in Section 24.

Table 5-6: Mitigation Actions – Hurricane/Tropical Storm

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2016-2: Stormproof/retrofit critical facilities and infrastructure	BV-2016-3: Secure generators for existing and new critical facilities and infrastructure
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Friendswood	F-2009-4: Construct and expand evacuation routes	F-2016-3: Update and renovate public works building and community services/park facility
Hitchcock	H-2011-10: Purchase and install emergency power generators and connection equipment to support critical facilities and infrastructure	H-2016-4: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation
Jamaica Beach	JB-2006-1: Implement beach and dune restoration program	JB-2006-4: Conduct annual hurricane town hall meetings
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2011-14: Harden existing critical facilities and infrastructure to be more resistant to all hazards
La Marque	LM-2011-7: Build Westside Public Safety Complex	LM-2011-11: Construct safe room shelter at EOC to house local residents
League City	LC-2005-8: Homeowner Mitigation Incentive Campaign	LC-2016-8: Safe Rooms
Santa Fe	SF-2016-2: Harden existing critical facilities and infrastructure to be more resistant to all hazards	SF-2016-4: Secure generators for existing and new critical facilities and infrastructure
Tiki Island	TI-2011-5: Elevate 11 wastewater lift stations and provide backup power	TI-2011-9: Replace the Tiki Drive bridge with an improved, hardened bridge to withstand storm surge and debris
Galveston County	GC-2011-9: Design and construct a multi-purpose EMS facility for Crystal Beach and High Island area residents	GC-2011-21: Implement the Corp of Engineers study of the Texas City Hurricane Flood Protection to improve the current levee system to provide protection from a Category 5 storm

6.0 Flood (Coastal and Inland)

6.1 Description

Floods result from excessive precipitation, and the severity of a flooding event is typically determined by a combination of several major factors, including stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and the degree of vegetative clearing and impervious surface. Generally, floods are long-term events that may last for several days. The primary types of general flooding include inland and coastal flooding, which are profiled in this section.

Inland or riverine flooding is a function of excessive precipitation levels and water runoff volumes within the watershed of a stream or river. It is natural and inevitable as it is the overbank flooding of rivers and streams, typically resulting from large-scale weather systems that generate prolonged rainfall over a wide geographic area. Some river floods occur seasonally when winter or spring rains fill river basins with too much water, too quickly. Torrential rains from decaying hurricanes or tropical systems can also produce river flooding.

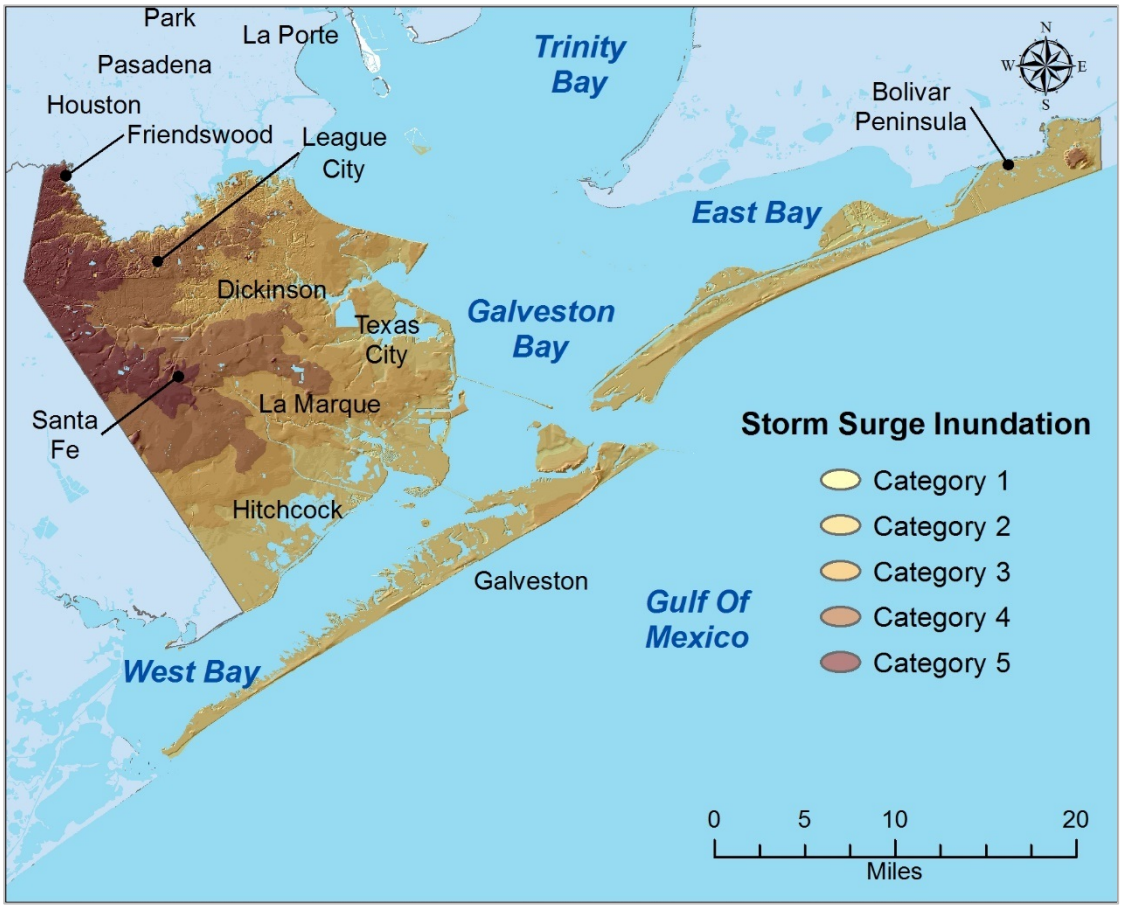
Coastal flooding is typically a result of storm surge, wind-driven waves and heavy rainfall produced by hurricanes, tropical storms, and other large coastal storms. Flooding in the coastal environment can be further exacerbated by tidal influence in the low-lying coastal areas. Higher tides will increase stream and river stage heights from the mouth while floodwaters rush in from upland areas. Flooding in coastal areas is defined by recurrence intervals and flood zones are determined. Coastal flood zones consider the velocity of wave action. Coastal flood results are provided for the five surge inundation zones, and Risk MAP VE zone results are provided in the coastal and inland flood section. Inland flooding is predominantly caused by coastal inundation from the Gulf of Mexico and the Galveston, East and West Bays.

6.2 Location

The coastal flood inundation zone is an area of high potential for property damage and loss of life due to storm surge induced high-velocity wave action. Figure 6.1 depicts these zones.

It is significant to note that Jamaica Beach is located on a barrier island. There are threats to this community that are not applicable to the majority of the other jurisdictions in Galveston County. Hurricane-generated storm surge could very possibly damage surrounding infrastructure, including the bridge leading off of the barrier island. Damage to the bridge could isolate island residents from the mainland and deprive residents of essential utility and emergency services.

Figure 6.1: Coastal Flood Inundation Zones in Galveston County



Inland and Coastal (V Zone) Flooding

The risk map data depicts the following flood hazard areas:

- Zone V/VE (areas of 100-year coastal flood with velocity)
- Zone A/AE (areas of 100-year flood)
- Zone B (areas between the limits of the 100-year flood and 500-year flood)
- Zone C (areas of minimal flooding)

Figures 6-2 through 6.12 graphically illustrate the flood zones listed above and provide an indication of where there is potential for damage to property and loss of life in the Galveston County study region. Much of the flooding is attributed to coastal and inland bay flooding.

Figure 6.2: Coastal/Inland V Zone Flooding Potential (County Wide)

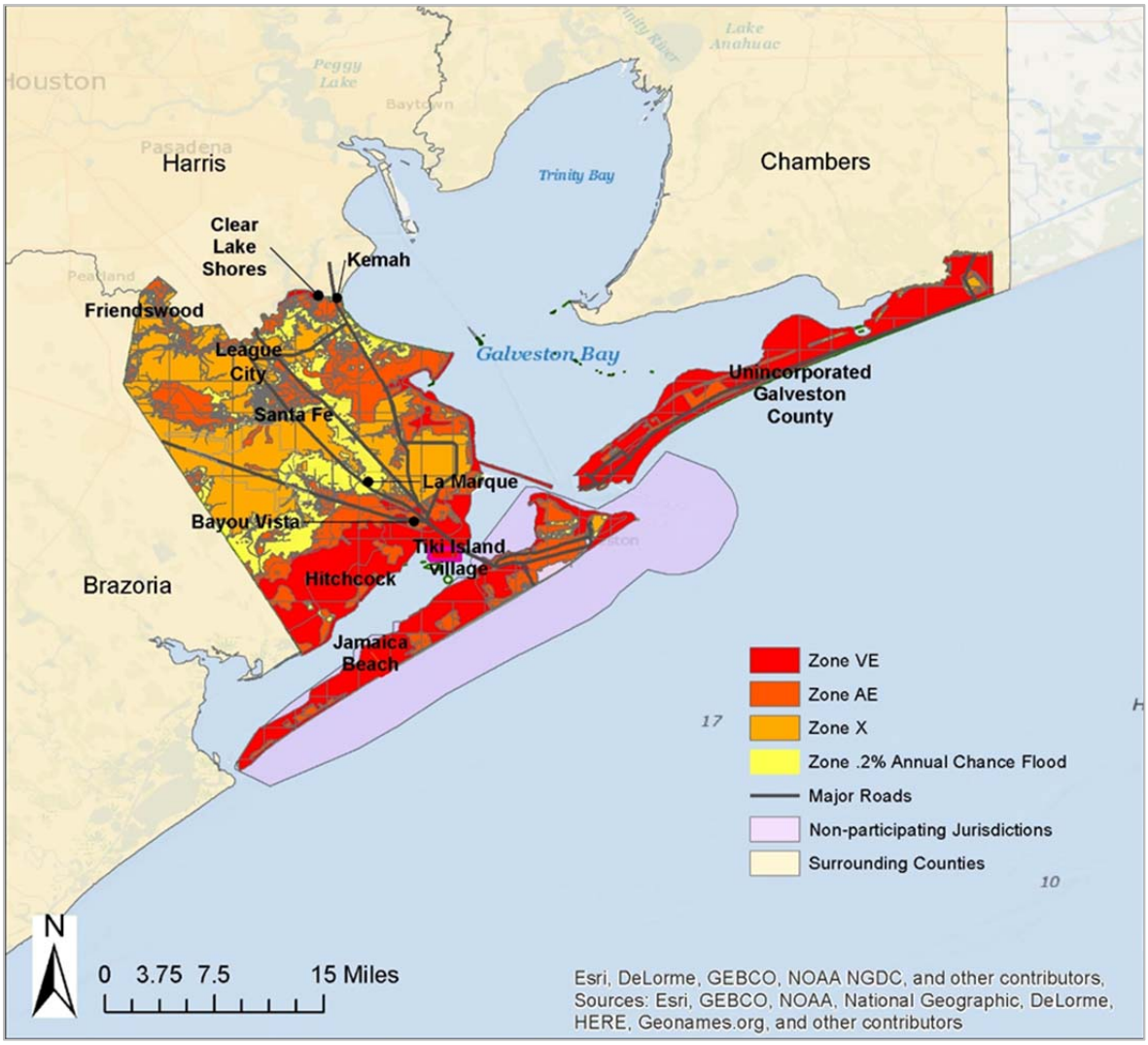


Figure 6.3: Inland and Coastal (V Zone) Flooding Potential (Bayou Vista)

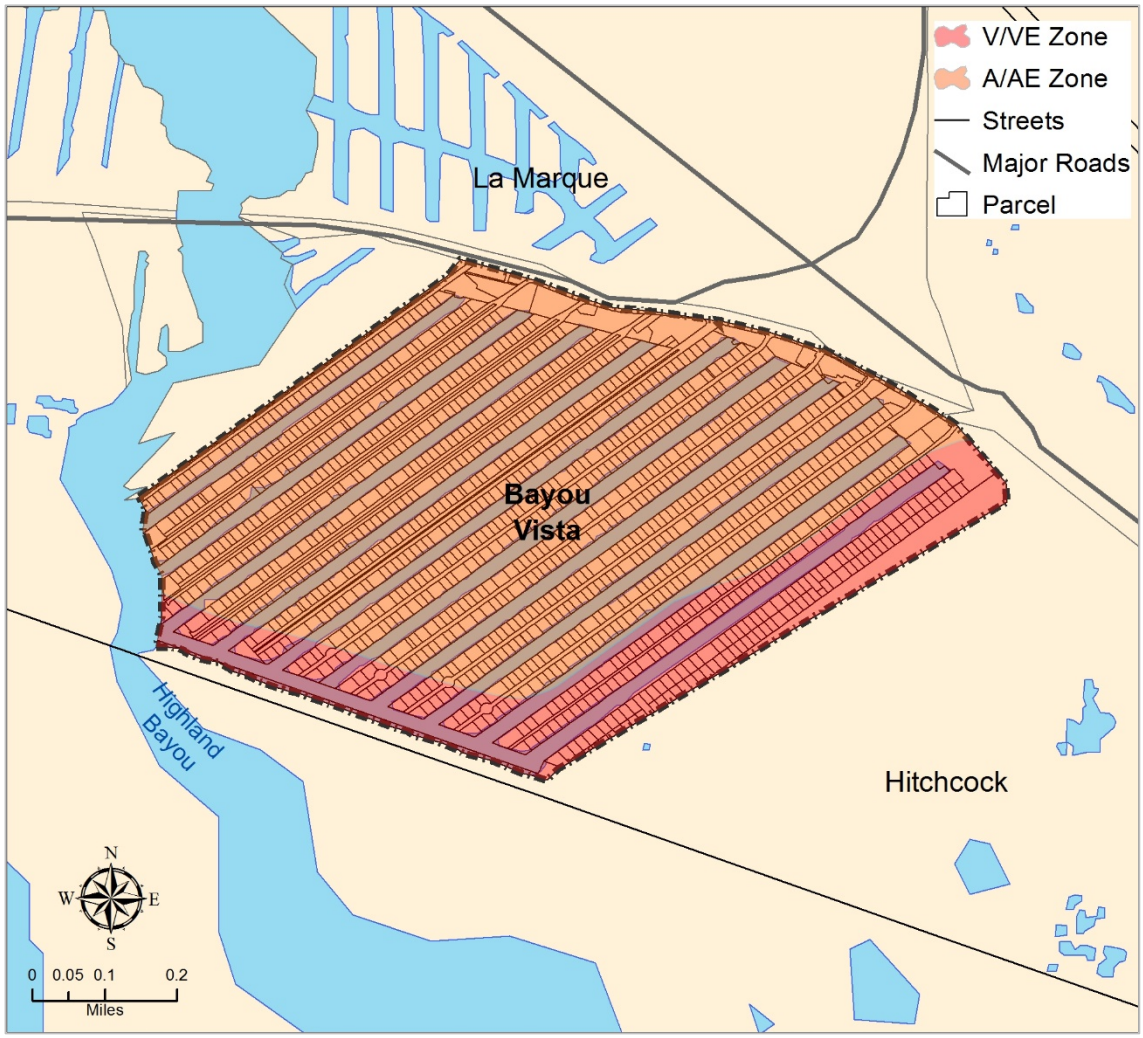


Figure 6.4: Inland and Coastal (V Zone) Flooding Potential (Clear Lake Shores)

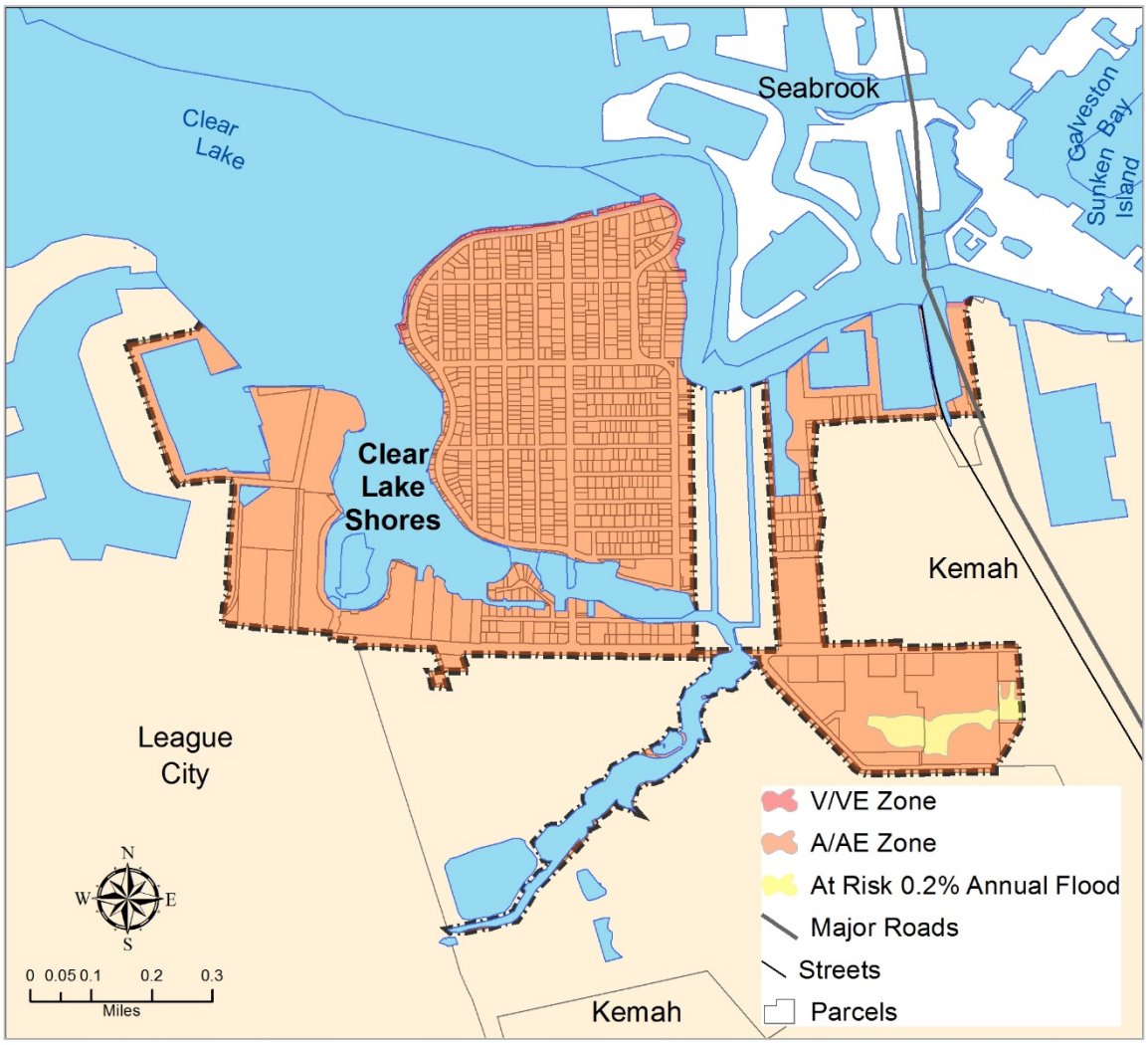


Figure 6.5: Inland and Coastal (V Zone) Flooding Potential (Friendswood)

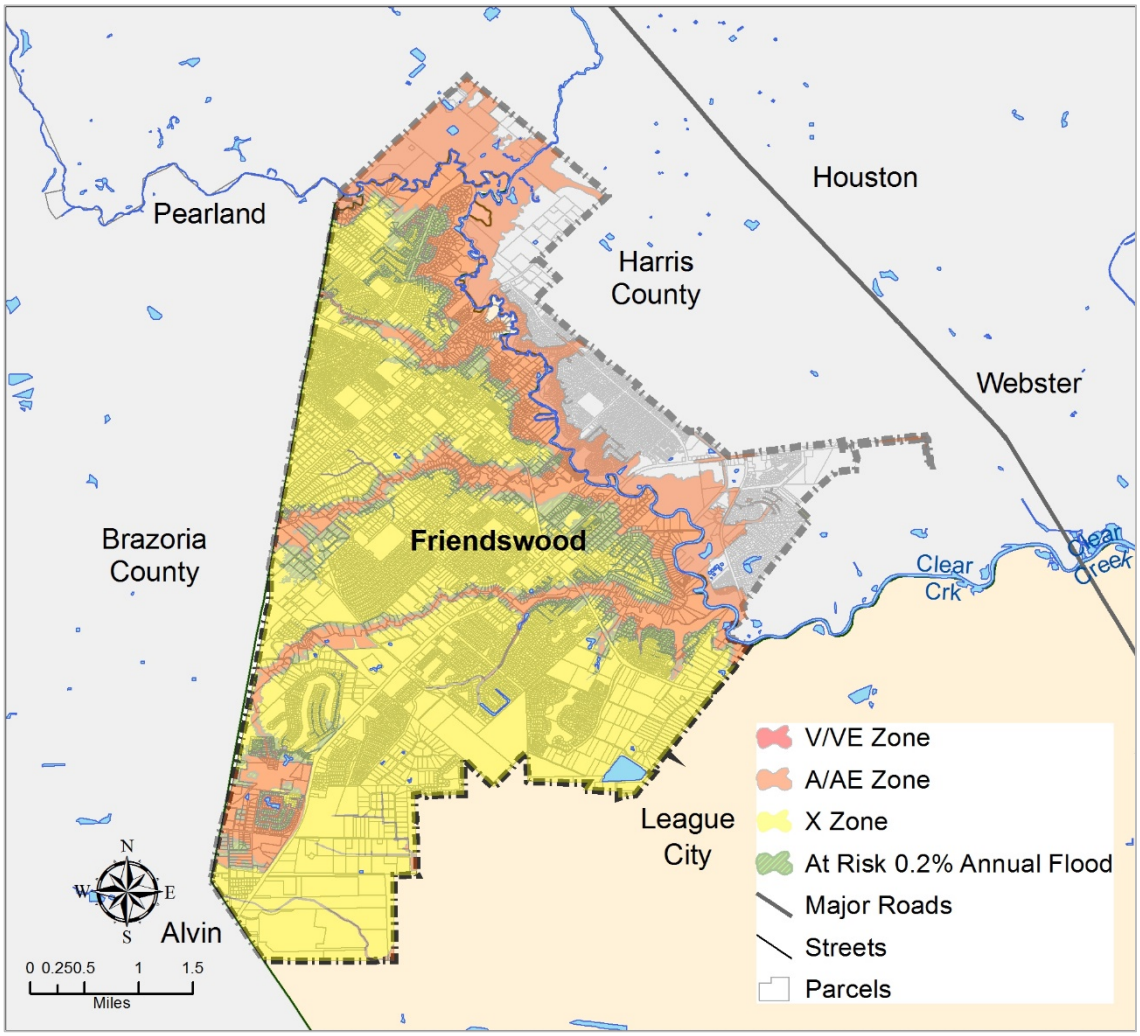


Figure 6.6: Inland and Coastal (V Zone) Flooding Potential (Hitchcock)

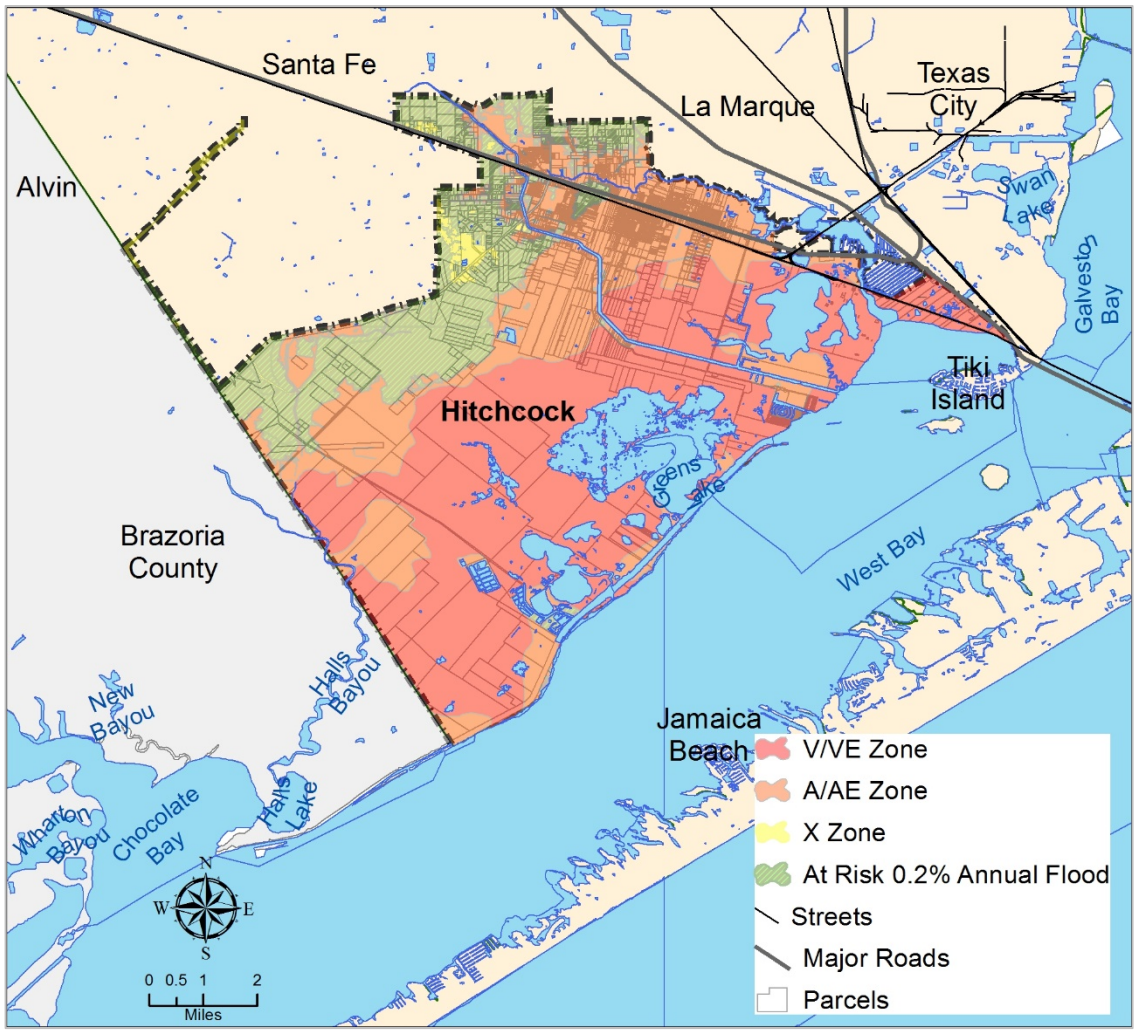


Figure 6.7: Inland and Coastal (V Zone) Flooding Potential (Jamaica Beach)

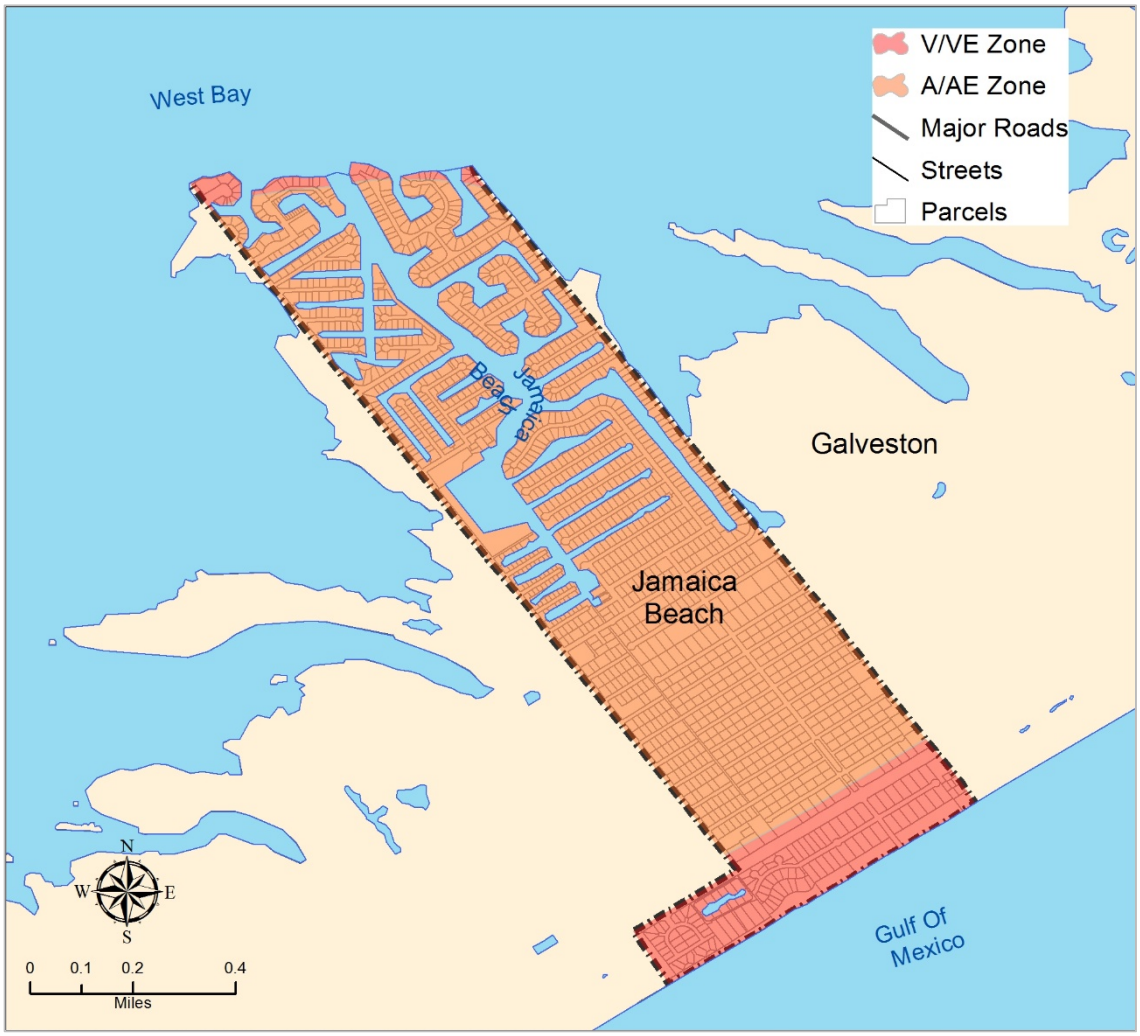


Figure 6.8: Inland and Coastal (V Zone) Flooding Potential (Kemah)

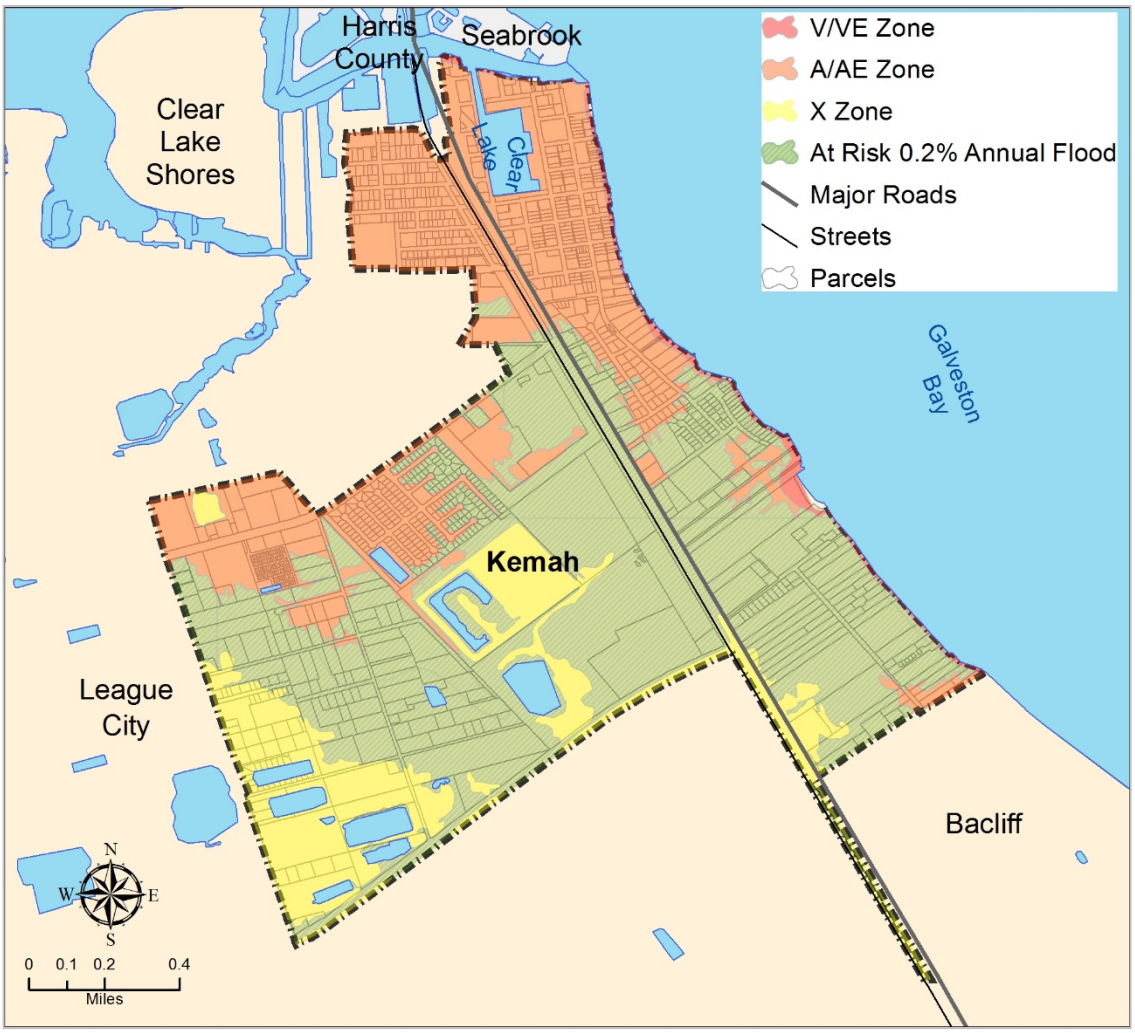


Figure 6.9: Inland and Coastal (V Zone) Flooding Potential (LaMarque)

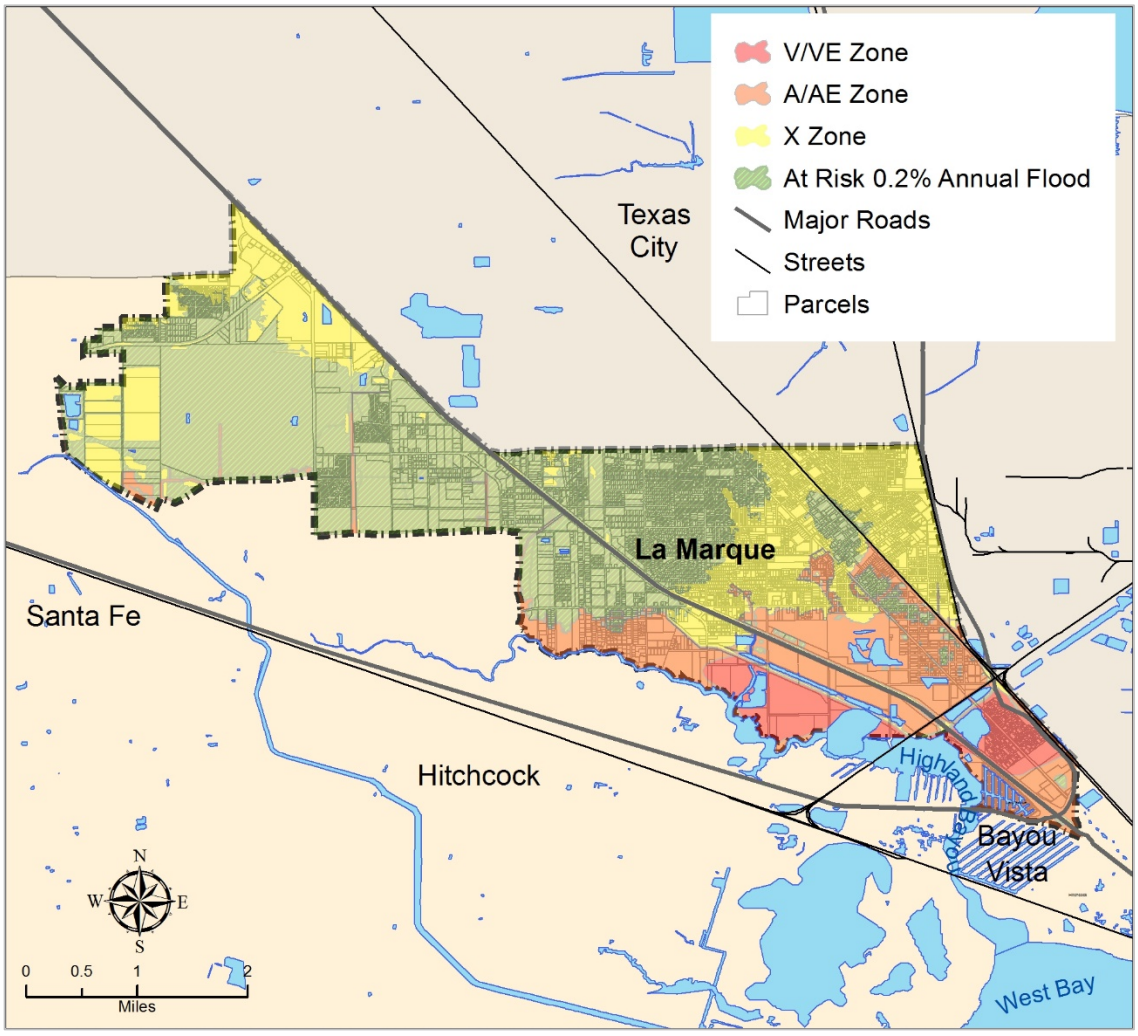


Figure 6.10: Inland and Coastal (V Zone) Flooding Potential (League City)

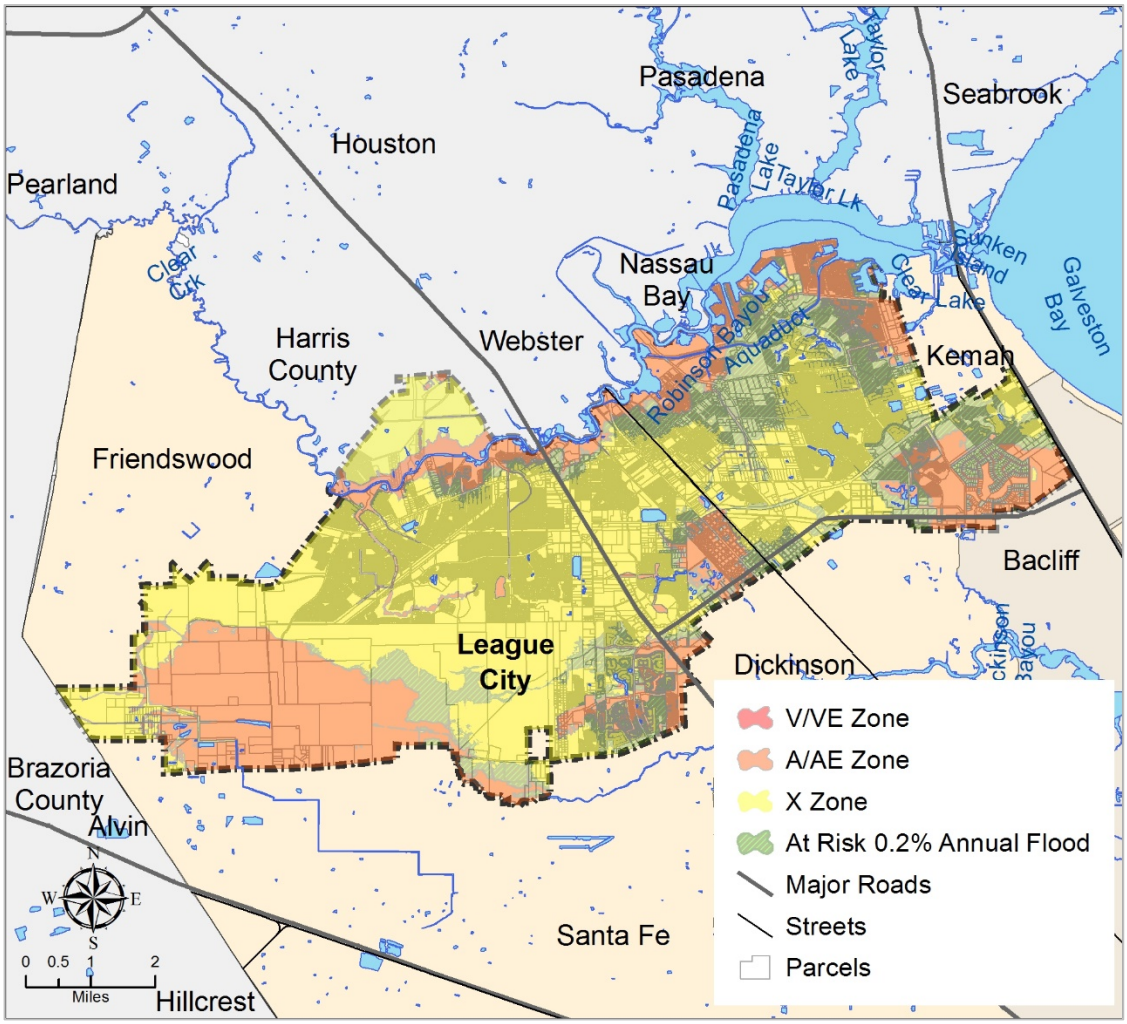


Figure 6.11: Inland and Coastal (V Zone) Flooding Potential (Santa Fe)

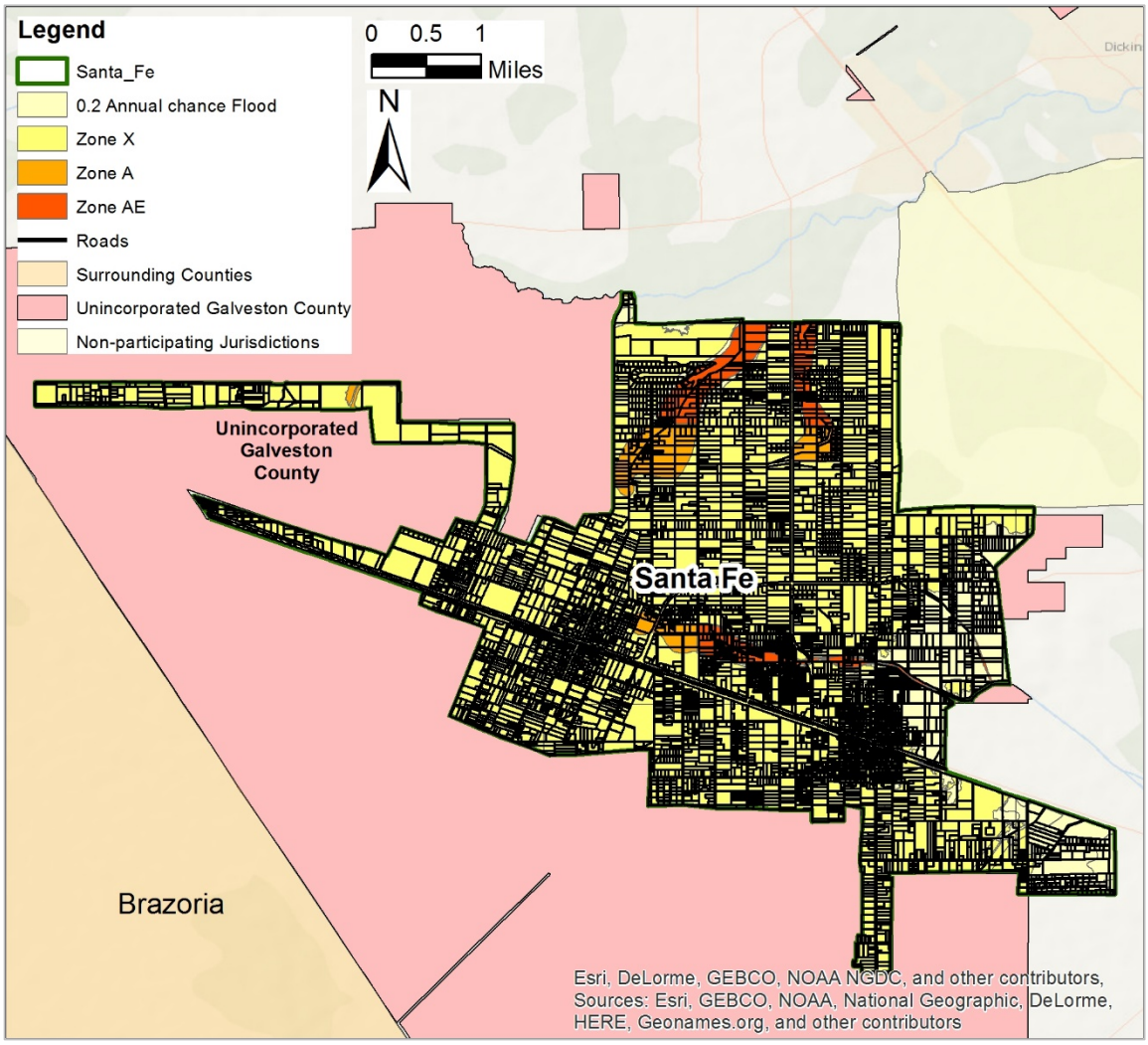


Figure 6.12: Inland and Coastal (V Zone) Flooding Potential (Village of Tiki Island)

6.3 Extent

Determining the intensity and magnitude of a flood event is dependent upon the flood zone and location of the flood hazard area. Figure 6.13 describes the flood impact in terms of severity or potential harm while Figures 6.2 through 6.12 depicts the flood location and potential magnitude of an event by jurisdiction. To determine the intensity of an event, the figures should be read together. For example, Tiki Island, as shown in Figure 6.12 is mainly in Zone V/VE, meaning that the area is subject to the 100-year flood with the velocity hazard or wave action.

A 100-year flood constitutes a threat to the County. Structures built in the Special Flood Hazard Area (SPHD) are subject to damage by rising waters and floating debris. Moving flood water exerts pressure on everything in its path and causes erosion of soil and scour around solid objects. Utility systems, such as heating, ventilation, air conditioning, fuel, electrical systems, sewage maintenance systems and water systems, if not elevated above base flood elevation, may also be damaged.

Figure 6.13: Extent Scales for Flood: Description of Flood Zones

Flood Zones		
Zone A	The 100-year or Base Floodplain. There are six types of A zones:	
	A	The base floodplain mapped by approximate methods, i.e., BFEs are not determined. This is often called an unnumbered A zone or an approximate A zone.
	A1-30	These are known as numbered A zones (e.g., A7 or A14). This is the base floodplain where the firm shows a BFE (old format).
	AE	The base floodplain where base flood elevations are provided. AE zones are now used on new format FIRMs instead of A1-30 zones.
	AO	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.
	AH	Shallow flooding base floodplain. BFE's are provided.
	A99	Area to be protected from base flood by levees or Federal flood protection systems under construction. BFEs are not determined.
	AR	The base floodplain that results from the de-certification of a previously accredited flood protection system that is in the process of being restored to provide a 100-year or greater level of flood protection
Zone V and VE	V	The coastal area subject to velocity hazard (wave action) where BFEs are not determined on the FIRM.
	VE	The coastal area subject to velocity hazard (wave action) where BFEs are provided on the FIRM.
Zone B and Zone X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and the 500-year floods. B zones are also used to designate base floodplains or lesser hazards, such as areas protected by levees from the 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.	
Zone C and Zone X (unshaded)	Area of minimal flood hazard, usually depiction FIRMs as exceeding the 500-year flood level. Zone C may have ponding and local drainage problems that do not warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood.	
Zone D	Area of undetermined but possible flood hazards.	

Source: Understanding Your Risks, identifying hazards and estimating losses, FEMA 386-2

6.4 Historical Occurrences

Rainfall averages 50.76 inches annually. When 50 inches fall periodically throughout the year, flooding is not an issue. However, when rain falls in less frequent rain events, flash flooding can result.

Previous occurrences for inland and coastal flood are depicted in Table 6.1; however, one extreme flooding event occurred in July 2007: a residential neighborhood in Hitchcock recorded 25 days of rain out of 30, leaving the ground saturated, the streets and waterways of southern Galveston County flooded, and water rose to 10 feet above normal.

Table 6.1: Historic Flood Occurrences in Galveston County

Location	Date	Time	Type	Death	Injury	Property Damage	Crop Damage
Clear Lake Shores	05/30/1995	0430	Flash Flood	0	0	$50,000	0
Coastal County	11/16/1996	1400	Coastal Flood	0	0	$250,000	0
Galveston	12/17/1995	0900	Flash Flood	0	0	$20,000	0
Galveston	12/18/1995	0026	Flash Flood	0	0	$5,000	0
Northern County	01/26/1996	1200	Flash Flood	0	0	$30,000	0
Countywide	01/27/1997	2024	Flash Flood	0	0	$5,000	0
Countywide	04/25/1997	1247	Coastal Flood	0	0	$350,000	0
East Portion	11/5/1997	500	Flash Flood	0	0	$20,000	0
Central Portion	12/8/1997	45	Flash Flood	0	0	$14,000	0
North Portion	1/4/1998	1645	Flash Flood	0	0	$3,000	0
South Portion	6/29/1998	40	Flash Flood	0	0	$0	0
South Portion	9/10/1998	2310	Flash Flood	0	0	$0	0
South Portion	10/4/1998	1843	Flash Flood	0	0	$35,000	0
South Portion	10/4/1998	1957	Flash Flood	0	0	$10,000	0
Friendswood	10/18/1998	1024	Flash Flood	0	0	$3,000	0
Northwest	06/25/1999	1230	Flash Flood	0	0	$50,000	0

Location	Date	Time	Type	Death	Injury	Property Damage	Crop Damage
Portion							
Countywide	9/13/2000	1230	Flash Flood	0	0	$100,000	0
Countywide	6/5/2001	1600	Flash Flood	0	0	$0	0
Central Portion	6/8/2001	400	Flash Flood	0	0	$0	0
Northern Portion	6/9/2001	100	Flash Flood	0	0	$0	0
Northern Portion	6/9/2001	1230	Flash Flood	0	0	$0	0
League City	4/8/2002	725	Flash Flood	0	0	$5,000	0
League City	5/17/2002	650	Flash Flood	0	0	$2,000	0
South Portion	8/15/2002	400	Flash Flood	0	0	$75,000	0
Countywide	8/15/2002	1100	Flash Flood	0	0	$100,000	0
Jamaica Beach	9/10/2002	325	Flash Flood	0	0	$45,000	0
League City	9/19/2002	2029	Flash Flood	0	0	$25,000	0
East Portion	10/8/2002	1729	Flash Flood	0	0	$15,000	0
North Portion	10/24/2002	1815	Flash Flood	0	0	$75,000	0
Countywide	11/5/2002	130	Flash Flood	0	0	$55,000	0
Central Portion	12/4/2002	630	Flash Flood	0	0	$20,000	0
League City	8/31/2003	100	Flash Flood	0	0	$3,000	0
Countywide	9/1/2003	715	Flash Flood	0	0	$4,000	0
Friendswood	11/17/2003	2205	Flash Flood	0	0	$5,000	0
Santa Fe	6/23/2004	0	Flash Flood	0	0	$3,000	0
League City	11/2/2004	245	Flash Flood	0	0	$3,000	0
Coastal County	10/16/2006	252	Coastal Flood	0	0	$75,000	
Friendswood	10/16/2006	430	Flash Flood	0	0	$250,000	0
League City-Arpt	9/14/2008	800	Flash Flood	0	0	$0	0
League City-	4/18/2009	1400	Flash Flood	0	0	Unknown	0

Location	Date	Time	Type	Death	Injury	Property Damage	Crop Damage
Arpt							
League City-Arpt	4/24/2009	2030	Flash Flood	0	0	$5,000	0
League City	10/1/2009	1549	Flash Flood	0	0	$5,000	0
League City-Arpt	10/22/2009	630	Flash Flood	0	0	$0	0
Coastal County	11/8/2009	1600	Coastal Flood	0	0	$0	0
Coastal County	12/1/2009	1500	Coastal Flood	0	0	$0	0
GLS-Airport	5/14/2010	2115	Flash Flood	0	0	$0	0
Coastal County	1/9/2011	0900	Coastal Flood	0	0	$5,000	0
League City	5/12/2012	300	Flash Flood	0	0	$5,000	0
Friendswood	10/31/2013	1050	Flash Flood	0	0	$10,000	0
League City-Arpt	9/18/2014	1230	Flash Flood	0	0	$0	0
League City-Arpt	4/17/2015	1900	Flash Flood	0	0	$2,000	0
League City	5/12/2015	2200	Flash Flood	0	0	$0	0
League City	6/13/2015	730	Flash Flood	0	0	$0	0

Source: NCDC

No losses of lives or injuries were reported for historical occurrences of coastal and inland flooding According to the National Climatic Data Center (NCDC). The approximate total amount of property damage was $1.73 million dollars.

6.5 Probability of Future Events

Although the intensity of a flood event can become lower as building codes and ordinances are made stronger or properties are "flood proofed," given the frequency of historical events, it is highly likely that the area will flood again. On average there are two flooding events each year.

6.6 Vulnerability Assessment

The building vulnerability assessment was conducted using a GIS mapping analysis process in which Category 1 -5 storm surge inundation GIS data were overlaid with local parcel data to determine the number of parcels that intersect these hazard zones. Data from the County's 2015 tax assessment was then used to determine the assessed value of these at-risk properties.

In making vulnerability determinations, it was decided that if any portion of structure was confirmed to be located within a storm surge inundation zone, then it was determined to be at risk to that flood hazard. While the GIS-based assessment does use specific attribute data tied to each property (i.e., year built and building value), it does not take into account certain unknown site-specific factors that may mitigate future flood losses on a building-by-building basis (such as finished floor elevations, surrounding topography, flood proofing measures, drainage, etc.). No further analysis of the potential vulnerability of structures to flooding was completed as part of this assessment.

Tables 6.2 through 6.6 show the potentially affected exposure for coastal flooding in Galveston County. Table 6.7 provides potential annualized losses due to coastal flooding, and Table 6.8 provides information on critical facilities and infrastructure potentially damaged due to coastal flooding.

111 *Table 6.2: Estimated Exposure of People and Parcels by Jurisdiction (Category 1 Storm Surge)*

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (Category 1 Zones)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,530	891	$164,088,970
Clear Lake Shores	1,069	1,051	$243,448,194	509	276	$64,142,744
Friendswood	26,364	10,853	$3,085,164,965	3,958	188	$47,767,140
Hitchcock	6,961	6,337	$460,075,283	1,505	564	$80,615,347
Jamaica Beach	983	1,590	$338,227,637	484	660	$169,399,172
Kemah	2,906	1,221	$294,986,165	947	96	$79,211,761
La Marque	14,543	8,972	$827,263,553	441	202	$40,218,160
League City	82,353	35,762	$8,164,064,546	10,196	1,256	$512,377,909
Santa Fe	12,814	6,457	$845,974,919	269	2	$267,000
Tiki Island	966	1,254	$445,402,231	933	778	$291,151,386
Unincorporated	40,244	34,756	$2,931,109,729	5,111	4,044	$408,179,054
Total	190,740	109,577	$17,860,872,212	25,883	8,957	$1,857,418,643

112 *Table 6.3: Estimated Exposure of People and Parcels by Jurisdiction (Category 2 Storm Surge)*

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (Category 2 Zones)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,537	1,324	$225,154,990
Clear Lake Shores	1,069	1,051	$243,448,194	1,069	1,035	$234,366,034
Friendswood	26,364	10,853	$3,085,164,965	5,822	408	$105,914,524
Hitchcock	6,961	6,337	$460,075,283	3,474	1,675	$160,331,192
Jamaica Beach	983	1,590	$338,227,637	983	1,590	$338,227,637
Kemah	2,906	1,221	$294,986,165	1,240	498	$162,042,541
La Marque	14,543	8,972	$827,263,553	1,409	982	$92,630,416
League City	82,353	35,762	$8,164,064,546	29,387	2,712	$1,023,852,238
Santa Fe	12,814	6,457	$845,974,919	976	5	$930,450
Tiki Island	966	1,254	$445,402,231	966	1,253	$445,380,771
Unincorporated	40,244	34,756	$2,931,109,729	11,155	18,253	$1,388,457,593
Total	190,740	109,577	$17,860,872,212	58,018	29,735	$4,177,288,386

113 *Table 6.4: Estimated Exposure of People and Parcels by Jurisdiction (Category 3 Storm Surge)*

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (Category 3 Zones)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,537	1,324	$225,154,990
Clear Lake Shores	1,069	1,051	$243,448,194	1,069	1,051	$243,448,194
Friendswood	26,364	10,853	$3,085,164,965	8,717	858	$244,692,012
Hitchcock	6,961	6,337	$460,075,283	6,849	5,946	$416,603,720
Jamaica Beach	983	1,590	$338,227,637	983	1,590	$338,227,637
Kemah	2,906	1,221	$294,986,165	2,906	1,217	$294,604,355
La Marque	14,543	8,972	$827,263,553	14,305	8,171	$665,852,808
League City	82,353	35,762	$8,164,064,546	65,964	19,061	$4,738,538,131
Santa Fe	12,814	6,457	$845,974,919	2,706	371	$51,274,960
Tiki Island	966	1,254	$445,402,231	966	1,254	$445,402,231
Unincorporated	40,244	34,756	$2,931,109,729	29,092	29,179	$2,272,739,367
Total	190,740	109,577	$17,860,872,212	135,094	70,022	$9,936,538,405

114 *Table 6.5: Estimated Exposure of People and Parcels by Jurisdiction (Category 4 Storm Surge)*

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (Category 4 Zones)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,537	1,324	$225,154,990
Clear Lake Shores	1,069	1,051	$243,448,194	1,069	1,051	$243,448,194
Friendswood	26,364	10,853	$3,085,164,965	19,539	4,435	$1,361,779,673
Hitchcock	6,961	6,337	$460,075,283	6,961	6,312	$457,397,363
Jamaica Beach	983	1,590	$338,227,637	983	1,590	$338,227,637
Kemah	2,906	1,221	$294,986,165	2,906	1,221	$294,986,165
La Marque	14,543	8,972	$827,263,553	14,543	8,969	$825,681,153
League City	82,353	35,762	$8,164,064,546	82,268	34,168	$7,809,891,714
Santa Fe	12,814	6,457	$845,974,919	10,241	4,444	$590,002,402
Tiki Island	966	1,254	$445,402,231	966	1,254	$445,402,231
Unincorporated	40,244	34,756	$2,931,109,729	38,071	32,805	$2,732,233,424
Total	190,740	109,577	$17,860,872,212	179,084	97,573	$15,324,204,946

Table 6.6: Estimated Exposure of People and Parcels by Jurisdiction (Category 5 Storm Surge)

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (Category 5 Zones)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,537	1,324	$225,154,990
Clear Lake Shores	1,069	1,051	$243,448,194	1,069	1,051	$243,448,194
Friendswood	26,364	10,853	$3,085,164,965	26,364	10,853	$3,085,164,865
Hitchcock	6,961	6,337	$460,075,283	6,961	6,337	$460,075,283
Jamaica Beach	983	1,590	$338,227,637	983	1,590	$338,227,637
Kemah	2,906	1,221	$294,986,165	2,906	1,221	$294,986,165
La Marque	14,543	8,972	$827,263,553	14,543	8,972	$827,263,553
League City	82,353	35,762	$8,164,064,546	82,353	35,762	$8,164,064,546
Santa Fe	12,814	6,457	$845,974,919	12,814	6,457	$845,974,919
Tiki Island	966	1,254	$445,402,231	966	1,254	$445,402,231
Unincorporated	40,244	34,756	$2,931,109,729	40,244	34,756	$2,931,109,729
Total	190,740	109,577	$17,860,872,212	190,740	109,577	$17,860,872,112

Table 6.7: Potential Annualized Losses Due to Storm Surge for Galveston County (Countywide)

Storm Events	Annualized Losses for Building Damage	Annualized Losses for Contents Damage	Annualized Losses for Inventory Loss	Annualized Percent Loss Ratio
Annualized	$702,705,416	$126,118,191	$936,078	1.9%

Table 6.8: Critical Facilities Exposed to Storm Surge in Galveston County(Countywide)

Storm Surge Based on Saffir Simpson Scale	Total Number and Value of Critical Facilities		Number and Value of Exposed Facilities	
	Number	Value	Number	Value
Category 1	263	$1,310,384,054	32	$53,919,000
Category 2			130	$509,699,012
Category 3			214	$1,005,940,037
Category 4			246	$1,154,987,049
Category 5			263	$1,310,384,054

In order to assess exposure to the flood hazard, digital flood hazard data was compared with census block data and parcel information provided by the county to determine the total estimated population, total estimated number of parcels, and total improved value of parcels intersecting three flood hazard areas. The three flood hazard areas analyzed consist of the 100-year inland flood hazard (based on mapped A/AE Zones), the 100-year coastal flood hazard (based on mapped V/VE Zones), and the 500- year flood hazard (based on mapped B Zones). Tables 6.9 to 6.11 show the results of each analysis by jurisdiction. Table 6.12 shows the potential impact on critical facilities.

Table 6.9: Estimated Exposure of People and Parcels by Jurisdiction (100-Year Flood—Inland)

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (A/AE Zones)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,470	1,099	$185,493,420
Clear Lake Shores	1,069	1,051	$243,448,194	1,069	987	$240,705,924
Friendswood	26,364	10,853	$3,085,164,965	14,097	2,162	$663,350,938
Hitchcock	6,961	6,337	$460,075,283	6,629	4,632	$286,761,580
Jamaica Beach	983	1,590	$338,227,637	961	1,438	$294,440,652
Kemah	2,906	1,221	$294,986,165	1,592	898	$230,750,405
La Marque	14,543	8,972	$827,263,553	3,704	1,401	$172,940,454
League City	82,353	35,762	$8,164,064,546	37,231	8,460	$2,084,836,964
Santa Fe	12,814	6,457	$845,974,919	4,221	609	$96,352,765
Tiki Island	966	1,254	$445,402,231	147	90	$22,118,888
Unincorporated	40,244	34,756	$2,931,109,729	20,469	10,714	$842,121,362
Total	190,740	109,577	$17,860,872,212	91,590	32,490	$5,119,873,352

128 *Table 6.10: Estimated Exposure of People and Parcels by Jurisdiction (100-Year Flood—Coastal)*

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (V/VE Zones)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,532	277	$49,006,030
Clear Lake Shores	1,069	1,051	$243,448,194	234	109	$23,213,493
Friendswood	26,364	10,853	$3,085,164,965	0	0	$0
Hitchcock	6,961	6,337	$460,075,283	281	728	$72,387,309
Jamaica Beach	983	1,590	$338,227,637	189	192	$60,784,015
Kemah	2,906	1,221	$294,986,165	169	110	$75,973,581
La Marque	14,543	8,972	$827,263,553	115	371	$4,234,692
League City	82,353	35,762	$8,164,064,546	2,560	110	$87,666,080
Santa Fe	12,814	6,457	$845,974,919	0	0	$0
Tiki Island	966	1,254	$445,402,231	966	1,211	$434,753,591
Unincorporated	40,244	34,756	$2,931,109,729	3,332	13,969	$1,217,475,012
Total	190,740	109,577	$17,860,872,212	9,378	17,077	$2,025,493,803

129 *Table 6.11: Estimated Exposure of People and Parcels by Jurisdiction (500-Year Flood)*

Jurisdiction	Total Est. Population	Total Est. Number of Parcels	Improved Value of Parcels	At Risk (0.2 % Annual Chance)		
				Number of People at Risk	Number of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	0	0	$0
Clear Lake Shores	1,069	1,051	$243,448,194	4	8	$22,789,590
Friendswood	26,364	10,853	$3,085,164,965	14,178	2,882	$954,702,397
Hitchcock	6,961	6,337	$460,075,283	4,705	1,779	$196,227,284
Jamaica Beach	983	1,590	$338,227,637	0	0	$0
Kemah	2,906	1,221	$294,986,165	2,494	471	$123,321,865
La Marque	14,543	8,972	$827,263,553	9,871	4,885	$516,860,254
League City	82,353	35,762	$8,164,064,546	49,569	11,365	$3,054,896,076
Santa Fe	12,814	6,457	$845,974,919	4,617	1,027	$142,152,322
Tiki Island	966	1,254	$445,402,231	0	0	$0
Unincorporated	40,244	34,756	$2,931,109,729	23,274	7,375	$706,082,824
Total	190,740	109,577	$17,860,872,212	108,712	29,792	$5,717,032,612

Table 6.12: Potential Impacts to Critical Facilities and Infrastructure

Jurisdiction	Critical Facilities and Infrastructure		
	Total Number	Number Inside the 100-year Floodplain	Percentage Susceptible to Flooding
Bayou Vista	0	0	0%
Clear Lake Shores	1	1	100%
Friendswood	14	0	0%
Hitchcock	11	4	36%
Jamaica Beach	1	1	100%
Kemah	3	2	67%
La Marque	13	0	0%
League City	28	2	7%
Santa Fe	9	1	11%
Tiki Island	2	2	100%
Unincorporated	14	5	36%
Total	96	18	19%

Source: HAZUS-MH

6.7 Impact

Based on the vulnerability assessment, a coastal flooding or storm surge event will have a greater impact on the area than an inland or riverine flood event. With a Category 5 storm surge, the total value at risk is over $17 billion dollars compared to approximately $5 billion with an inland flooding event. Based on the relative exposure and history of previous occurrences, the potential severity and impact of a major flood event are substantial. A major event or storm surge could result in multiple fatalities, a complete shutdown of facilities for 30 or more days, leaving more than half of all property destroyed or substantially damaged.

Mitigation Strategy

Table 6.12 provides a summary of the mitigation actions identified by each jurisdiction to address flood. Details for these actions are provided in Section 24.

Table 6.12: Mitigation Actions - Flood

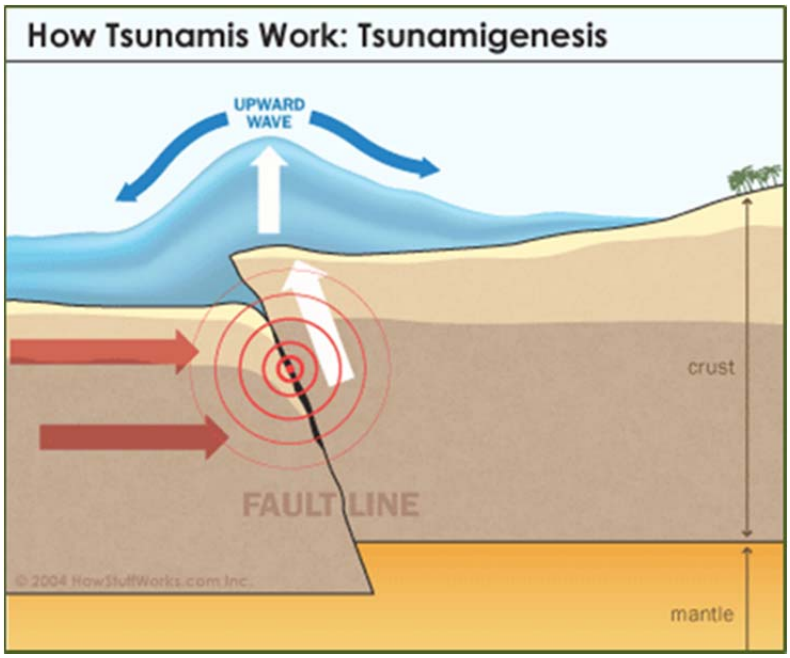
Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2011-4: Implement drainage improvement program to reduce standing water and runoff, and reduce minor flooding for residents located in District No. 12	BV-2011-8: Reconstruct/upgrade storm sewer systems
Clear Lake Shores	CLS-2016-2: Continue efforts on mitigating RFC/SRL properties when feasible	CLS-2016-3" Upgrade drainage systems and culvers
Friendswood	F-2016-2: Purchase Tiger Dam Systems	F-2016-15: Database development and maintenance for RL/SRL properties – elevation, relocation and acquisition
Hitchcock	H-2011-11: Implement storm sewer system improvement projects to mitigate flooding	H-2016-2: Continue efforts on mitigating RFC/SRL properties when feasible
Jamaica Beach	JB-2006-3: Improve / maintain participation in the NFIP and CRS programs	JB-2016-3: Continue efforts on mitigating RFC/SRL properties when feasible
Kemah	K-2016-3:Continue efforts on mitigating RFC/SRL properties when feasible	K-2016-4: Upgrade drainage systems and culverts
La Marque	LM-2011-14: Construct a stormwater detention area on the east side of the city	LM-2016-1: Continue efforts on mitigating RFC/SRL properties when feasible
League City	LC-2005-1: Stormwater drainage improvement	LC-2005-4: Shellside detention
Santa Fe	SF-2016-5: Continue efforts on mitigating RFC/SRL properties when feasible	SF-2016-6: Upgrade drainage systems and culverts
Tiki Island	TI-2011-11: Improve NFIP CRAS rating above current class 8	TI-2016-1: Continue efforts on mitigating RFC/SRL properties when feasible
Galveston County	GC 2016-5: Continue efforts on mitigating RFC/SRL properties when feasible	GC-2016-7: Upgrade drainage systems and culverts

7.0 Tsunami

7.1 Description

Tsunamis events can cause significant damage, injuries, and loss of life. The word tsunami is Japanese and means "harbor wave." A tsunami is a series of ocean waves generated by the sudden displacement of sea water most often caused by movement of the sea floor, landslides, or volcanic activity. Tsunami waves propagate outward from the area of the disturbance and can originate hundreds or even thousands of miles away from affected coastal areas.

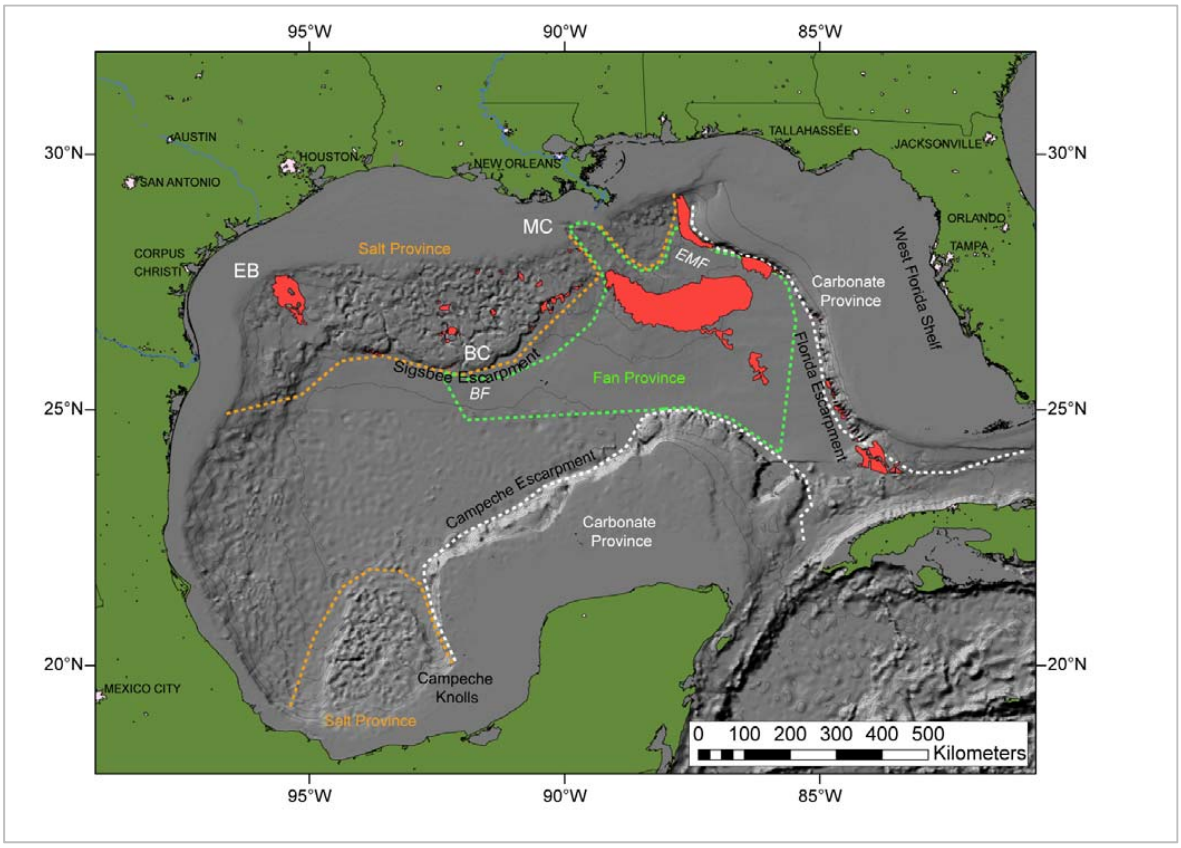
In the open ocean, tsunami waves travel at speeds of up to 600 miles per hour but are hidden in the deep water the wave travels in. The time between wave crests may range from five to 90 minutes. As the tsunami wave approaches shallow coastal waters, the wave slows down. The wave height becomes noticeable once it moves into shallower water. Waves can, without warning, rise to several feet or, in rare cases, tens of feet. Although the waves slow down as they enter shallow water, it is a negligible amount considering a 100-foot wave has been traveling at 600 miles per hour across the open ocean. In some extreme cases, a tsunami can throw several 100-foot tall waves onto the shore. The waves will come in sets. The first wave is almost never the largest; successive waves may be spaced tens of minutes apart and continue arriving for many hours.



7.2 Location

Galveston County is not at a high risk from tsunami due to the local rarity of the geologic events that most often generate these dangerous waves. However, according to the "Regional Assessment of Tsunami Potential in the Gulf of Mexico: US Geological Survey Administrative Report (2009)", there is sufficient evidence to consider submarine landslides in the Gulf of Mexico as a present-day tsunami hazard, as there are clear observations of large landslides along the continental margin of the Gulf. In this study hydrodynamic modeling of potential maximum tsunamis from landslide sources were conducted for the East Breaks (EB) slide (south Texas) and for hypothetical slides along the Florida/Campeche margin. Wave propagation yielded potential maximum tsunami run-up of approximately 4 meters or 13 feet (relative to mean sea level).

Figure 7.1: USGS Geological Provinces in the Gulf of Mexico



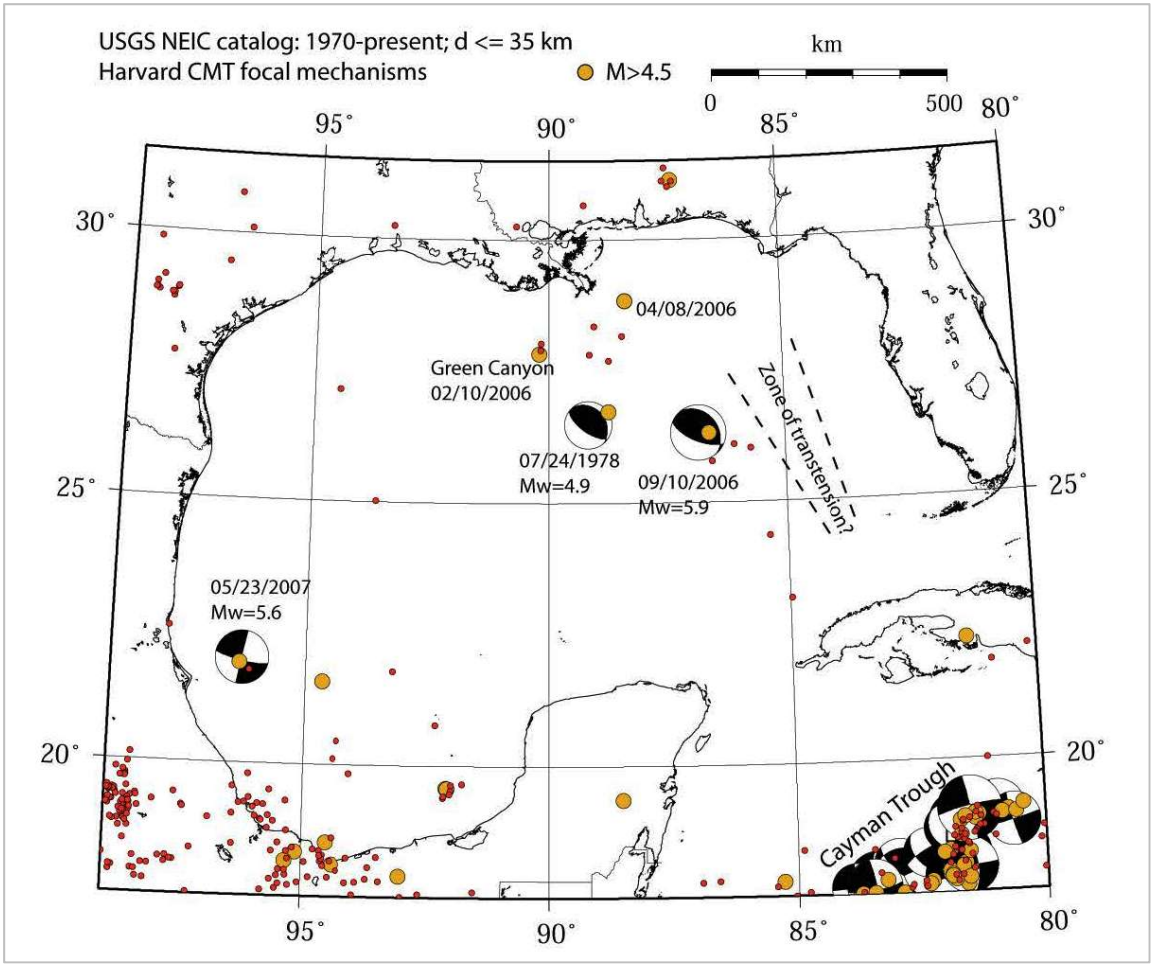
Source: Regional Assessment of Tsunami Potential in the Gulf of Mexico: U.S. Geological Survey Administration Report (2009)

Note: Landslide deposits are shaded in red

Primary impacts of a tsunami event would occur along the beachfront and island communities of the county. The area of impact would likely be similar in coverage to a hurricane storm surge or coastal flood, affecting Bolivar Peninsula (unincorporated County) and Jamaica Beach.

Figure 7.2 displays the historical seismicity data for the Gulf of Mexico 1970 to 2009.

Figure 7.2: Coastal Inundation Zone Locations



Source: Regional Assessment of Tsunami Potential in the Gulf of Mexico: U.S. Geological Survey Administration Report (2009)

7.3 Extent

Severity for a tsunami depends on the amount of energy that propagates the wave, velocity of that wave, basin shape, population density, structures present, and warning time.

A modified Tsunami Intensity Scale was developed in 2001 by Gerassimos Papadopoulos and Fumihiko Imamura as is shown in Table 7.1. This 12-point scale of tsunami intensity is meant to correspond to current earthquake intensity scales and is arranged according to a tsunami's effects on: a) humans; b) objects including boats; and c) damage to buildings.

Based on the rare historical occurrences and opportunity for future events, Galveston County and participating jurisdictions can expect a potential tsunami event from a Level I to a Level X on the Tsunami Intensity Scale.

Table 7.1: Tsunami Intensity Scale

Level	Description
I	Not Felt
II	Scarcely Felt a. Felt by few people onboard small vessels. Not observed on the coast. b. No effect. c. No damage.
III	Weak a. Felt by most people on board small vessels. Observed by a few people on the coast. b. No effect. c. No damage.
IV	Largely Observed a. Felt by all onboard small vessels and by few people onboard large vessels. Observed by most people on the coast. b. Few small vessels move slightly onshore. c. No damage.
V	Strong (wave height 1 meter) a. Felt by all onboard large vessels and observed by all on the coast. Few people are frightened and run to higher ground. b. Many small vessels move strongly onshore, few of them crash into each other or overturn. Traces of sand layer are left behind on ground with favorable circumstances. Limited flooding of cultivated land. c. Limited flooding of outdoor facilities (such as gardens) of near-shore structures.
VI	Slightly damaging (2 m) a. Many people are frightened and run to higher ground. b. Most small vessels move violently onshore, crash strongly into each other, or overturn. c. Damage and flooding in a few wooden structures. Most masonry buildings withstand.

Level	Description
VII	Damaging (4 m) a. Many people are frightened and try to run to higher ground. b. Many small vessels damaged. Few large vessels oscillate violently. Objects of variable size and stability overturn and drift. Sand layer and accumulations of pebbles are left behind. Few aquaculture rafts washed away. c. Many wooden structures damaged, few are demolished or washed away. Damage of grade 1 and flooding in a few masonry buildings.
VIII	Heavily damaging (4 m) a. All people escape to higher ground; a few are washed away. b. Most of the small vessels are damaged; many are washed away. Few large vessels are moved ashore or crash into each other. Big objects are drifted away. Erosion and littering of the beach. Extensive flooding. Slight damage in tsunami-control forests and stop drifts. Many aquaculture rafts washed away, few partially damaged. c. Most wooden structures are washed away or demolished. Damage of grade 2 in a few masonry buildings. Most reinforced-concrete buildings sustain damage, in a few damage of grade 1 and flooding is observed.
IX	Destructive (8 m) a. Many people are washed away. b. Most small vessels are destroyed or washed away. Many large vessels are moved violently ashore, few are destroyed. Extensive erosion and littering of the beach. Local ground subsidence. Partial destruction in tsunami-control forests and stop drifts. Most aquaculture rafts washed away, many partially damaged. c. Damage of grade 3 in many masonry buildings, few reinforced-concrete buildings suffer from damage grade 2.
X	Very destructive (8 m) a. General panic. Most people are washed away. b. Most large vessels are moved violently ashore, many are destroyed or collide with buildings. Small boulders from the sea bottom are moved inland. Cars overturned and drifted. Oil spills, fires start. Extensive ground subsidence. c. Damage of grade 4 in many masonry buildings, few reinforced-concrete buildings suffer from damage grade 3. Artificial embankments collapse, port breakwaters damaged.
XI	Devastating (16 m) b. Lifelines interrupted. Extensive fires. Water backwash drifts cars and other objects into the sea. Big boulders from sea bottom are moved inland. c. Damage of grade 5 in many masonry buildings. Few reinforced-concrete buildings suffer from damage grade 4, many suffer from damage grade 3.
XII	Completely devastating (32 m) Practically all masonry buildings demolished. Most reinforced-concrete buildings suffer from at least damage grade 3.

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7.4 Historical Occurrences

According to the NCDC, a "definite" tsunami impacted Galveston, Texas, on October 24, 1918 around 3:45 a.m. The tsunami was generated by an earthquake that occurred in Puerto Rico. The observed wave run-up height was undetermined according to NOAA. A "questionable" tsunami impacted the same area on May 2, 1922 around 8:25 p.m. The cause for both events is believed to be earthquake activity originating near Puerto Rico. Galveston County is over 1,800 miles from the source of both events. There is no information available for either event concerning deaths, injuries or damages.

7.5 Probability of Future Events

An analysis of historical data indicates a very low risk for future occurrences of a tsunami for the Galveston County area. The probability of future occurrence is unlikely, with the last definite occurrence in 1918 nearly 100 years ago.

7.6 Vulnerability Assessment

The coastal areas of the county are those at greatest risk. Tsunamis can cause great loss of life and property damage where they come ashore, and most deaths are the result of drowning. Associated risks include water pollution, damaged gas lines, and flooding.

If an intense tsunami of a Level X were to strike the area, wooden structures in the path of waves and those with pier-and- beam foundations could be destroyed. Waves can wash ships and shipping containers ashore, which become floating debris, causing extensive external damage. Critical infrastructure and commercial properties within the inundation area for a tsunami area would suffer major damage, with shutdowns for at least two weeks as critical infrastructure consists of low-rise, reinforced concrete buildings. It is expected that while the contents and non-structure components could be destroyed during an intense, Level X event, the outside structures for critical facilities and commercial properties could suffer major damage.

7.7 Impact

Even though the probability of a tsunami is low, the severity could be substantial. Records are unavailable to indicate the impact of the two suspected tsunamis for the area. However, several factors have changed since those events. The county and participating jurisdictions adhere to higher standards for building codes and the population density has increased substantially. Therefore, it's expected that the impact on structures would not be as devastating as the potential loss of life.

Mitigation Strategy

Table 7.2 provides a summary of the mitigation actions identified by jurisdiction's that could be impacted by a tsunami event. Details for these actions are provided in Section 24.

Table 7.2: Mitigation Actions - Tsunami

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2011-16: Install a deflective shield over two clarifiers	BV-2006-1: Continue efforts on public information and awareness for all hazards
Clear Lake Shores	CLS 2011-16: Review current building codes and periodically review code and update accordingly	CLS-2016-1: Implement public awareness campaigns for all hazards
Jamaica Beach	JB-2016-2: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2011-14: Harden existing critical facilities and infrastructure to be more resistant to all hazards
Tiki Island	TI-2011-9: replace the Tiki Drive bridge with an improved, hardened bridge to withstand storm surge and debris	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2006-12: Incorporate GIS system into emergency planning and operations	GC-2011-6: Continue efforts on public information and awareness for all hazards

8.0 Tornado

8.1 Description

Tornadoes are nature's most violent storms, spawned from powerful thunderstorms, causing fatalities and devastating properties in seconds. A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 300 miles per hour. Damage paths can exceed one mile wide and 50 miles long. Some tornadoes are clearly visible while rain or nearby low-hanging clouds obscure others. Occasionally, tornadoes develop so rapidly little, if any, advance warning is possible. Before a tornado hits, the wind may die down, and the air may become very still. A cloud of debris can mark the location of a tornado even if a funnel is not visible. Tornadoes generally occur near the trailing edge of a thunderstorm. It is not uncommon to see clear, sunlit skies behind a tornado.

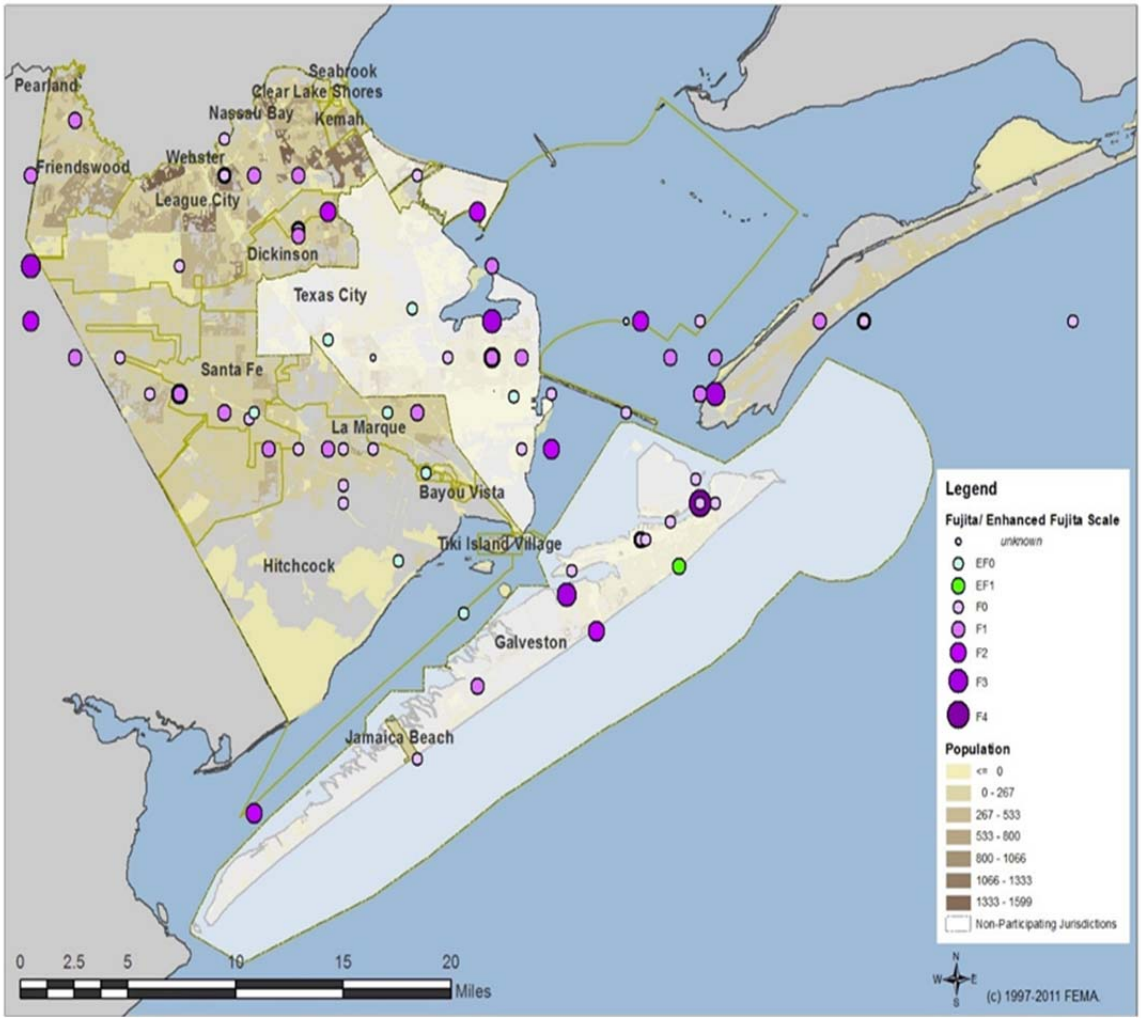
Galveston County Tornado September 5, 2014
Courtesy of KHUO-11 News

Galveston County, which borders the Texas Gulf Coast, is known for frequent severe weather and thunderstorms. In addition, tornadoes occasionally accompany tropical storms and hurricanes that move over land. Tornadoes are the most common to the right and front of the storm center path as it comes ashore.

8.2 Location

While historical tornado events in the Galveston County area total 92 from 1950 to 2015 (Figure 8.1), locations of these incidents are random and unpredictable. In fact, the historical evidence indicates that most of the area is vulnerable to the tornado hazard.

Figure 8.1: Location of Historical Tornado Events (NOAA Data1950–2015)



8.3 Extent

The Enhanced Fujita Scale, or EF Scale (Table 8.1), is the current scale for rating the strength of tornadoes in the United States; magnitude is estimated via the damage left behind. Implemented in February 2007, it replaced the Fujita Scale. The scale has the same basic design as the original Fujita Scale, six categories from zero to five, representing increasing degrees of damage. The new scale takes into account how most structures are designed, and is thought to be more accurate representation of the surface wind speeds in the most violent tornadoes.

Table 8.1: Enhanced Fujita Scale

Enhanced Fujita Category	Wind Speed (mph)	Potential Damage
EF0	65-85	Light damage. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	86-110	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111-135	Considerable damage. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136-165	Severe damage. Entire stories of well-constructed houses destroyed; severe damage to large buildings, such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166-200	Devastating damage. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	>200	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 m (109 yd.); high-rise buildings have significant structural deformation; incredible phenomena will occur.

Source: NOAA

8.4 Historical Occurrences

Historical evidence shows that most of the area is vulnerable to tornadic activity. This hazard can result from severe thunderstorm activity or may occur during a major tropical storm or hurricane. Table 8.2 shows aggregated historical information by jurisdiction.

Table 8.2: Overall Historical Tornado Impact by Jurisdiction (1950-2015)

Jurisdiction	Property Damage	No. of Events	Magnitude (Fujita Scale)						Magnitude (Enhanced Fujita Scale)					
			F0	F1	F2	F3	F4	F5	EF0	EF1	EF2	EF3	EF4	EF5
Bayou Vista	$0	0												
Clear Lake Shores	$0	0												
Friendswood	$1,520,000	5	2	2							1			
Hitchcock	$72,000	2	1						1					
Jamaica Beach	$0	1	1											
Kemah	$0	0												
La Marque	$0	1							1					
League City	$120,000	2	1	1										
Santa Fe	$122,000	4	3						1					
Village of Tiki Island	$0	0												
Galveston County	$32,372,270	78	35	26	9	5	1		0	0	0	0	0	0
Total	$34,206,270	93	43	29	9	5	1		3	0	1	0	0	0

Source: National Climatic Data Center (note: two events in the County had unknown intensity)

8.5 Probability of Future Events

Based on historical events and the location of the county in terms of risk, the occurrence of a tornado is highly likely, with an event expected in the next year. On average, a tornado occurs in the planning area once every 1.4 years.

8.6 Vulnerability Assessment

Because tornadoes often cross jurisdictional boundaries, all existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted. However, it is important to note that only reported tornadoes have been factored into this assessment.

Table 8.3 shows potential annualized property losses for each jurisdiction. "Negligible" indicates the annualized expected property losses are less than $5,000. To estimate losses due to a tornado, NCDC historical tornado loss data was used. In this model:

- Losses were obtained for each jurisdiction
- Expected annualized losses were calculated through a non-linear regression of historical data

Table 8.3: Potential annualized losses by jurisdiction in the Galveston County area

Jurisdiction	Total Exposure*	Annualized Expected Property Losses	Annualized Percent Loss Ratio
Bayou Vista	$148,402,840	**Negligible	0.00%
Clear Lake Shores	$169,233,443	**Negligible	0.00%
Friendswood	$2,372,450,647	$8,000	0.00%
Hitchcock	$291,155,638	**Negligible	0.00%
Jamaica Beach	$253,449,835	**Negligible	0.00%
Kemah	$184,174,314	**Negligible	0.00%
La Marque	$616,967,900	**Negligible	0.00%
League City	$6,285,876,473	**Negligible	0.00%
Santa Fe	$633,204,508	**Negligible	0.00%
Tiki Island	$307,035,208	**Negligible	0.00%
Unincorporated	$1,738,099,508	$498,035	0.00%
Total	$13,000,049,864	$510,866	0.00%

Note: *Total Exposure is improved value of parcels in Galveston County

**Negligible is less than $5,000

8.7 Impact

Seasonal patterns are relevant to tornadoes. Thunderstorms form when warm, moist air collides with cooler, drier air. Since these masses tend to come together during the transition from summer to winter, most thunderstorms and resulting tornadoes occur during the spring (April through June) and fall (October through December). Warning time for tornadoes is minimal and ranges from no warning time to 30 minutes.

Based on the seasonal occurrence of tornadoes and the potential losses that could result, the impact can be substantial. They can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or sustain major damage.

Friendswood tornado, October 31, 2015 – Courtesy of onenewspage.com

Mitigation Strategy

Table 8.4 provides a summary of the mitigation actions identified by each jurisdiction to address tornadoes. Details of these actions are provided in Section 24.

Table 8.4: Mitigation Actions - Tornado

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2016-1: Install/maintain severe weather warning systems
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-6: Integrate hazard mitigation into local planning
Friendswood	F-2016-1: Purchase and install warning equipment within city parks	F-2016-13: Bury power lines
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2011-8: Implement a tree trimming/vegetation removal program from public right of ways
Jamaica Beach	JB-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-2: Develop severe weather audio alert system	K-2011-1: Participate in NWS tornado drills along with elementary school in jurisdiction
La Marque	LM-2016-10: Become a certified NWS StormReady community	LM-2011-11: Construct safe room shelter at EOC to house local residents
League City	LC-2005-6: Tornado public education campaign	LC-2016-8: Safe rooms
Santa Fe	SF-2016-8: Implement/maintain tree/vegetation trimming/removal near infrastructure, drainage, and roadside areas	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-10: Become a NOAA StormReady community	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2016-1: Install/maintain severe weather warning systems	GC-2011-6: Continue efforts on public information and awareness for all hazards

9.0 Windstorm

9.1 Description

Thunderstorms are associated with frontal boundaries and surface heating of the earth. Every year approximately 100,000 thunderstorms occur in the United States. Though they most likely occur in the spring and summer months and during the afternoon and evening, thunderstorms can occur year round and at any given hour. The strongest of these storms can cause damage to property and threaten lives with strong winds. The National Weather Service (NWS) wind speed threshold for a severe thunderstorm is a surface wind speed of 58 miles per hour (93 km/h) or greater.

Thunderstorm wind events fall into the following categories:

- ***Straight-line wind*** is a term used to define any thunderstorm wind that is not associated with rotation, and is used mainly to differentiate from tornadic winds.
- A ***downdraft*** is a small-scale column of air that rapidly sinks toward the ground.
- A ***downburst*** is a result of a strong downdraft. A downburst is a strong downdraft with horizontal dimensions larger than 4 km (2.5 mile) resulting in an outward burst of damaging winds on or near the ground. (Imagine the way water comes out of a faucet and hits the bottom of the sink.) Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.

Downburst – Courtesy of Jason Boggs, 2014

- A ***microburst*** is a small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally small (less than 4 km across) and short-lived, lasting only 5-10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.

Microburst – Courtesy of Jason Boggs, 2014

- A ***gust front*** is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up the air above them, forming a shelf cloud or detached roll cloud.

- A ***derecho*** is a widespread, long-lived wind storm that is associated with a band of rapidly moving showers or thunderstorms. A typical derecho consists of numerous microbursts, downbursts, and downburst clusters. By definition, if the wind damage swath extends more than 240 miles (about 400 km) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, then the event may be classified as a derecho.

Source: http://www.nssl.noaa.gov/education/svrwx101/wind/types/

In addition to windstorms directly related to thunderstorms, strong winds can also be produced by strong ***arctic cold fronts*** that plunge southward across the Great Plains from Canada. After the cold front has passed extreme differences in air pressure and temperature, they have a history of producing local winds at wind advisory levels with higher gusts. The NWS recognizes and defines three levels of wind-related advisories as follows:

- ***Wind Advisory*** – Sustained winds of 30 mph or more or gusts of 45 mph or greater for a duration for one hour or longer.

- ***High Winds*** – Sustained winds of 40 mph or greater for at least one hour, or frequent gusts of wind to 58 mph or greater.

- ***Extreme Wind Warnings*** – Sustained winds of 115 mph or greater during a land-falling hurricane.

Another potential source of local windstorms is a phenomenon known as a gravity wave. High winds from gravity waves are caused by rapid warming and drying on the back edge of a trailing region of rain usually associated with weakening thunderstorms. If conditions are right, this process can lead to falling pressure, which in turn may cause dramatic increases in wind speeds.

Visible Satellite Image of Gravity Wave Clouds off the Texas Coast (NOAA)

9.2 Location

Windstorms vary in terms of size, intensity, duration, and impact. High winds associated with thunderstorms are frequent occurrences throughout Galveston County. Windstorms produced by arctic cold fronts and gravity waves are infrequent, however, they are often more expansive. It is assumed that all of the jurisdictions are uniformly exposed to windstorm events.

9.3 Extent

The strength of thunderstorm winds can vary from a light breeze to over 100 mph. Windstorms produced by cold fronts and gravity waves have been known to produce winds over 60 mph. The Beaufort wind scale exhibits the range in impacts of wind speeds as shown in Table 9.1. The Galveston County planning area is subject to all the World Meteorological Organization (WMO) classifications listed below.

Table 9.1: Beaufort Wind Scale

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves 1-4 ft. becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves 4-8 ft. taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves 8-13 ft., whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-20 ft., white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (13-20 ft.) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Whole trees in motion, resistance felt walking against wind
9	41-47	Strong Gale	High waves (20 ft.), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs, slate blows off roofs
10	48-55	Storm	Very high waves (20-30 ft.) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (30-45 ft.) waves, foam patches cover sea, visibility more reduced	
12	64+	Hurricane	Air filled with foam, waves over 45 ft., sea completely white with driving spray, visibility greatly reduced	

Source: NOAA Storm Prediction Center

9.4 Historical Occurrences

Historical evidence shows countywide vulnerability to windstorms. Of the 116 windstorms identified, there was one gravity wave and one arctic cold front.

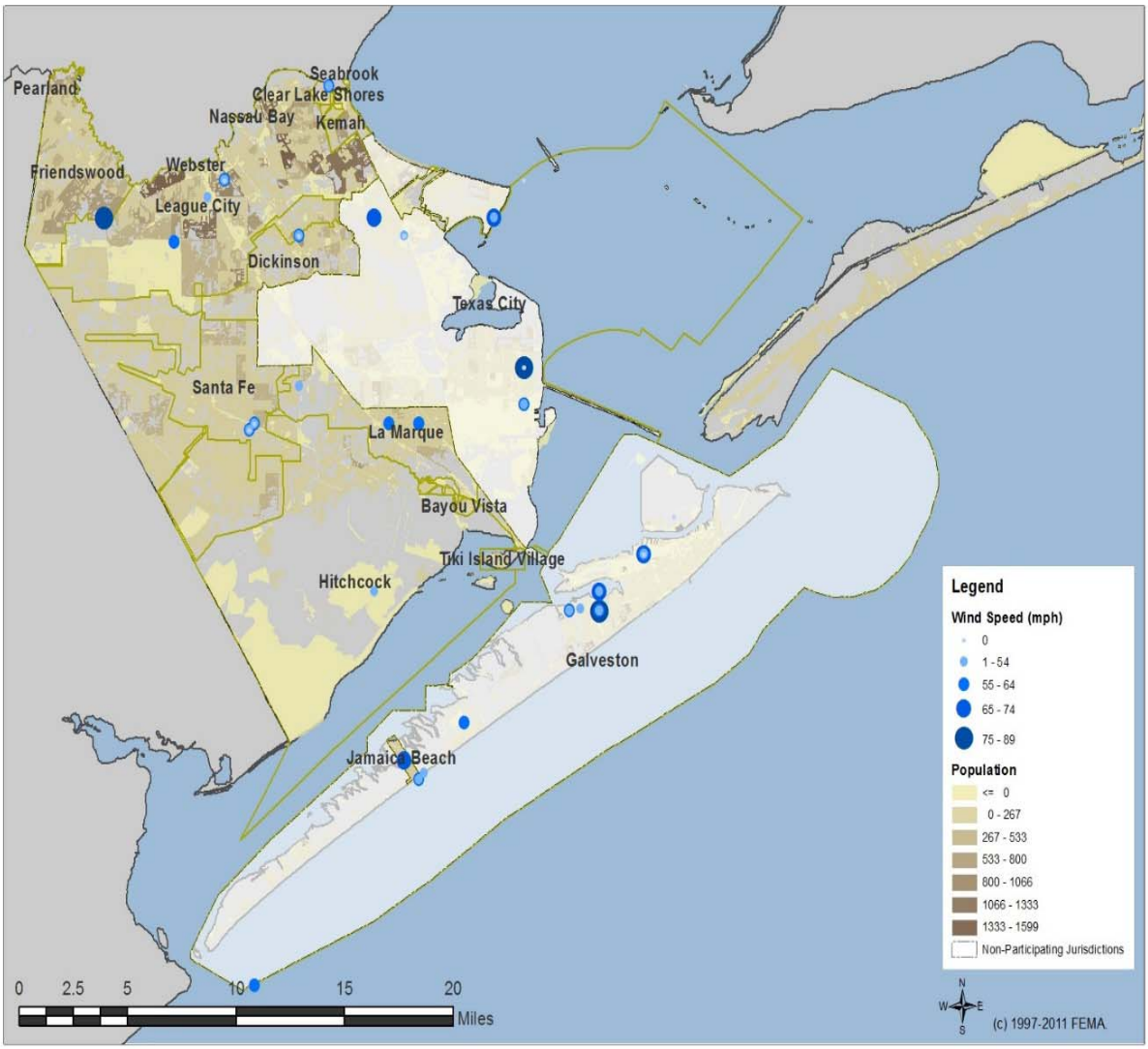
A strong cold front swept into the area on November 15, 2006 with estimated wind gusts of 55 kts and a gravity wave impacted the area on April 24, 2004 with a measured gust of 69 mph at Galveston Scholes Airport. Also, a severe thunderstorm occurred on May 2, 1993 which caused an estimated 50 million dollars in damages across the county. The geographic extent of these wind fields is unknown and for this study these three windstorms have been included with information for unincorporated Galveston County. Table 9.2 shows aggregated historical information on windstorm events by jurisdiction and Figure 9.1 on the subsequent page provides a graphic representation of these events.

Table 9.2: Historical Windstorm Events 1950-2015

Jurisdiction	Number of Events	Maximum Wind (kt / mph)	Property Damage	Crop Damage
Bayou Vista	1	Unknown	$500	$0
Clear Lake Shores	2	55 / 63	$11,000	$0
Friendswood	3	54 / 62	$118, 000	$0
Hitchcock	2	52 / 60	$56,000	$0
Jamaica Beach	6	70 / 81	$54,000	$0
Kemah	2	Unknown	$165,000	$0
La Marque	2	61 / 70	$15,000	$0
League City	15	62 / 71	$357,000	$0
Santa Fe	7	57 / 66	$156,000	$0
Village of Tiki Island	0	NA	$0	$0
Galveston County (Unincorporated)	76	85 / 98	$50,040,000	$2,000
Total	116	62 / 71	$50,952,500	$2,000

Source: NCDC

Figure 9.1: Spatial Historical Wind Events (NOAA Data 1950–2015)



Note: Only wind events with latitude, longitude locations are plotted

9.5 Probability of Future Events

Based on the historical occurrences high wind events are highly likely. On average, a windstorm event occurs in the planning area once every 1.7 years. The strongest wind gust recorded in the study occurred on May 2, 1993 at Scholes Air Field and was 98 mph. The NWS issues watches and warnings for severe thunderstorms and the lead times can vary from minutes to hours. However, the impacts of thunderstorms can occur with little to no warning.

9.6 Vulnerability Assessment

All existing and future buildings, facilities, and populations are considered to be exposed to windstorm hazards and could potentially be impacted. It is important to note that only reported thunderstorm-related events have been factored into this vulnerability assessment[1].

NCDC historical loss data (1950-2015) was used to develop a stochastic model for averaged annualized losses. Expected annualized losses were calculated through a non-linear regression of historical data and are presented in Table 9.3.

Table 9.3: Potential Annualized Losses (Windstorm)

Jurisdiction	Total Exposure*	Annualized Expected Property Losses	Annualized Percent Loss Ratio
Bayou Vista	$148,402,840	**Negligible	0.00%
Clear Lake Shores	$169,233,443	**Negligible	0.00%
Friendswood	$2,372,450,647	**Negligible	0.00%
Hitchcock	$291,155,638	**Negligible	0.00%
Jamaica Beach	$253,449,835	**Negligible	0.00%
Kemah	$184,174,314	**Negligible	0.00%
La Marque	$616,967,900	**Negligible	0.00%
League City	$6,285,876,473	**Negligible	0.00%
Santa Fe	$633,204,508	**Negligible	0.00%
Tiki Island	$307,035,208	No damages recorded	0.00%
Unincorporated	$1,738,099,508	$769,615	0.00%
Total	$13,000,049,864	$783,885	0.00%

Source: NCDC 1950-2015

Note: *Total Exposure is improved value of parcels in Galveston County
**Negligible is less than $5,000

9.7 Impact

The impacts of windstorms are considered to be moderate. Minor injuries can be expected and are typically treatable with first aid. Damages to property can vary from minimal; shutting down critical facilities and services for 24 hours or less to significant in higher windstorm events.

[1] It is likely that additional thunderstorm events occurred that were not reported to the NCDC and are not accounted for in this analysis.

Mitigation Strategy

Table 9.4 provides a summary of the mitigation actions identified by each jurisdiction to address windstorm. Details for these actions are provided in Section 24.

Table 9.4: Mitigation Actions - Windstorm

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2016-1: Install/maintain severe weather warning systems
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Friendswood	F-2016-1: Purchase and install warning equipment within city parks	F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2011-19: Evaluate, design, and implement hardening measures to protect existing critical facilities and infrastructure
Jamaica Beach	JB-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2006-2: Develop severe weather audio alert system
La Marque	LM-2011-19: Continue efforts on public information and awareness for all hazards	LM-2016-10: Become a certified NWS StormReady community
League City	LC-2005-8: Homeowner mitigation incentive program	LC-2016-6: Public outreach and education for all hazards
Santa Fe	SF-2016-2: Harden existing critical facilities and infrastructure to be more resistant to all hazards	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-10: Become a NOAA StormReady community	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2016-1: Install/maintain severe weather warning systems	GC-2011-6: Continue efforts on public information and awareness for all hazards

10.0 Hailstorm

10.1 Description

Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Early in the developmental stages of a hailstorm, ice crystals form within a low-pressure front due to the rapid rising of warm air into the upper atmosphere and subsequent cooling of the air mass. Frozen droplets gradually accumulate into ice crystals until they fall as precipitation that is round or irregularly shaped masses of ice. The size of hailstones is a direct result of the size and severity of the storm. High-velocity updraft winds are required to keep hail suspended where it can grow in size. The strength of the updraft is a byproduct of heating on the earth's surface. Higher temperature gradients above the earth's surface result in increased suspension time and hailstone size.

April 2, 2013 hailstorm in Galveston County near Hitchcock and Santa Fe
Courtesy of KHOU - Channel 11 Houston, Texas

10.2 Location

Hailstorms vary tremendously in terms of size, location, intensity, and duration but are considered frequent occurrences throughout Galveston County. It is assumed that all of the jurisdictions are uniformly exposed to hail events just as they are exposed to the thunderstorms that produce the hail events.

10.3 Extent

The severity of hail events ranges are based on the size of hail, winds, and structures in the path of a hail storm. A scale showing intensity categories was developed by the National Climatic Data Center (NCDC) and is included at Table 10.1.

Table 10.1: Hail Intensity and Magnitude

Size Code	Intensity Category	Size (diameter inches)	Descriptive Term	Typical Damage
H0	Hard Hail	up to 0.33	pea	no damage
H1	Potentially Damaging	0.33-0.60	marble	slight damage to plants and crops
H2	Potentially Damaging	0.60-0.80	dime	significant damage to plants and crops
H3	Severe	0.80-1.20	nickel	severe damage to plants and crops
H4	Severe	1.2-1.6	quarter	widespread glass and auto damage
H5	Destructive	1.6-2.0	half dollar	widespread destruction of glass, roofs, and risk of injuries
H6	Destructive	2.0-2.4	ping pong ball	aircraft bodywork dented and brick walls pitted
H7	Very Destructive	2.4-3.0	golf ball	severe roof damage and risk of serious injuries
H8	Very Destructive	3.0-3.5	hen egg	severe damage to all structures
H9	Super Hailstorms	3.5-4.0	tennis ball	extensive structural damage could cause fatal injuries
H10	Super Hailstorms	4.0 +	baseball	extensive structural damage could cause fatal injuries

Source: NCDC

10.4 Historical Occurrences

Historical evidence shows county-wide vulnerability to hail events. Typically, hail results from severe thunderstorm activity. Figure 10.1 presents a map of historical hail events recorded in the Galveston County study region. Table 10.2 shows aggregated historical information by jurisdiction. The largest hail recorded within the planning area fell in Hitchcock on April 2, 2013, and caused an estimated 1.1 million dollars in damages.

Figure 10.1: Spatial Historical Hail Events (NOAA Data 1950–2015)

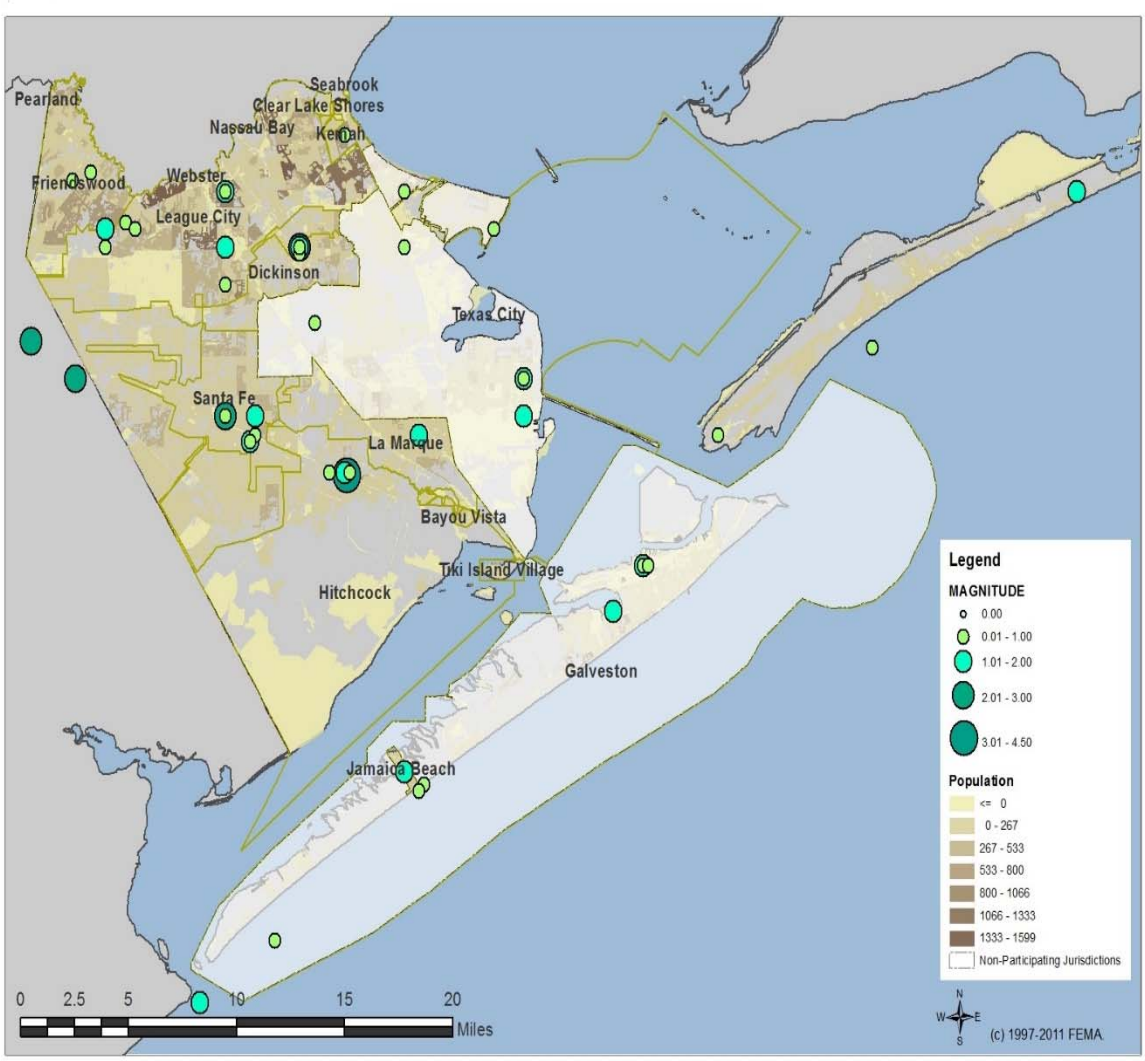


Table 10.2: Historical Hail Impact by Jurisdiction-please add property damage costs

Jurisdiction	Number of Events	Maximum hail size (inches)	Property Damage
Bayou Vista	1	1.75	$5,000
Clear Lake Shores	0	NA	$0
Friendswood	7	1.75	$500,000
Hitchcock	4	4.50	$1,112,000
Jamaica Beach	7	1.75	$61,000
Kemah	1	0.75	$3,000
La Marque	1	1.75	$3,000
League City	12	2.00	$80,000
Santa Fe	7	1.75	$39,000
Village of Tiki Island	0	NA	$0
Galveston County Unincorporated	30	2.75	$6,000
Total	70	2.08 *(Averaged)*	$1,809,000

Source: National Climatic Data Center (1950-2015)

10.5 Probability of Future Events

Based on the historical occurrences of hailstorms, hail events are highly likely, meaning an event is probable in the next year or on a yearly basis. Most hailstorms occur during the spring (March, April, and May) and in the fall during the month of September. The warning time for a hailstorm is generally minimal, or there is no warning. The National Weather Service classifies a storm as severe if hail of 1 inch in diameter or greater occurs or is imminent based on observers or radar intensity.

10.6 Vulnerability Assessment

All existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted. It is important to note that only reported hail events with geo-referenced point data have been factored into this vulnerability assessment.[1]

NOAA historical hail loss data was used to develop a stochastic model for averaged annualized losses (Table 10.3). Expected annualized losses were calculated through a non-linear regression of historical data.

Table 10.3: Potential Annualized Losses by Jurisdiction (Hail)

Jurisdiction	Total Exposure*	Annualized Expected Property Losses	Annualized Percent Loss Ratio
Bayou Vista	$148,402,840	**Negligible	0.00%
Clear Lake Shores	$169,233,443	No damages recorded	0.00%
Friendswood	$2,372,450,647	$7,538	0.00%
Hitchcock	$291,155,638	$17,107	0.00%
Jamaica Beach	$253,449,835	**Negligible	0.00%
Kemah	$184,174,314	**Negligible	0.00%
La Marque	$616,967,900	**Negligible	0.00%
League City	$6,285,876,473	**Negligible	0.00%
Santa Fe	$633,204,508	**Negligible	0.00%
Tiki Island	$307,035,208	No damages recorded	0.00%
Unincorporated	$1,738,099,508	**Negligible	0.00%
Total	$13,000,049,864	$28,386	0.00%

Note: *Total Exposure is improved value of parcels in Galveston County
**Negligible is less than $5,000

10.7 Impact

The severity of a hailstorm impact is considered to be limited since they generally result in injuries treatable with first aid, and less than ten percent of affected properties sustain major damage.

[1] It is possible that additional hail events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

Mitigation Strategy

Table 10.4 provides a summary of the mitigation actions identified by each jurisdiction to address hailstorm. Details for these actions are provided in Section 24.

Table 10.4: Mitigation Actions - Hailstorm

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2016-1: Install/maintain severe weather warning systems
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Friendswood	F-2016-1: Purchase and install warning equipment within city parks	F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2011-19: Evaluate, design, and implement hardening measures to protect existing critical facilities and infrastructure
Jamaica Beach	JB-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2006-2: Develop severe weather audio alert system
La Marque	LM-2011-19: Continue efforts on public information and awareness for all hazards	LM-2016-10: Become a certified NWS StormReady community
League City	LC-2005-8: Homeowner mitigation incentive program	LC-2016-6: Public outreach and education for all hazards
Santa Fe	SF-2016-2: Harden existing critical facilities and infrastructure to be more resistant to all hazards	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-10: Become a NOAA StormReady community	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2016-1: Install/maintain severe weather warning systems	GC-2011-6: Continue efforts on public information and awareness for all hazards

11.0 Lightning

11.1 Description

Lightning is one of the top three storm-related killers in the United States. It is also one of the least understood weather phenomena. Below is a description of lightning and thunder as defined by NOAA:[1]

- ***Lightning*** is a giant spark of electricity in the atmosphere or between the atmosphere and the ground. In the initial stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground; however, when the difference in charges become too great, the insulating capacity of the air breaks down, and there is a rapid discharge of electricity known as lightning.

  Lightning can occur between opposite charges within the thunderstorm cloud (Intra-Cloud Lightning) or between opposite charges in the cloud and on the ground (Cloud-To-Ground Lightning). Cloud-to-ground lightning is divided into two different types of flashes depending on the charge in the cloud where the lightning originates.

- ***Thunder*** is the sound made by a flash of lightning. As lightning passes through the air, it heats the air quickly. This causes the air to expand rapidly and creates the sound wave we hear as thunder. Normally, you can hear thunder about 10 miles from a lightning strike. Since lightning can strike outward 10 or more miles from a thunderstorm, if you hear thunder, you are likely within striking distance of a storm.

11.2 Location

Lightning in association with thunderstorms vary in terms of size, intensity, duration, and impacts, but are considered frequent occurrences throughout Galveston County. It is assumed that all of the jurisdictions are uniformly exposed to thunderstorm events and the associated impact lightning. According to information calculated from the NOAA Severe Weather Data Inventory (SWDI), there were nearly 10,000 cloud-to-ground lightning strikes within the county between January 1986 and May 2013; this information indicates an average of 378 lightning strikes per year in the county.

[1] http://www.lightningsafety.noaa.gov/science/science-overview.shtml

Figures 11.1 and 11.2 depict cloud to ground lightning strikes from 2005 to 2014.

Figure 11.1: Vaisala Flash Density 2005 to 2014

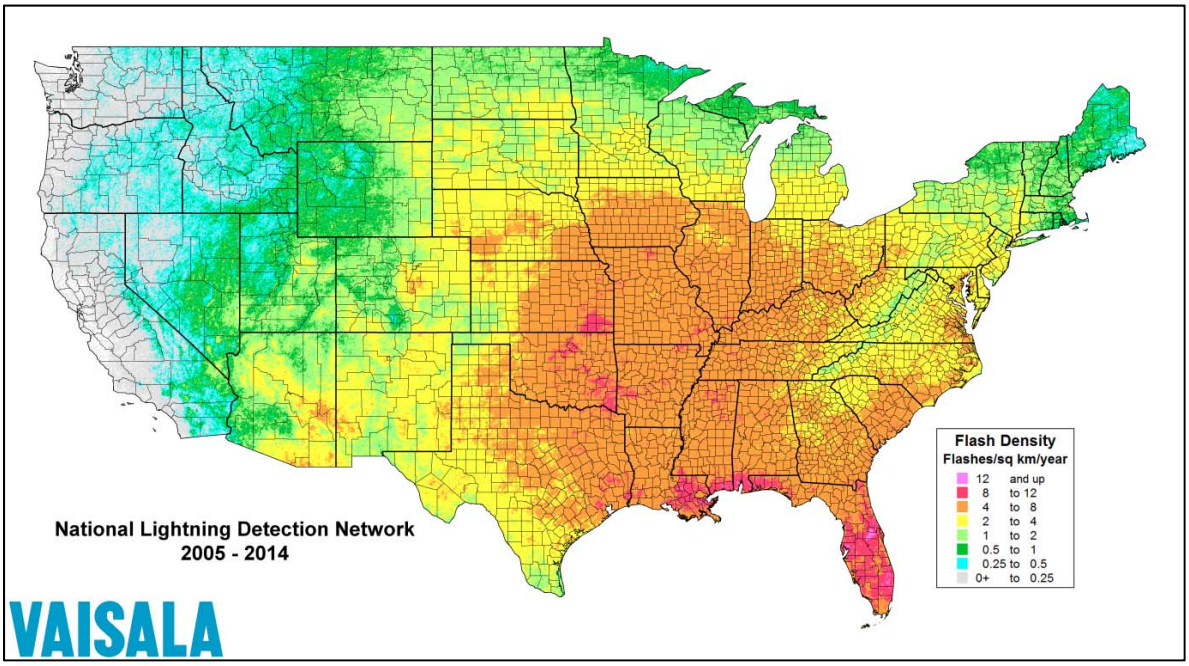
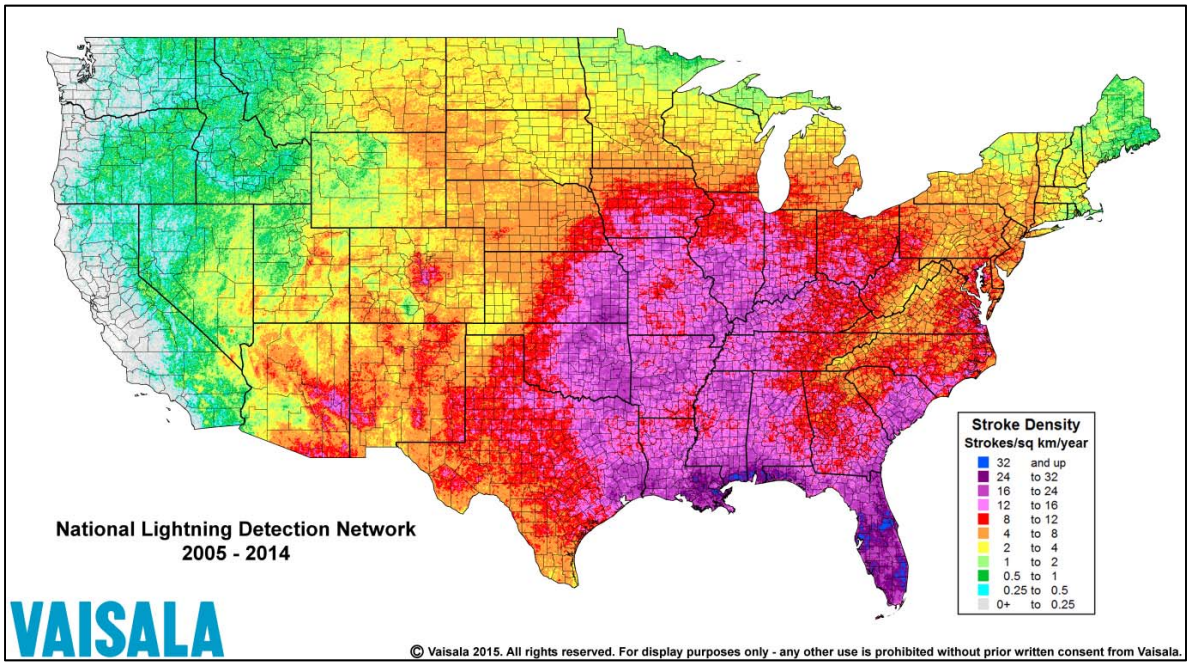


Figure 11.2: Vaisala Stroke Density 2005 to 2014



11.3 Extent

The range in intensity of lightning strikes is largely dependent upon the type of charge transferred during the strike. In this respect, there are three forms of lightning: positive, negative, and bipolar. All three forms of lightning strikes can injure, kill and cause damage, so NOAA utilizes lightning activity levels to quantify the extent of lightning activity as defined below in Table 11.1.

Table 11.1: NOAA Lightning Activity Levels (LAL)

LAL	Cloud and Storm Development	Lightning Strikes / 15 Minutes
1	No thunderstorm	0
2	Cumulus clouds are common but only a few reach the towering cumulus stage. A single thunderstorm must be confirmed in the observation area. The clouds produce mainly virga, but light rain will occasionally reach the ground. Lightning is very infrequent.	1-8
3	Towering cumulus covers less than two-tenths of the sky. Thunderstorms are few, but two to three must occur within the observation area. Light to moderate rain will reach the ground, and lightning is infrequent.	9-15
4	Towering cumulus covers two to three-tenths of the sky. Thunderstorms are scattered and more than three must occur within the observation area. Moderate rain is common and lightning is frequent.	16-25
5	Towering cumulus and thunderstorms are numerous. They cover more than three-tenths and occasionally obscure the sky. Rain is moderate to heavy and lightning is frequent and intense.	>25
6	Dry lightning, similar to LAL 3 except thunderstorms are dry.	

Positive lightning makes up less than five percent of all strikes. While all lightning poses similar dangers, the much larger currents, charge transfers, and current duration associated with a positive flash, makes it more lethal and more likely to damage power transmission facilities and cause fires. Positive lightning is more dangerous because its electrical field is much stronger, its flash duration is longer, and its peak charge potential can be ten times greater than a negative strike. Positive strikes have a peak charge potential of one billion volts. The dispersion of lightning intensity and lightning strikes in Galveston County is assumed to be uniform across the area.

11.4 Historical Occurrences

Historical evidence of lightning activity shows countywide vulnerability to lightning strikes. Currently, data contained in the NCDC database captures reported events that resulted in fatalities, injury, and property damage. In a review of this information, there were no fatalities or injuries recorded. This information is passively collected; the actual coverage of detected strikes in Table 11.1 shows the extensive nature of the hazard, and Table 11.2 captures the reported occurrences with associated damages.

Table 11.2: Summary of Historical Events for Lightning – 1950 to 2015

Jurisdiction	Number of E vents	Property Damage
Bayou Vista	0	$0
Clear Lake Shores	0	$0
Friendswood*	7	$549,500
Hitchcock	0	$0
Jamaica Beach	1	$15,000
Kemah	1	$10,000
La Marque	0	$0
League City	1	$15,000
Santa Fe	0	$0
Village of Tiki Island	0	$0
Unincorporated	1	$250,000
Total	11	$578,500

Source: NCDC
Note: Data provided by Friendswood as" lightning fires", not documented as lightning on NCDC

11.5 Probability of Future Events

Based on historical occurrences of thunderstorms and associated impacts of lightning, lightning events are highly likely and probable on an annual basis. On average, several hundred strikes occur each year within the planning area. Most thunderstorms occur during the spring (March, April, and May) and in the fall during the month of September. The NWS issues watches and warnings for severe thunderstorms; however, lightning is not criteria for issuance and the lead times can vary from minutes to hours. The impacts of thunderstorms can occur with little to no warning and lightning strikes can occur as far as 10-15 miles away from a thunderstorm.

11.6 Vulnerability Assessment

All existing and future buildings, facilities, and populations are considered to be exposed to this hazard and could potentially be impacted. It is important to note that only reported lightning events with geo-referenced point data have been factored into this vulnerability assessment.[2] National Climatic Data Center (NCDC) historical loss data as shown in Table 11.3 was used to estimate losses due to lightning.

Table 11.3: Potential Annualized Losses - Lightning

Jurisdiction	Total Exposure*	Annualized Expected Property Losses	Annualized Percent Loss Ratio
Bayou Vista	$148,402,840	**Negligible	0.00%
Clear Lake Shores	$169,233,443	**Negligible	0.00%
Friendswood	$2,372,450,647	**Negligible	0.00%
Hitchcock	$291,155,638	**Negligible	0.00%
Jamaica Beach	$253,449,835	**Negligible	0.00%
Kemah	$184,174,314	**Negligible	0.00%
La Marque	$616,967,900	**Negligible	0.00%
League City	$6,285,876,473	**Negligible	0.00%
Santa Fe	$633,204,508	**Negligible	0.00%
Tiki Island	$307,035,208	**Negligible	0.00%
Unincorporated	$1,738,099,508	**Negligible	0.00%
Total	$13,000,049,864	**Negligible	0.00%

Note: *Total Exposure is improved value of parcels in Galveston County
**Negligible is less than $5,000

11.7 Impact

The impact of lightning is considered to be moderate since it may result in injuries or deaths, shut down critical facilities and services for 24 hours or less, and affected properties may sustain damage and can be destroyed.

[2] It is likely that additional thunderstorm-related events occurred that were not reported to the NCDC and are not accounted for in this analysis.

Mitigation Strategy

Table 11.4 provides a summary of the mitigation actions identified by each jurisdiction to address lightning. Details for these actions are provided in Section 24.

Table 11.4: Mitigation Actions - Lightning

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2016-16: Install lightning grounding systems and protection devices on critical facilities/infrastructure
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Friendswood	F-2016-1: Purchase and install warning equipment within city parks	F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2011-19: Evaluate, design, and implement hardening measures to protect existing critical facilities and infrastructure
Jamaica Beach	JB-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2011-14: Harden existing critical facilities and infrastructure to be more resistant to all hazards
La Marque	LM-2011-19: Continue efforts on public information and awareness for all hazards	LM-2016-2: Install lightning grounding systems and protection devices on infrastructure and municipal buildings
League City	LC-2005-7: Install lightning/surge protection equipment on city buildings	LC-2016-6: Public outreach and education for all hazards
Santa Fe	SF-2016-7: Install lightning grounding systems and protection devices on infrastructure and municipal buildings	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-10: Become a NOAA StormReady community	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2011-6: Continue efforts on public information and awareness for all hazards	GV-2016-8: Install lightning grounding systems and protection devices on critical facilities/infrastructure

12.0 Severe Winter Weather

12.1 Description

A severe winter storm event is identified as a storm with snow, ice, or freezing rain—all of which can cause significant problems for area residents. Although rare in southeast Texas, winter weather does occasionally occur. January is the month when snow, sleet, or freezing rain is most likely to be observed; yet, winter weather conditions can occur at any time during the winter and early spring months. The leading cause of death during winter storms is transportation accidents. Hypothermia and frost bite are other dangers from very cold winter temperatures.

The National Weather Service (NWS) defines a winter storm as having three factors: cold air, moisture, and lift. These three factors acting together create conditions suitable for a winter storm. Below is a listing of definitions for winter weather events that could impact the planning area:

- ***Snow Flurries*** **-** Light snow falling for short durations with no accumulation expected.
- ***Snow Showers*** **-** Snow falling at varying intensities for brief periods of time. Some accumulation is possible.
- ***Sleet*** **-** Rain drops that freeze into ice pellets before reaching the ground. Sleet usually bounces when hitting a surface and does not stick to objects. However, it can accumulate like snow and cause a hazard to motorists.
- ***Freezing Rain*** **-** Rain that falls onto a surface with a temperature below freezing. This causes it to freeze to surfaces, such as trees, cars, and roads, forming a coating or glaze of ice. Even small accumulations of ice can cause a significant hazard.
- ***Wind Chill*** **-** The combination of wind and temperature that serves as an estimate of how cold it actually feels to exposed human skin. Wind chill values below -19 degrees are considered dangerous.

12.2 Location

Winter storms vary in location, intensity and duration but are considered rare occurrences in Galveston County and the upper Texas Gulf Coast. It is assumed all of the jurisdictions are equally susceptible to winter storm events; therefore, all areas of the county are equally exposed.

12.3 Extent

Table 12.1 displays the magnitude of severe winter storms. The wind-chill factor is further described in Figure 12.1. This index was developed by the NWS, although the chart is not applicable when temperatures are over 50° or winds are calm.

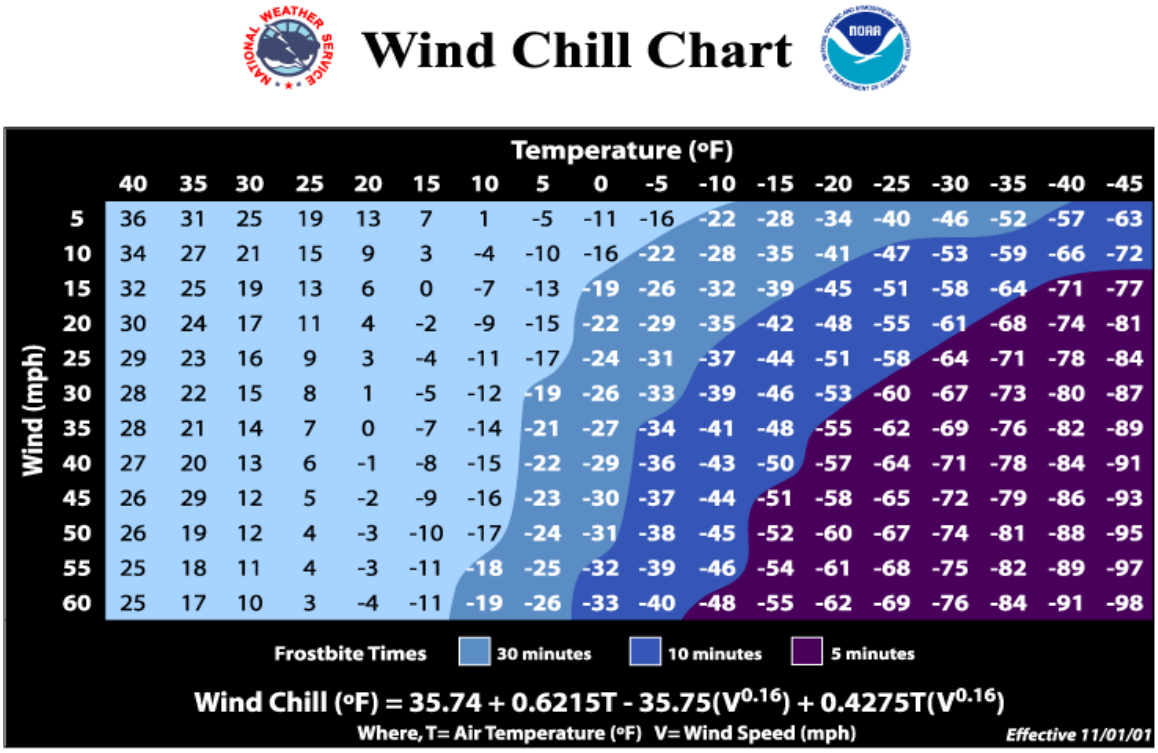
Table 12.1: Extent Scale - Winter Weather Alerts

Winter weather advisory	This alert may be issued for a variety of severe conditions. Weather advisories may be announced for snow, blowing or drifting snow, freezing drizzle, freezing rain, or a combination of weather events.
Winter storm watch	Severe winter weather conditions may affect your area (freezing rain, sleet or heavy snow may occur separately or in combination).
Winter storm warning	Severe winter weather conditions are imminent.
Freezing rain or freezing drizzle	Rain or drizzle is likely to freeze upon impact, resulting in a coating of ice glaze on roads and all other exposed objects.
Sleet	Small particles of ice usually mixed with rain. If enough sleet accumulates on the ground, it makes travel hazardous.
Blizzard warning	Sustained wind speeds of at least 35 mph are accompanied by considerable falling or blowing snow. This alert is the most perilous winter storm with visibility dangerously restricted.
Frost/freeze warning	Below freezing temperatures are expected and may cause significant damage to plants, crops and fruit trees.
Wind chill	A strong wind combined with a temperature slightly below freezing can have the same chilling effect as a temperature nearly 50 degrees lower in a calm atmosphere. The combined cooling power of the wind and temperature on exposed flesh is called the wind-chill factor.

Source: National Weather Service

Wind chill temperature is a measure of how cold the wind makes real air temperature feel to the human body, similar to the heat index for extreme heat (Figure 13.1). Since wind can dramatically accelerate heat loss from the body, a blustery 30° day would feel just as cold as a calm day with 0° temperatures.

Figure 12.1: Wind Chill Chart



Galveston County has never experienced a blizzard, but based on previous occurrences, the county has been subject to winter storm watches, warnings, freezing rain, sleet, snow and wind chill.

12.4 Historical Occurrences

Over the past 50 years, the NCDC reports that a severe ice storm occurred in 1997 and 2011, and one heavy snow fall in 2004. The 1997 ice storm effected trees, powerlines and roadways. The weight of the ice caused trees and powerlines to snap and fall. Glazed roadways posed hazardous driving conditions. Schools were closed for two to three days to prevent additional traffic collisions. Over 1100 traffic accidents were reported in Southeast Texas which accounted for three deaths in 1997 and $800,000 in property damages. In 2004, snowfall totals ranged from 1-12 inches across the region. The heavier snowfall occurred over the coastal counties south of Houston because this area had more moisture in the atmosphere (being closer to the Gulf), and was also closer to the track of the upper level low. Table 13.2 depicts historical occurrences for the county.

Table 13.2: Historical Winter Storms (Galveston County)

Date	Type	Deaths	Injuries	Property Damage	Description
Jan. 12-13, 1997	Ice Storm	3	0	$800,000	Trees, power lines and roadways were all affected by freezing rain and sleet. Glazed roadways posed hazardous driving conditions. Over 1,100 traffic accidents were reported in southeast Texas, causing 3 deaths.
Dec. 24-25, 2004	Heavy Snow	0	0	$0	A rare and record breaking snowfall occurred across southeast Texas. Snowfall totals ranged from 1-12 inches across the region. Approximately 4 inches fell on Galveston Island.
Feb. 3, 2011	Ice Storm	0	0	$0	A period of freezing rain and freezing drizzle led to icy roads, especially bridges and overpasses, and numerous accidents. Between one and two tenths of an inch of ice accumulated.

Source: National Climatic Data Center

Although not recorded in the NCDC, a cold upper level low pressure system moved across southeast Texas on December 10, 2008. An inch of snow fell on Galveston Island with generally an inch to two inches over the inland portions of county. This is the earliest accumulating snow that has affected southeast Texas and the island.

12.5 Probability of Future Events

Though infrequent, significant future winter weather events are possible given the historical occurrence. Snowfall and ice storms have been recorded once each in the last 50 years for Galveston County. Based on the historical events, winter storms for the area average about every four to seven years, indicating that the probability of a future event would be occasional, with an event possible in the next five years.

12.6 Vulnerability Assessment

It is important to note that only reported winter storms have been factored into this vulnerability assessment.[1]

To estimate losses due to winter storm, NCDC historical winter storm loss data was used to develop a winter storm stochastic model. In this model:

- Losses were obtained for each jurisdiction and scaled for inflation. For all events impacting the entire county (loss data not provided for specific jurisdictions), losses were averaged across all jurisdictions;
- Average historic winter storm damageability was used to generate losses for historical winter storm events where losses were not reported;
- Expected annualized losses were calculated through a non-linear regression of historical data; and
- Probabilistic losses were scaled to account for would-be losses where no exposure/instrument was present at the time of the event.

Based on the stochastic model, the vulnerability assessment for winter storm as applied to Galveston County using statistical methods resulted in negligible annualized property losses and percent loss ratios for each jurisdiction in Galveston County.

[1] It is possible that additional winter storm events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

12.7 Impact

Winter storms often impact large areas and cross jurisdictional boundaries. All existing and future buildings, facilities and populations are considered to be exposed to this hazard and could potentially be impacted. A heavy accumulation of ice can break power and telephone lines, television towers, and trees. Highways become hazardous to travel on, and even stepping outdoors can be extremely risky. Utility disruptions from winter storms can severely impact the delivery of services. Water pipes can freeze and crack in sub-freezing temperatures, ice can build up on power lines and cause them to break under the weight, and ice accumulation on tree limbs can cause breakage and affect nearly power lines. These events can disrupt electric service for long periods. Warning time for winter storms is generally six to twelve hours.

Therefore, the impact for the county is minor. It is likely that very few buildings in Galveston County will be directly threatened or damaged by winter storms; in addition, any building damages directly attributable to the winter storm hazard would be considered negligible for the purposes of this risk assessment.

Mitigation Strategy

Table 12.3 provides a summary of the mitigation actions identified by each jurisdiction to address severe winter weather. Details for these actions are provided in Section 24.

Table 12.3: Mitigation Actions – Severe Winter Weather

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2011-19: Implement a plan for the hardening of water systems during freeze events
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-4: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County
Friendswood	F-2016-4: Purchase and install a natural gas generator at the Activity Center	F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2011-10: Purchase and install generators and connection equipment to support critical facilities and infrastructure
Jamaica Beach	JB-2016-2: Secure generators for existing and new critical facilities and infrastructure	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2016-2: Secure generators for existing and new critical facilities and infrastructure
La Marque	LM-2011-19: Continue efforts on public information and awareness for all hazards	LM-2011-11: Construct safe room shelter at EOC to house local residents for emergency and non-emergency events
League City	LC-2016-6: Public outreach and education for all hazards	LC-2016-9: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County
Santa Fe	SF-2016-4: Secure generators for existing and new critical facilities and infrastructure	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2016-4: Continue efforts on public information and awareness for all hazards	TI-2011-5: Elevate wastewater lift stations and provide backup power
Galveston County	GC-2011-6: Continue efforts on public information and awareness for all hazards	GC-2016-4: Secure generators for existing and new critical facilities and infrastructure

13.0 Drought

13.1 Description

Drought is a period of time without substantial rainfall that persists from one year to the next. Drought is a normal part of all climatic regions, including areas with high and low average rainfall. Drought is the consequence of anticipated natural precipitation reduction over an extended period of time, usually a season or more in length. Drought can be classified as meteorological, hydrologic, agricultural, and socioeconomic. Table 13.1 presents definitions for these different types of drought.

Drought is one of the most complex of all natural hazards as it is difficult to determine their precise beginning or end. In addition, drought can lead to other hazards such as extreme heat and wildfires. Their impact on wildlife and area farming is enormous, often killing crops, grazing land, edible plants and even in severe cases, trees. A secondary hazard to drought is wildfire because dying vegetation serves as a prime ignition source. Consequently, a heat wave combined with a drought is a very dangerous situation.

Table 13.1: Drought Classification Definitions

Meteorological Drought	The degree of dryness or departure of actual precipitation from an expected average or normal amount based on monthly, seasonal, or annual time scales.
Hydrologic Drought	The effects of precipitation shortfalls on stream flows and reservoir, lake, and groundwater levels.
Agricultural Drought	Soil moisture deficiencies relative to water demands of plant life, usually crops.
Socioeconomic Drought	The effect of demands for water exceeding the supply as a result of a weather-related supply shortfall.

Source: Multi-Hazard Identification and Risk Assessment: A Cornerstone of the National Mitigation Strategy, FEMA

13.2 Location

Drought occurs regularly in the Texas Gulf Basin and is a normal condition. However, they can vary greatly in their intensity and duration. On average, a year-long drought takes place somewhere in Texas once every three years and a major drought every 20 years. There is no distinct geographic boundary to drought; therefore, it can occur throughout the Galveston County area equally.

13.3 Extent

The Palmer Drought Indices are used to measure the extent of drought. The Z Short-Term Conditions Index measures short-term drought on a weekly scale. The Meteorological Drought Index attempts to measure the duration and intensity of the long-term drought-inducing circulation patterns. Long-term drought is cumulative, with the intensity of drought during the current month dependent upon the current weather patterns plus the cumulative patterns of previous months. The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop. The Hydrological Drought Index in Table 13.2 is used to quantify the long term hydrological effects while Table 13.3 depicts magnitude of drought indices.

Table 13.2: Palmer Drought Classification Indices

	Drought Condition Classifications						
Drought Index	Extreme	Severe	Moderate	Normal	Moderately Moist	Very Moist	Extremely Moist
Z index	-2.75 and below	-2.00 to -2.74	-125 to -1.99	-1.24 to +.99	+1.00 to +2.49	+2.50 to +3.49	n/a
Meteorological	-4.00 and below	-3.00 to -3.99	-2.00 to 2.99	-1.99 to +1.99	+2.00 to +2.00	+3.00 to +3.00	+4.00 and above
Hydrological	-4.00 and below	-3.00 to -3.99	-2.00 to-2.99	-1.99 to +1.99	+2.00 to +2.00	+3.00 to +3.00	+4.00 and above

Table 13.3: Palmer Drought Category Descriptions

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	-1.0 to -1.9
D1	Moderate Drought	Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent, voluntary water use restrictions requested	-2.0 to -2.9
D2	Severe Drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed	-3.0 to -3.9
D3	Extreme Drought	Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions	-4.0 to -4.9
D4	Exceptional Drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies	-5.0 or less

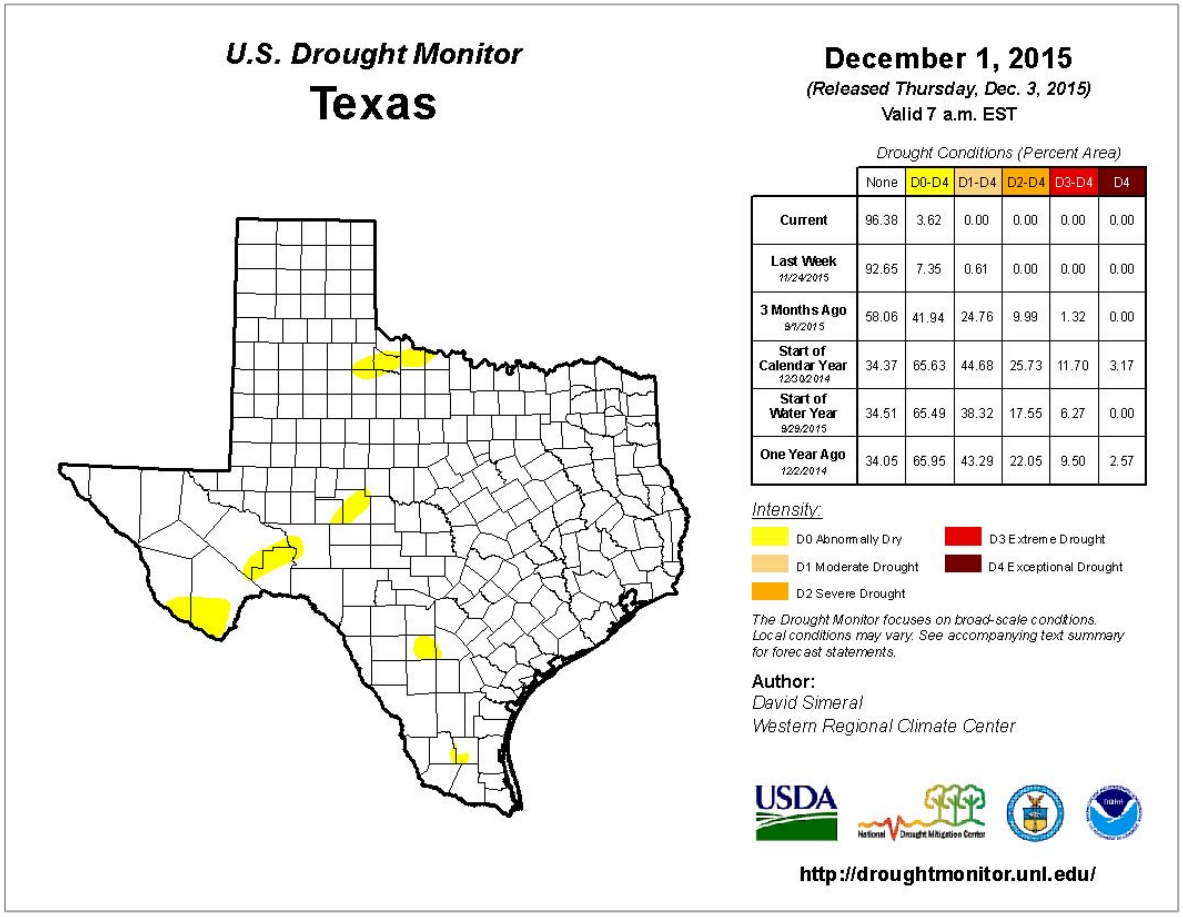
Source: National Drought Mitigation Center

Drought is a slow-onset hazards, but over time can have damaging effects on crops, municipal water supplies, recreation, and wildlife. If drought extends over a number of years, the direct and indirect economic impact can be significant.

Drought warnings are issued by the State Drought Preparedness Council, as directed by H.B. 2660, based upon input from NOAA, the Office of the State Climatologist, the U.S. Geological Service, the Texas Water Development Board, Texas Commission on Environmental Quality, and the Texas Agricultural Statistics Service. Warnings utilize five "levels of concern" and take into account assessments of climatology, agriculture, and water availability for each of 10 climatic regions of the state.

Drought is monitored nationwide by the National Drought Mitigation Center (NDMC). Indicators are used to describe broad scale drought conditions across the U.S. Indicators correspond to the intensity of drought. A snapshot of the region from December 2015 is included as Figure 13.1.

Figure 13.1: NCDC: U.S. Drought Monitor Indices, December 2015



13.4 Historical Occurrences

Although the Galveston County area does not typically experience severe or extreme drought due to its proximity to the coast, it has been affected by key historic events. Provided below is a summary of the events recorded through NCDC followed by a summary of damages sustained in Table 13.4.

1996 Drought

From April to June of 1996, Southeast Texas, including Galveston County, experienced moderate to severe drought due to below normal precipitation that fell in the winter of 1995 to 1996. Some areas received only about 30 percent of their normal rainfall. Although exact county estimates are not available, total property damage across Southeast Texas reached $2 million with approximately $8 million in agricultural losses.

1998 Drought

Galveston County experienced another period of severe drought in 1998, beginning in May and ending in August. Rainfall levels were nine inches below normal, yet the area experienced temperates at or above 96 degrees for months. Total crop and property damages reached $8.3 million for the county.

2000 Drought

High heat and dry conditions brought moderate to extreme drought to the area. Rainfall levels were down from 30 to 50 percent from their normal levels for the months of August and September. Wildfires broke out in neighboring counties, and the total crop damages for Southeast Texas were estimated at $102.3 million.

2005 Drought

Texas experienced record drought from 2005 to 2006 with a shortage of rainfall that lasted from May to December. Although the Galveston area was not affected as much as counties in North and Central Texas, it did experience abnormally dry conditions and moderate drought. The statewide drought losses from this event were estimated at $4.1 billion.

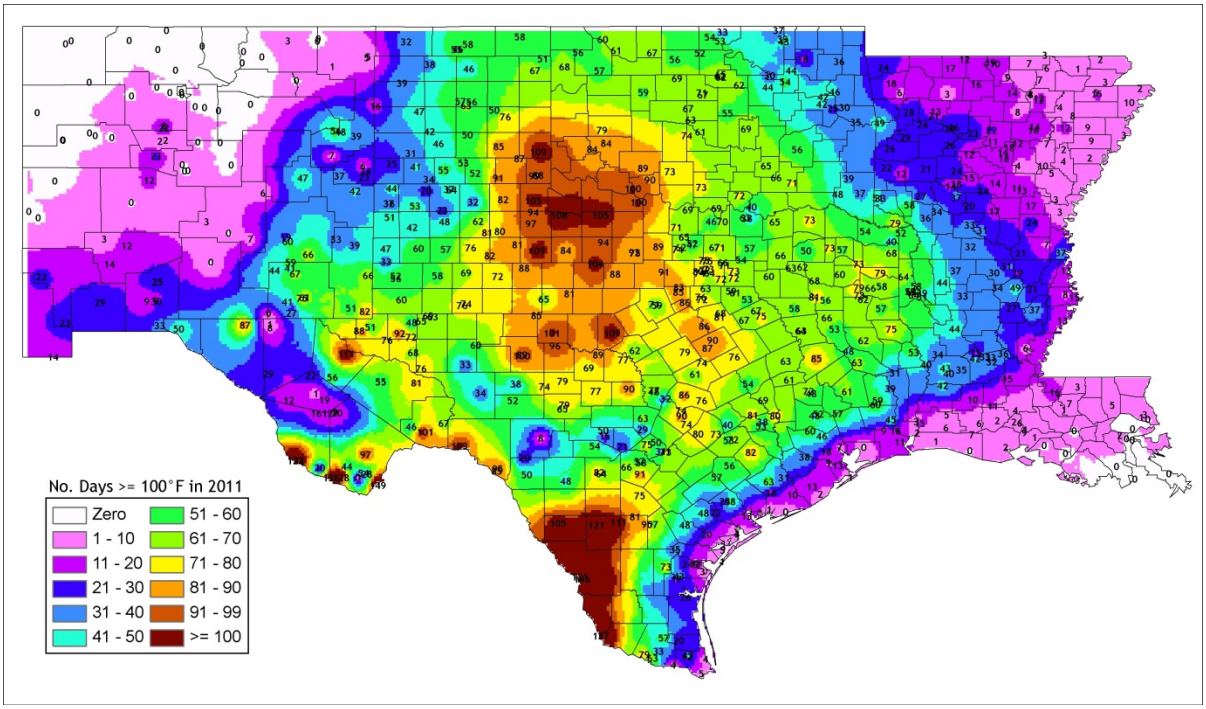
2009 Drought

Like the 2005 drought, this period of high heat coupled with a lack of rainfall affected the entire state. The drought began in March and did not lessen in intensity until the fall months of 2009. Galveston County experienced abnormally dry conditions, moderate and severe drought, with conditions improving in October of 2009.

2011 Drought

This drought was the most severe one-year drought on record for the State. Most of the State, including Galveston County, experienced D-4 Extreme Drought conditions. July of 2011 was the warmest month on record statewide; coastal portions of Galveston County did see some relief with slightly lower high temperatures due to the proximity to the Gulf of Mexico.

Figure13.2: Number of Days with Maximum Temperatures Equaling or Exceeding 100° in 2011 (through October 17, 2011)



Note: Graphic created by Brent McRoberts, Office of the State Climatologist, from Applied Climate Information System data in the 2011 Texas Drought Briefing Packet.

Table 13.4: Galveston County Summary of Drought Events 1996 to 2000

Date	Deaths	Injuries	Property Damage	Crop Damage
April 1, 1996	0	0	0	0
May 1, 1996	0	0	0	0
June 1, 1996	0	0	0	0
May 1, 1998	0	0	0	0
June 1, 1998	0	0	0	0
July 1, 1998	0	0	0	0
August 1, 1998	0	0	$1,000,000	$7,300,000
August 1, 2000	0	0	0	0
September 1, 2000	0	0	0	$102,300,000
Total	0	0	$1,000,000	$109,600,000

Source: NCDC

13.5 Probability of Future Events

The occurrence of drought is occasional. Based on the historical frequency, it is expected that every six years the Galveston County area will experience at least one drought season. Historical frequencies from 1895 to 1995 reveal that the entire Texas Gulf Coast Basin suffered drought conditions every 10 or 20 years and half of the basin suffered drought every five years.

13.6 Vulnerability Assessment

Drought impacts large areas and crosses jurisdictional boundaries. All existing and future buildings, facilities and populations are exposed to this hazard and could potentially be impacted. However, drought impacts are mostly experienced in water shortages and crop/livestock losses on agricultural lands and typically have no impact on buildings.

In order to analyze the risk of Galveston County to drought and estimate potential losses, 100 years of statistical data from the University of Nebraska was used (this data was developed by the University based on Palmer Drought and Crop Severity Indices) as well as 2002 USDA agriculture data. A drought event frequency-impact was then developed to determine a drought impact profile on non-irrigated agriculture products (including livestock) and estimate potential losses due to drought in the area. County-level data was scaled for inflation to estimate exposure of crops in Galveston County at $6,746,395.

To estimate losses due to drought, NCDC historical drought loss data for Galveston County was also used to develop a drought stochastic model.[1] Four major considerations were integrated into this model:

- Losses were obtained for each jurisdiction and scaled for inflation. For all events impacting the entire county (loss data not provided for specific jurisdictions), losses were averaged across all jurisdictions.
- Average historic drought damageability was used to generate losses for historical drought events where losses were not reported.
- Expected annualized losses were calculated through a non-linear regression of historical data.
- Probabilistic losses were scaled to account for would-be losses where no exposure/instrument was present at the time of the event.

Using this method based on historical losses and crop market value exposure for Galveston County as a whole, annualized expected crop/livestock losses were approximately $384,063 with an annualized percent loss ratio of 5.69 percent for Galveston County.

In review of the current NCDC data set presented in Table 13.4 the average loss of property and crops due to drought is $44,615.

13.7 Impact

The potential severity of impact of drought is substantial, especially taking into consideration the economic losses that may result. If drought extends over a number of years, the direct and indirect economic impact can be significant as they produce a complex web of impacts that spans many sectors of the economy and reach well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services.

[1] Only drought events that have been reported have been factored into this vulnerability assessment. It is possible that additional drought events may have occurred since 1950 that were not reported to NCDC and are not accounted for in this analysis.

Mitigation Strategy

Table 13.5 provides a summary of the mitigation actions identified by each jurisdiction to address drought. Details for these actions are provided in Section 24.

Table 13.5: Mitigation Actions - Drought

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2011-9: Implement water conservation measures
Clear Lake Shores	CLS-2011-2: Review drought plan with WCID 12 and implement when necessary	CLS-2016-1: Implement public awareness campaigns for all hazards
Friendswood	F-2009-5: Monitor water supply and establish conservation regulations	F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2016-3: Participate in local and statewide studies, workshops and communities that address all hazards prone in Galveston County. (Determine if a drought contingency plan is needed for Hitchcock)
Jamaica Beach	JB-2011-5: Prepare a drought and extreme head contingency plan	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2011-8: Review, participate, and implement any updates for drought contingency plans as developed by the WCID 12
La Marque	LM-2011-19: Continue efforts on public information and awareness for all hazards	LM-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies (Water Conservation Regulation)
League City	LC-2016-6: Public outreach and education for all hazards	LC-2016-7: Rainwater collection incentive
Santa Fe	SF-2016-9: Participate in local and statewide studies, workshops and communities that address all hazards prone in Galveston County. (Determine if a drought contingency plan is needed for Santa Fe)	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-2: Implement water conservation awareness campaign	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2011-6: Continue efforts on public information and awareness for all hazards	GC-2016-6: Update/develop applicable plans and studies as needed. (Drought Contingency Plan)

14.0 Extreme Heat

14.1 Description

Severe, excessive summer heat is characterized by a combination of exceptionally high temperatures and humidity. When these conditions persist over a period of time, it is called a heat wave. Many areas of the country are susceptible to heat waves, including the Texas Gulf Coast and Galveston County.

Major human risks associated with severe summer heat include heatstroke, heat exhaustion, and heat cramps. Most at risk are outdoor workers, the elderly, children, and people in poor physical health. The effects of severe summer heat are always more pronounced in urbanized areas than in rural areas. Within urbanized areas, pervasive heat is exacerbated by what is known as the heat island effect, in which concrete and metal infrastructure absorbs radiant heat energy from the sun during the day and emits that heat energy during the night. This cyclical process essentially traps the heat in urbanized areas and makes it as much as 10 degrees warmer than surrounding areas.

During summer months, Galveston County is frequently affected by severe heat hazards. Daily high temperatures range into the upper 90's and low 100's. Moderate to high relative humidity levels are prevalent in the county. The heat index can move into dangerous levels. A heat index of 105 degrees is where many people begin to experience extreme discomfort or physical distress.

Severe summer heat is an invisible killer. Although a heat wave does not happen with the spectacle of other hazards such as tornadoes and floods, the National Center for Environmental Health[1] reports that from 1999-2009, excessive heat exposure caused 7,233 deaths in the United States. Heat-related deaths were reported most frequently among males (69 percent) and 36 percent were adults aged 65 years and older. Ninety-four percent of heat-related deaths occurred during May–September, with the highest numbers reported during July (39 percent) and August (27 percent).

14.2 Location

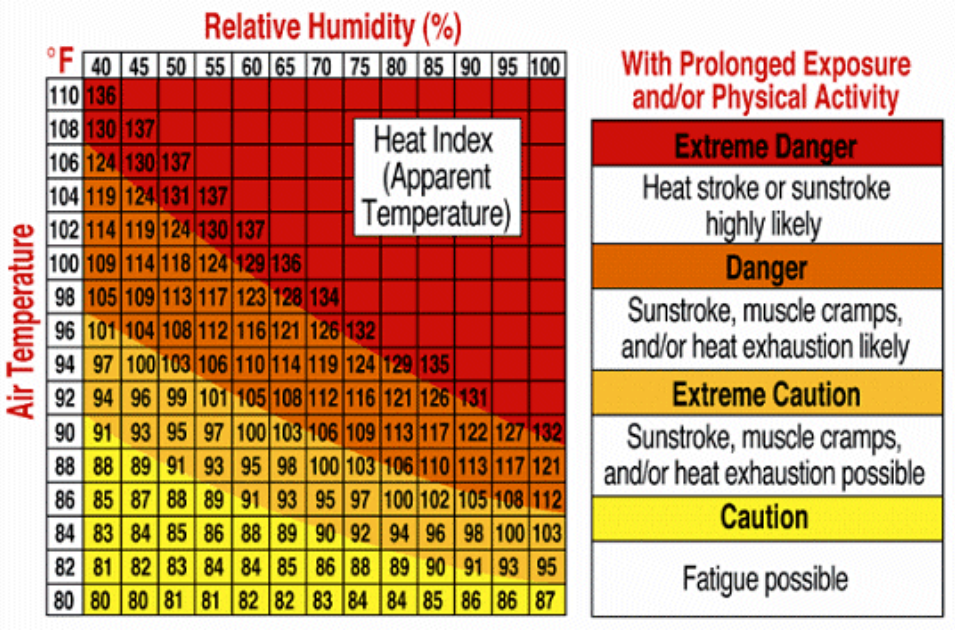
There is no distinct geographic boundary to excessive summer heat. Excessive summer heat can occur in every area of the Gulf Coast and Galveston County area.

[1] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6222a1.htm Kochanek K, Xu J, Murphy S, Minino A, Kung H. Deaths: final data for 2009. Natl Vital Stat Rep 2011;60(3).

14.3 Extent

Extreme summer heat is measured not only in terms of excessive high temperatures, but also on relative humidity with regard to temperature. Galveston County has experienced periods of extreme summer heat, which leads to injury and even death. Due to its location, the county also experiences high humidity along with high temperatures. Temperatures can often climb above 100 degrees during the summer months. This high heat combined with a high percentage of humidity increases the Heat Index as shown in Figure 14.1 below.

Figure 14.1: Extent Scale for Extreme Summer Heat



Based on the extent scale in Figure 14-1 an extreme summer heat event could occur with an air temperature as low as 80°F if the percentage of humidity was equal to or greater than 40 percent. Even though this temperature seems relatively low, given the high humidity, fatigue is possible. Citizens, especially children and the elderly should exercise caution by staying out of the heat for prolonged periods at this temperature and relative humidity. As the chart indicates, fatigue is possible, but can also occur with prolonged exposure or physical activity. Citizens who work outdoors should exercise caution even at the lower temperature if the humidity is at a high level. With prolonged exposure or physical activity, fatigue could result in causing dizziness, headaches or nausea.

Because Galveston County is affected seasonally by extreme summer heat, the extent scales provide a means for better targeting mitigation actions to protect lives. For example, it is important to note that heat stroke and associated fatigue are possible even when the temperature is not at a high peak. Using the extent scale in Figure 14-1 to combine heat and humidity allows officials to better predict events and more accurately warn citizens of danger.

Table 14.1 displays the National Weather Service's heat advisory and warning descriptions.

Table 1.-1: Extreme Summer Heat Warnings

Intensity	Detailed Description
Heat Advisory	Extreme heat index making it feel hot, typically between 105 °F to 110 °F (41 °C to 43 °C) for 3 hours or more during the day and at or above 75 °F (24 °C) at night.
Excessive Heat Warning	Extreme heat index making it feel very hot, typically above 105 °F (41 °C) for 3 hours or more during the day and at or above 80 °F (27 °C) at night.

Source: National Weather Service

14.4 Historical Occurrences

In other parts of the country and the world, severe summer heat hazards have had devastating consequences. For instance, in 1995 a two-week-long heat wave hit Chicago and the heat index peaked at 119°F. There were 465 deaths directly attributable to the heat wave and more than half of the victims were 75 years of age or older.

In June 2013, scorching heat, caused by a dome of hot air trapped by a high pressure ridge, pushed temperatures above 100°F in parts of Texas, California, Arizona, Idaho, Colorado, Nevada, and Utah. This event claimed the life of one man in California and numerous illness/injuries throughout the impacted area.[2]

According to the National Climatic Data Center, a strong heat wave effected Texas in the summers of 1999 and 2000. This increases the importance of increased public awareness regarding the danger of extreme heat. Specific occurrences for Galveston County are listed in Table 14.2.

[2] http://www.reuters.com/article/us-usa-weather-heat-idUSBRE95S0AS20130630

Table 14.2: Historical Excessive Heat Events in Galveston County

Event Date	Deaths	Injuries	Property Damage	Crop Damage
7/21/1995	2	200	0	0
6/26/1999	3	0	0	0
8/01/1999	6	0	0	0
7/06/2000	19	0	0	0
8/29/2000	3	0	0	0
9/01/2000	5	0	0	0

Source: NCDC

14.5 Probability of Future Events

The likelihood or future probability of occurrence of excessive summer heat in the Galveston County area is "Possible", with an event likely in the next four to five years. Extreme drought conditions and above-average temperatures for 2009 have affected all of Central Texas as far southeast as Galveston County. In the past, multiple counties throughout the region have issued burn bans to prevent the occurrence of wildfires due to extreme heat and dry conditions.

14.6 Vulnerability Assessment

There is no defined geographic boundary for excessive summer heat events. While all of Galveston County is exposed to extreme temperatures, existing buildings, infrastructure, and critical facilities are not considered vulnerable to significant damage caused by extreme heat events. Therefore, any estimated property losses associated with these hazards are anticipated to be minimal across the area. However, extreme temperatures do present significant life and safety threats to the population of Galveston County. As a result, excessive summer heat deserves mitigation consideration by the participating jurisdictions.

14.7 Impact

The potential impact of excessive summer heat is minor, resulting in few, if any, injuries. The effect on property would be limited, with minimal disruption to quality of life. Any shutdown of facilities is temporary.

Mitigation Strategy

Table 14.3 provides a summary of the mitigation actions identified by each jurisdiction to address extreme heat. Details for these actions are provided in Section 24.

Table 14.3: Mitigation Actions – Extreme Heat

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2011-21: Identify and implement all public buildings and critical facilities for flood proofing and hardening (provide cooling centers)
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-4: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County
Friendswood	F-2016-4: Purchase and install natural gas generator at the Activity Center (provide cooling center)	F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2011-10: Purchase and install generators and connection equipment to support critical facilities and infrastructure.
Jamaica Beach	JB-2011-5: Develop a drought and extreme heat contingency plan	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2011-8: Review, participate, and implement any updates for drought contingency plans as developed by the WCID #12
La Marque	LM-2011-11: Construct safe room shelter at EOC to house residents for emergency and non-emergency events (provide cooling center)	LM-2011-19: Continue efforts on public information and awareness for all hazards
League City	LC-2005-8: Homeowner mitigation incentive campaign	LC-2016-6: Public outreach and education for all hazards
Santa Fe	SF-2016-4: Secure generators for existing and new critical facilities and infrastructure	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-2: Implement water conservation awareness	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2011-9: Design and construct a multi-purpose EMS facility for Crystal Beach and high Island. (Provide cooling center)	GC-2011-6: Continue efforts on public information and awareness for all hazards

15.0 Wildfire (Urban and Rural)

15.1 Description

A wildfire is any fire that burns uncontrollably in a natural setting (such as grasslands, forest, and brush land). Prescribed burnings are the only exception to a wildfire, which can be either man-made or natural. Lightning, open burning of debris and/or garbage are typical causes of natural wildfires.

Prescribed burning, also known as controlled burning is the deliberate use of fire under specified and controlled conditions. Prescribed burning is used by forest management professionals and individual landowners to accomplish one or more of the following tasks:

- ***Fuel Reduction*** – The reduction of accumulated grass, weeds, pine needles, and hardwood leaves. This type of vegetation can encourage wildfires in young stands and hinder regeneration of older stands.
- ***Hardwood Control*** – Prevents hardwood trees from competing with pines for nutrients and moisture; impeding visibility and access through the stands; and interfering with natural regeneration in areas better suited for growing pines.

Wildfires are very common in many places around the world but not particularly in the Galveston County planning area. Fires are more prevalent in summer, autumn and during droughts when fallen branches, leaves, grasses and scrub can dry out and become highly flammable.

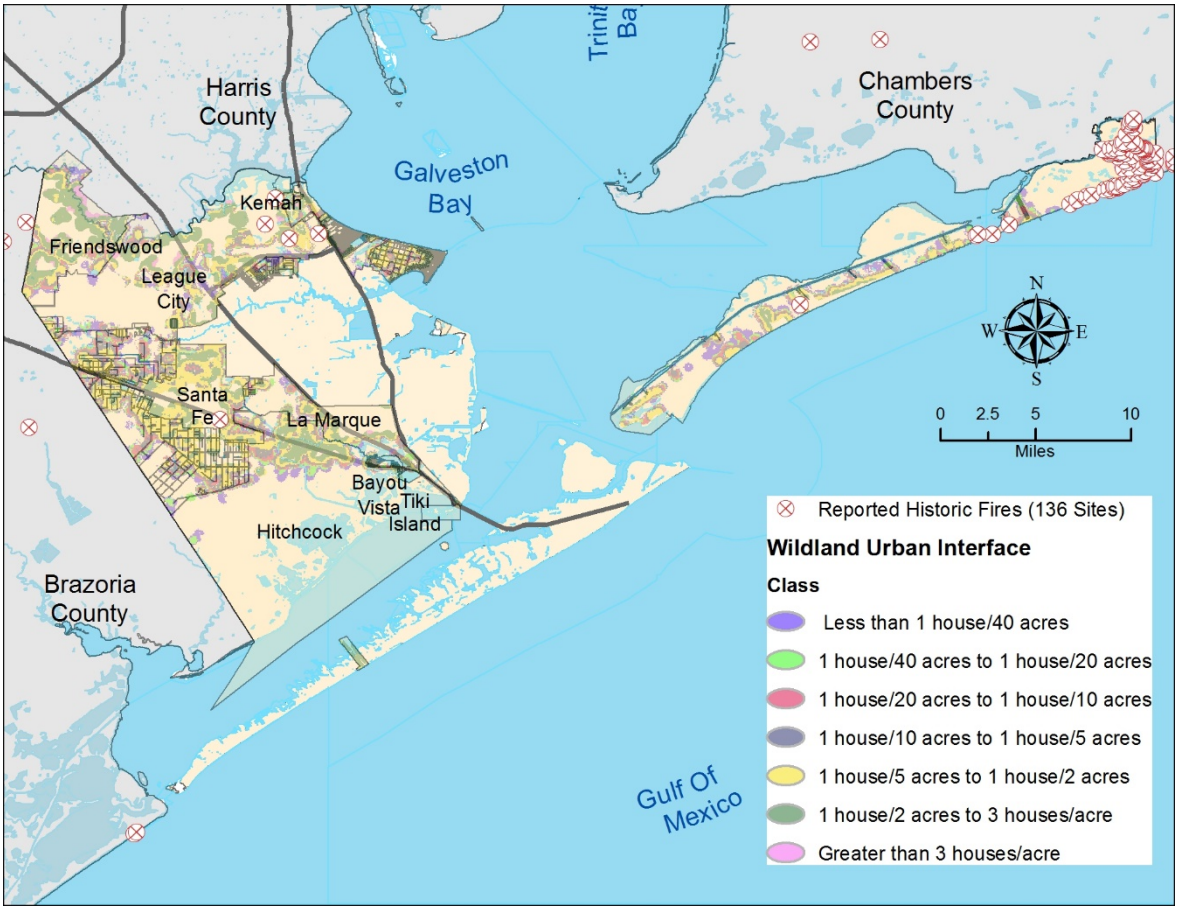
It is important to note what constitutes an urban fire and how that impacts mitigation planning for the participating jurisdictions in Galveston County. Urban fires may be created by electrically-related structural and vehicle fires, incendiary arson, unattended cooking fires, smoking materials, heating devices, fuel systems, sparks, hazardous material spills, and spontaneous combustion.

The wildland interface problem has grown due to increases in population, urban expansion, land-management decisions, parks, greenbelts and the ever-present desire to intermingle with nature.

15.2 Location

GIS data depicting historic wildfires and the wildland-urban interface from the Texas Forrest Service has been used to highlight areas of concern. Figure 15.1 graphically illustrates the wildfire hazard areas and provides an indication of where there is potential for damage to property and loss of life in the Galveston County study region.

Figure 15.1: Wildland Urban Interface (WUI) Areas and Reported Historic Fires



15.3 Extent

The extent or intensity of wildfire depends on the fuels, weather conditions and terrain. Factors such as: the level of drought; percentage of rainfall; how quickly the grasses, brush, and trees dry out; and how readily they will ignite and burn, are all considered by the Texas Forest Service when assessing the impact a wildfire can have on a region. Factors that contribute to intensity are presented in Table 15.1.

Table 15.1: Factors Contributing to Intensity of Wildfire

Intensity	Fuels	Weather	Terrain
Low	Green branches	High humidity	Flat or gently rolling terrain
Moderate	Any combination of low and high fuels, weather, and terrain.		
High	Grass Twigs	Low humidity High winds thunderstorms	Canyons Steep slopes

The Galveston County planning area can expect a wildfire event that is in the range of low to moderate intensity based on the amount of previous occurrences, the proximity to the Texas Gulf Coast and the amount of urban interface.

15.4 Historical Occurrences

Information gathered from the Wildfire data for the historic fires which were reported are provided as a summary in Figure 15.1 with details (location, date, acres burned, and cause) in Table 15.2.

Figure 15.1: Summary of Galveston County Wildland Fires 2005-2009

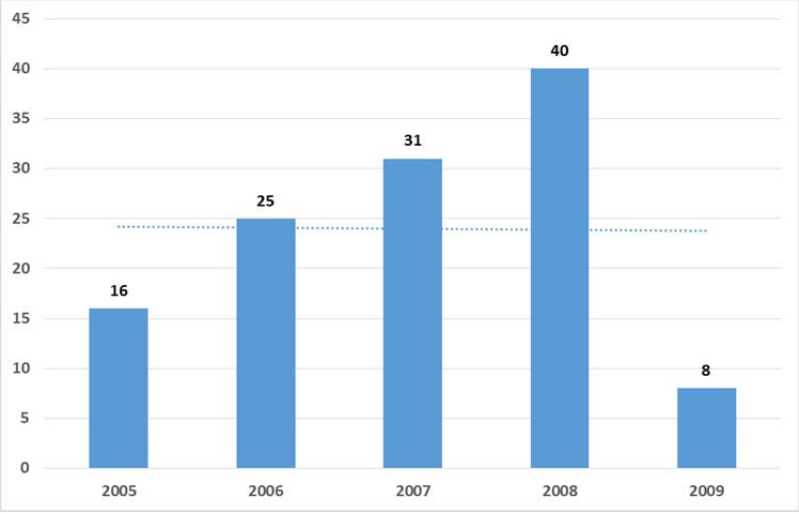


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Table 15.2: Historical Wildfire Events

Responder Name	Start Date	Fire Name	Acres Burned	Cause
FWS	10/17/2009	No High Island Fire	0.5	Miscellaneous
	9/4/2008	Wf Two X Levee 2	5	Miscellaneous
	9/4/2008	Wf Two X Levee	15	Miscellaneous
	9/4/2008	Two X Levee 4	2	Miscellaneous
	9/4/2008	Two X Levee 3	6	Miscellaneous
	8/31/2008	No High Island North 08	2	Miscellaneous
	7/13/2008	Wf High Island Se	667	Miscellaneous
	3/2/2008	No Cade Estate Central	1	Miscellaneous
	2/27/2008	Wf Flow Line	0.7	Miscellaneous
	12/21/2007	Wf Cade Estate Small Ring Levee	25	Miscellaneous
	12/21/2007	Wf Cade Estate Cattle Pens	25	Miscellaneous
	12/5/2007	Wf Cade Estate West	100	Miscellaneous
	11/11/2007	No N. Ring Levee	11	Miscellaneous
	11/6/2007	No Sulfur Fire	2.6	Miscellaneous
	12/16/2006	No E. High Island Battery Tank	1.6	Miscellaneous
	10/15/2005	No Cade Estate	2	Miscellaneous
	7/20/2005	No Cattle Pen	19.2	Lightning
	5/17/2005	Giww Bridge Fa	5	Miscellaneous
High Island VFD	5/4/2009	Wildland fire	2	Incendiary
	4/8/2009	Wildland fire	20	Incendiary
	4/2/2009	Wildland fire	25	Incendiary
	4/2/2009	Wildland fire	1	Incendiary
	2/21/2009	Wildland fire	20	Debris burning
	12/28/2008	Wildland Fire	100	Incendiary
	12/11/2008	Wildland Fire	3	Incendiary
	12/6/2008	Brush fire	0.5	Debris burning
	11/29/2008	Brush fire	0.5	Debris burning
	11/14/2008	Wildland fire	50	Debris burning
	11/2/2008	Wildland fire	25	Incendiary
	10/20/2008	Wildland fire	4	Debris burning
	9/4/2008	Wildland fire	200	Incendiary
	8/3/2008	Wildland fire	100	Incendiary
	8/2/2008	Wildland fire	2	Campfire
	8/2/2008	Wildland fire	20	Incendiary

Responder Name	Start Date	Fire Name	Acres Burned	Cause
High Island VFD	7/26/2008	Brush fire	0.5	Debris burning
	7/20/2008	Wildland fire	100	Incendiary
	7/14/2008	Wildland fire	10	Incendiary
	7/13/2008	Wildland fire	2	Incendiary
	7/5/2008	Wildland fire	20	Incendiary
	4/28/2008	Grass fire	0.5	Debris burning
	4/17/2008	Wildland fire	5	Incendiary
	4/5/2008	Wildland fire	10	Incendiary
	3/31/2008	Wildland fire	0.5	Campfire
	3/17/2008	Wildland fire	0.5	Debris burning
	3/17/2008	Wildland fire	5	Incendiary
	3/15/2008	Wildland fire	0.5	Campfire
	3/15/2008	Wildland fire	3	Incendiary
	3/15/2008	Wildland fire	25	Incendiary
	3/2/2008	Wildland fire	4	Incendiary
	2/6/2008	Wildland fire	15	Incendiary
	1/13/2008	Wildland fire	2	Debris burning
	12/21/2007	Wildland Fire	60	Incendiary
	12/20/2007	Wildland Fire	50	Incendiary
	11/12/2007	Wildland Fire	1	Debris burning
	11/9/2007	Wildland Fire	20	Incendiary
	11/4/2007	Wildland Fire	10	Incendiary
	10/29/2007	Wildland Fire	25	Incendiary
	10/27/2007	Wildland Fire	10	Incendiary
	10/26/2007	Wildland Fire	5	Incendiary
	10/23/2007	Wildland Fire	1	Campfire
	10/23/2007	Wildland Fire	20	Incendiary
	8/27/2007	Wildland Fire	10	Incendiary
	8/27/2007	Wildland Fire	20	Incendiary
	8/15/2007	Wildland Fire	0.5	Incendiary
	7/29/2007	Wildland Fire	60	Debris burning
	6/28/2007	Wildland Fire	100	Incendiary
	5/24/2007	Wildland Fire	100	Incendiary
	5/24/2007	Wildland Fire	50	Incendiary
	5/17/2007	Wildland Fire	25	Incendiary
	5/16/2007	Wildland Fire	20	Incendiary

Responder Name	Start Date	Fire Name	Acres Burned	Cause
High Island VFD	5/14/2007	Wildland Fire	10	Incendiary
	4/16/2007	Wildland Fire	10	Debris burning
	3/30/2007	Wildland Fire	1	Campfire
	3/15/2007	Wildland Fire	0.5	Incendiary
	2/26/2007	Wildland Fire	10	Incendiary
	2/18/2007	Wildland Fire	1	Debris burning
	2/13/2007	Wildland Fire	0.5	Campfire
	12/31/2006	Wildland Fire	0.5	Incendiary
	12/31/2006	Wildland Fire	2	Incendiary
	11/18/2006	Wildland Fire	20	Incendiary
	9/21/2006	Grass Fire	0.05	Equipment use
	9/14/2006	Wildland Fire	10	Incendiary
	9/6/2006	Wildland Fire	25	Incendiary
	9/4/2006	Wildland Fire	20	Incendiary
	9/3/2006	Wildland Fire	1	Campfire
	9/1/2006	Wildland Fire	10	Incendiary
	8/26/2006	Wildland Fire	10	Lightning
	8/3/2006	Wildland Fire	5	Debris burning
	7/25/2006	Wildland Fire	10	Incendiary
	7/25/2006	Wildland Fire	5	Incendiary
	6/7/2006	Wildland Fire	15	Incendiary
	4/27/2006	Wildland Fire	2	Incendiary
	4/20/2006	Wildland fire	10	Debris burning
	4/15/2006	Wildland fire	2	Campfire
	3/11/2006	Wildland fire	2	Incendiary
	3/5/2006	wildland fire	5	Debris burning
	3/4/2006	wildland fire	10	Incendiary
	3/4/2006	wildland fire	30	Incendiary
	3/2/2006	wildland fire	10	Incendiary
	2/26/2006	wildland fire	20	Incendiary
	1/31/2006	Wildland fire	25	Incendiary
	10/20/2005	Grass Fire	2	Debris burning
	8/30/2005	Marsh fire	50	Incendiary
	8/22/2005	Grass Fire	10	Equipment use
	8/8/2005	Grass Fire	2	Equipment use
	7/6/2005	Grass Fire	1	Incendiary

Responder Name	Start Date	Fire Name	Acres Burned	Cause
High Island VFD	7/5/2005	Grass Fire	1	Incendiary
	7/4/2005	grass fire	5	Incendiary
	7/2/2005	Grass Fire	1	Campfire
	7/1/2005	Marsh Fire	20	Incendiary
	6/30/2005	Marsh Fire	25	Incendiary
	6/25/2005	Marsh Fire	100	Incendiary
	6/3/2005	Marsh Fire	20	Incendiary
	5/3/2005	Grass Fire	4	Miscellaneous
League City	1/30/2009	Bayridge	6	Equipment use
	1/13/2009	Sunset Ridge	20	Incendiary
	11/9/2008	State Highway 146	50	Incendiary
	1/12/2008	Leisure Lane	200	Debris burning
Santa Fe	1/11/2008	FM 1764	2	Debris burning

Source: Texas Forest Service

The Texas Fire Incident Reporting System (TEXFIRS) captures fire incident reports voluntarily provided by fire departments within the planning area and is presented in Table 15.3.

Table 15.3: Types of Fires from 2010-2015 by Jurisdiction

Responder	Structure	Vehicle	Natural Vegetation	Outside Rubbish	Special Outside	Other	Crop	Total
Tiki Island F & R	3	7	6	2	2	0	0	20
Jamaica Beach FD	14	1	15	23	14	1	2	68
Kemah FD	15	23	13	6	10	15	0	82
Bayou Vista FD	12	11	17	16	5	1	2	62
Friendswood FD	105	42	68	79	22	5	3	324
Hitchcock VFD	81	31	42	59	4	1	0	218
Santa Fe F & R	29	9	51	29	8	5	0	131
La Marque FD	97	69	40	73	12	12	1	303
League City FD	206	119	113	170	27	0	2	637
High Island VFD	8	2	45	17	2	2	0	76
Port Bolivar VFD	8	2	18	24	3	10	0	65
Bacliff FD	24	11	17	30	7	13	0	102

Source: TEXFIRS (2010-2015)

15.5 Probability of Future Events

Wildland fires can occur at any time of the year. Climatic conditions such as severe freezes and drought can significantly increase the intensity of wildland fires since these conditions kill vegetation, creating a prime fuel source for these types of fires. The intensity of fires and the rate at which they spread are directly related to wind speed, temperature, and relative humidity.

The threat of wildland fire changes with the season, but overall, the probability of future occurrence, or likelihood, of a wildland fire is possible, with an event possible in the next 4-5 years.

15.6 Vulnerability Assessment

Table 15.4 provides information on the number of persons potentially exposed to wildfire hazard based upon mapped wildfire hazard areas previously shown, along with the estimated number of buildings at risk and total exposure for at-risk buildings.

Table 15.4: Estimated Exposure of People and Parcels by Jurisdiction

Jurisdiction	Total Est. Population	Total Est. No. of Parcels	Improved Value of Parcels	At Risk		
				No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,324	$225,154,990	1,465	232	$36,501,220
Clear Lake Shores	1,069	1,051	$243,448,194	313	192	$78,888,441
Friendswood	26,364	10,853	$3,085,164,965	22,686	6,652	$1,964,292,327
Hitchcock	6,961	6,337	$460,075,283	6,906	5,009	$335,741,794
Jamaica Beach	983	1,590	$338,227,637	955	1,420	$277,279,567
Kemah	2,906	1,221	$294,986,165	2,604	718	$171,765,945
La Marque	14,543	8,972	$827,263,553	5,284	2,980	$401,180,580
League City	82,353	35,762	$8,164,064,546	58,404	16,296	$4,184,914,187
Santa Fe	12,814	6,457	$845,974,919	9,167	4,094	$548,588,359
Tiki Island	966	1,254	$445,402,231	29	6	$1,108,760
Galveston County Unincorporated	40,244	34,756	$2,931,109,729	31,014	22,280	$1,926,155,791
Total	190,740	109,577	$17,860,872,212	138,827	59,879	$9,926,416,971

15.7 Impact

Wildland fires are more likely to occur during periods of high wind and low humidity; warning time is minimal to none. Due to the humid climate of the Galveston County planning area, the amount of previous occurrences and the potential property at risk, the impact of an event would be minor, with few injuries and less than 10 percent of property affected, damaged or destroyed.

Mitigation Strategy

Table 15.5 provides a summary of the mitigation actions identified by jurisdiction's who could be impacted by wildfire (urban and rural) events. Details for these actions are provided in Section 24.

Table 15.5: Mitigation Actions – Wildfire (Urban and Rural)

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BV-2011-9: Implement water conservation measures
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Hitchcock	H-2011-2: Routinely check and maintain fire hydrants	H-2011-8: Implement a tree trimming/vegetation removal program from public right of ways
Kemah	K-2006-1: Continue effort on public information and awareness for all hazards	K-2011-13: Develop maintenance and flow testing program for fire hydrants in jurisdiction
La Marque	LM-2011-6: Purchase new rescue pumper for fire station	LM-2011-16: Purchase 100' aluminum aerial platform fire apparatus for residential and commercial structure fire rescues
Santa Fe	SF-2016-8: Implement/maintain tree/vegetation trimming/removal near infrastructure, drainage systems and roadside areas	SF-2016-16: Continue effort on public information and awareness for all hazards
Galveston County	GC-2011-3: Implement/maintain tree and vegetation trimming/removal program	GC-2011-6: Continue efforts on public information and awareness for all hazards

16.0 Coastal Erosion and Retreat

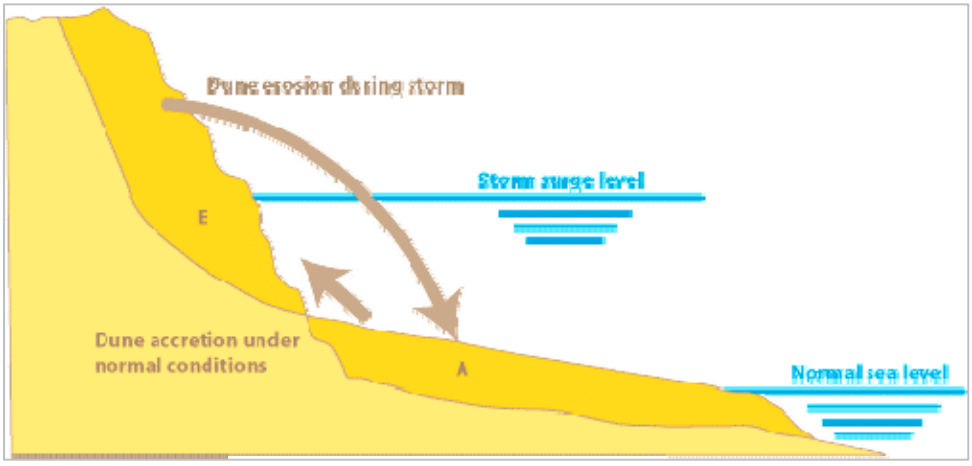
16.1 Description

As defined by NOAA, coastal erosion is a process whereby large storms, flooding, strong wave action, sea level rise, and human activities, such as inappropriate land use, alterations, and shore protection structures, erodes the beaches and bluffs along the U.S. ocean coasts. Erosion undermines and often destroys homes, businesses, and public infrastructure and can have long-term economic and social consequences. Figure 16.1 provides a graphic representation of the coastal erosion process.

Contributing processes to coastal erosion include tides, relative sea-level rise, subsidence, tropical and non-tropical low pressure centers. Model projections by the Intergovernmental Panel on Climate Change predict that global sea level rise will continue at an increase of as much as one meter during the next 100 years. Sea level rise measured by Texas Coastal Ocean Observation Network tide gauges in the Galveston area measured a current rise of about six millimeters per year. At this current rate of rise, local sea levels in the Galveston County area can be projected to be 0.6 meters (approximately two feet) by the year 2100.

A small rise in sea level can result in a significant shoreline retreat and an increased risk of inundation of wetlands, marshes, private property, and public infrastructure. Relative sea level rise increases the vulnerability of barrier islands and peninsulas to inundation from storm surge, wind driven waves, and tides from non-tropical weather systems.

Figure 16.1: Coastal Erosion Process



Source: http://www.conscience-eu.ne

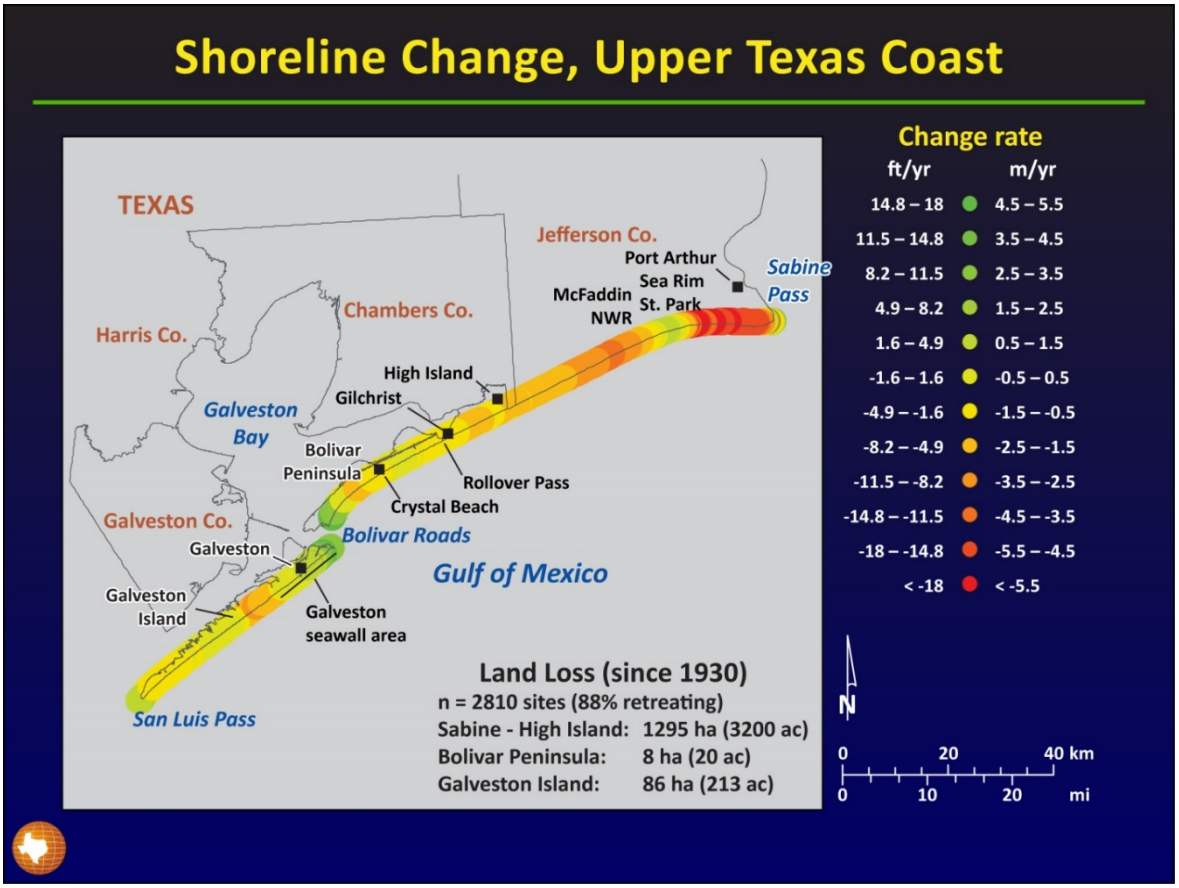
16.2 Location

Coastal erosion applies to all jurisdictions in Galveston County that border the Gulf or tidal waterway.

16.3 Extent

Galveston County has approximately 55 miles of Gulf shoreline and 291 miles of Bay shoreline. As shown in Figure 16.2, the Galveston County planning area has experienced substantial land loss along the shoreline.

Figure 16.2: Land Loss Since 1930



The Gulf of Mexico is impacted by the development of oil, gas and mineral resources. The Gulf accounts for over 95 percent of the U.S.'s outer continental shelf oil and gas production, and the region processes over two-thirds of the nation's oil imports. Invasive species are a serious threat to native biota in many Gulf coast ecosystems, and aquatic nuisance species pose severe economic problems, interfering with transportation, energy production, reservoir capacity and recreational uses. The effect of oil breaches on coastal erosion is determined by how much oil reaches the coastal regions and how long it remains. Oiled plants can die, along with roots that bind and stabilize the soil, leading to erosion.

Loss of wetlands and marsh is another important concern, since wetlands may contribute to reducing storm surge associated with hurricanes. It is estimated coastal wetlands within the United States are being lost at a rate of approximately 59,000 acres per year (source NOAA).

16.4 Historical Occurrences

Coastal erosion is averaged on an annual basis and the Texas coastline average rate of erosion is about 1.2 meters per year (source: Bureau of Economic Geology, University of Texas, http://earthsky.org/earth/jeffrey-paine-retreating-shoreline-along-texas-gulf-coast). Tables 16.1 and 16.2 provides a summary of data collected by the Bureau of Economic Geology for the *Shoreline movement along the Texas Gulf Coast, 1930's to 2012* study.

Table 16.1: Locations of Critical Erosion for Galveston County using 2010 Data from the Texas General Land Office

Population*	Gulf Shoreline	Bay Shoreline	Critical Erosion (Gulf)	Erosion Rate (Gulf)
250,158	290,400 ft. (55 miles)	1,536,480 ft. (291 miles)	253.440 ft (48 miles)	-2 to -11 ft/yr

Source: State of Texas Mitigation Plan Update 2013
Note: *2000 Census

Table 16.2: Galveston County Land Area Changes

Time Frame	No. of Measurement Points	Net rate (m/yr)	Std. Dev (m/yr)	Range (m/yr)	Area Change Rate (ha/yr)	Area Change (ha)
1950 to 2012	1,740	-1.12	1.57	-3.6 to 6.3	-9.7	-555
2000 to 2012	1,740	-0.10	2.63	-10.5 to 24.9	-0.9	-11

Source: http://earthsky.org/earth/jeffrey-paine-retreating-shoreline-along-texas-gulf-coast

Natural hazards can shorten the renourishment time frame and coastal storms significantly erode the sand beach. In the past decade, the following storms had an impact on the sand beach area within the Galveston County planning area:

- High Surf (September 3, 2011) – high offshore winds associated with Tropical Storm Lee impacted areas of Galveston County
- High Winds (April 24, 2010) - A low pressure system combined with a gravity wave disturbance produced a period of strong winds mainly along the coast. Wind gusts were in excess of 69 mph.
- Hurricane Ike (September 12, 2008) - Ike produced damage due to high storm surge and high winds along Galveston Island, the Bolivar Peninsula, and along the Galveston Bay. Storm tides of 10 to 15 feet above mean sea level were observed in these areas.
- Tropical Storm Edouard (September 5, 2008) - Storm tide damage on the Bolivar Peninsula was confined to the Gilchrist area. Ten single family homes experienced flooding up to eighteen inches deep inside the home. Fifteen single family homes and two mobile homes experienced flooding up to six inches deep inside the home.
- Hurricane Humberto (September 12, 2007) – Developed from a tropical depression into a hurricane within nineteen hours. Maximum rainfall totals from Humberto ranged from around two inches to over fourteen inches mainly along and east of a line from Freeport to the Hitchcock and Texas City area to around Winnie.
- High Winds (November 15, 2006) - A strong cold front moved through Southeast Texas in the morning. A tight surface pressure gradient behind the front produced winds at wind advisory levels with some higher gusts observed at Bacliff.
- Hurricane Rita (September 23, 2005) - In Galveston County, tropical storm force sustained winds with gusts to hurricane force were reported across the county, especially on the Bolivar Peninsula.
- Hurricane Claudette (July 14, 2003) – The highest recorded tide level, 7.56 ft. above mean low-lower water, was recorded at Pleasure Pier in Galveston.

16.5 Probability of Future Events

Given the localization of this hazard to those locations that border waterways, the collective rankings from participating jurisdictions was 1.5 on a scale of 1-10. This information indicates that coastal erosion is a low probability event.

16.6 Vulnerability Assessment

Development can destroy wetlands that serve as important buffers again storm surge and other types of flooding. While nothing can be done to prevent coastal hazard events, their adverse impacts can be reduced through proper planning. Channel management and stewardship can reduce and, in some cases, reverse coastal erosion. When sediment is allowed to build-up along the shorelines, coastal land loss is reduced. However, sediment can also negatively impact navigable waterways and dredging activity is required to maintain the channels. Dredge spoils may be pumped beyond the gulf shelf or dumped inland in landfills. If used properly, dredge spoils can reduce or reverse coastal erosion through beach nourishment or land reclamation.

Residents, tourists and business owners who rely on tourism business could potentially be affected by degradation of the sand beach. Roadways can be impacted by wind-borne erosion from the sand beach. During extraordinary high tides and periods of consistent southerly winds, sand can be carried over the seawall and deposited on roadways.

16.7 Impact

Coastal erosion is a dynamic process and is often event driven and its consequences may be at least partially reversed during calmer periods. Galveston County is susceptible to coastal erosion and retreat but with proper planning and enforcement of ordinances and regulations, potential losses to structures can be limited.

Mitigation Strategy

Table 16.3 provides a summary of the mitigation actions identified by jurisdiction's that could be impacted by coastal erosion and retreat. Details for these actions are provided in Section 24. In addition to the jurisdiction's mitigation actions, beach re-nourishment projects have been utilized to target locations with the most significant erosion. Table 16.4 provides a listing of those projects located within the Galveston County planning area.

Table 16.3: Mitigation Actions – Coastal Erosion and Retreat

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Hitchcock	H-2011-1: Provide public awareness materials and information at community events and city website regarding all hazards	H-2016-4: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Jamaica Beach	JB 2006-1: Implement beach and dune restoration program	JB-2016-9: Continue efforts on public information and awareness for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2016-8: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Tiki Island	TI-2016-2: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2011-6: Continue efforts on public information and awareness for all hazards	GC-2016-10: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies

Table 16.4: Galveston County Coastal Erosion Projects for Significant Occurrences

Project	Description
Galveston Seawall Emergency Beach Nourishment	Beach Nourishment: This project included the design and construction of a beach nourishment project placing beach- quality sand on the gulf beach in front of the seawall from 10th to 61st street in the Citv of Galveston. due to erosion caused bv Hurricane Ike.
Jamaica Beach Dune Restoration Repair	Dune Restoration: FEMA funds used to restore engineered dune complex back to original project specifications pre- Hurricane Ike.
Galveston Island	Beach Nourishment, Dune Restoration: Episodic erosion from storm surge and wave action following Hurricane Ike resulted in the natural dune system being severely damaged or destroyed. The lack of a healthy beach and dune system leaves property and public infrastructure vulnerable to future storms.
Bolivar Peninsula	Beach Nourishment/Dune Restoration: Hurricane Ike caused an estimated 130 to 300 feet of Gulf shoreline retreat along Bolivar Peninsula, including over three feet of vertical erosion, while destroying over 3,500 homes. The result of this elevation loss increased Bolivar Peninsula's vulnerability to inundation even with a small storm event, threatening State Highway 87.

Source: State of Texas Mitigation Plan Update 2013

17.0 Land Subsidence

17.1 Description

Land subsidence is the lowering of the ground as a result of water, oil, gas extraction, as well as other phenomena such as soil compaction, decomposition of organic material, and tectonic movement.

In the Houston-Galveston region, subsurface clay layers compact in response to ground-water withdrawals from the Chicot and Evangeline aquifers and oil and gas extraction. Other conditions contributing to subsidence with minor noticeable impacts currently include oil and gas extraction, and the existence of salt domes and fault scarps, small step-like changes in elevation caused by fault slip in the ground.[1] [2] [3] Ground-water pumping from aquifers is the leading cause of subsidence in the region.[4] Groundwater withdrawn from the regional aquifers was the primary source of water for municipal supply, industrial and commercial use, and irrigation.[5]

By the 1970's the effects of groundwater withdrawals on subsidence and resultant flooding were apparent. Extensometers were installed in 1973 in the region to measure the rate of compaction. In 1975, the Texas State Legislature authorized the establishment of the Harris-Galveston Subsidence District (HGSD) "for the purpose of ending subsidence which contributes to, or precipitates, flooding, inundation, and overflow of any area within the district including, without limitation, rising waters resulting from storms or hurricanes."[6] Regulatory plans and groundwater regulations were subsequently established to manage groundwater resources. By 1979, subsidence was measured at 10 feet in some areas of the Houston-Galveston region.[7] Subsidence in the greater Houston-Galveston Bay area has led to damage to industrial and transportation infrastructure, investments in levees, reservoirs, and surface-water distribution facilities, and substantial loss of wetland habitats.

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1 Department of Earth and Atmospheric Sciences, National Center for Airborne LiDAR Mapping. "Is There Deep-Seated Subsidence in the Houston-Galveston Area?" International Journal of Geophysics Volume 2014 (2014). Retrieved online January 2016: http://www.hindawi.com/journals/ijge/2014/942834/

2 Coplin, Laura. "Houston-Galveston, Texas: Managing Coastal Subsidence" USGS. 2007. Retrieved online January 2016: http://pubs.usgs.gov/circ/circ1182/pdf/07Houston.pdf

3 http://earthquake.usgs.gov/learn/glossary/?term=fault%20scarp

4 Coplin, Laura 2007

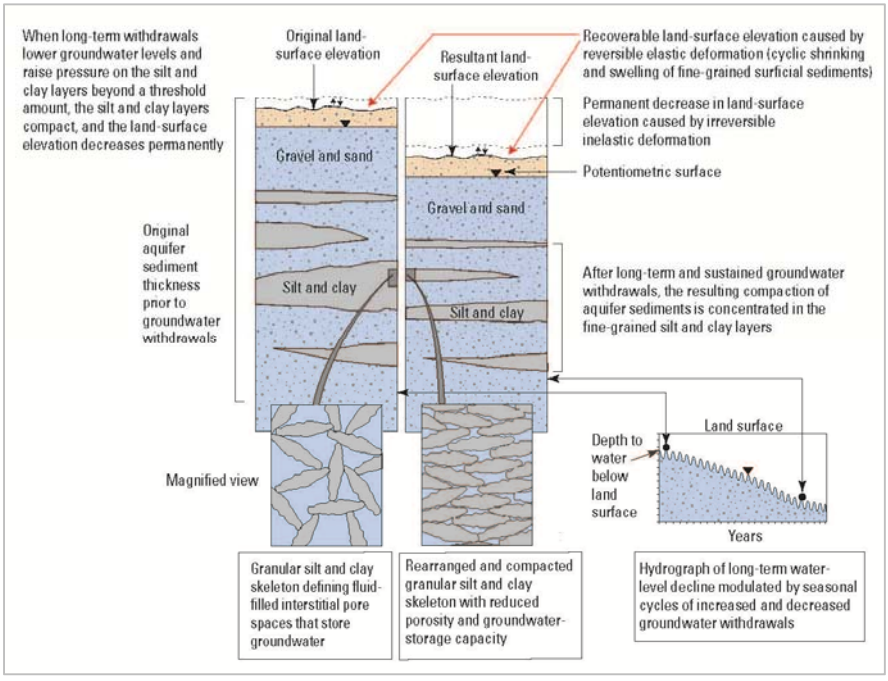
5 Kasmarek, M.C. "Groundwater withdrawals 1976, 1990, and 2000–10 and land-surface-elevation changes 2000–10 in Harris, Galveston, Fort Bend, Montgomery, and Brazoria Counties, Texas: U.S. Geological Survey Scientific Investigations Report 2013–5034" 2013 Retrieved online January 2016: http://pubs.usgs.gov/sir/2013/5034/

6 Chapter 8801 special districts code

Soils in the region can shrink and swell 15-20 ft. below the surface with large variations in soil moisture. As much as 0.2 to 0.3 ft. of vertical movement can occur within days as clay soils respond to seasonal variations in rainfall and temperature.[8] Subsidence or compaction will vary by measurement site due not only to groundwater withdrawal, but also to ratios of sand, silt, and clay beneath the surface and the tendency of each mixture to compress. [9]

However, once the water has been removed from the sediment, it cannot be replaced (Figure 17.1). Only about 5.3 million acre-feet of the total rainfall "recharge" Texas aquifers each year. In 1996, approximately 9.9 million acre-feet of groundwater were pumped resulting in a net loss of 4.6 million acre-feet of groundwater.[10] As a regional example, groundwater withdrawals contributed to water-level-altitude declines of as much as 300 to 350 ft. below datum in the Chicot and Evangeline Aquifers in Harris County by 1977 as measured by extensometers in the region.[11]

Figure 17.1: The Subsidence Process



[8] Zilkoski, David 2001
[9] Kasmarek, Mark C. 2013
[10] City of Friendswood Hazard Mitigation Plan 2015
[11] Kasmarek, Mark C. 2013

As the rate of groundwater withdrawal decreased in response to the establishment of the HGSD the rates of compaction slowed and water levels in the aquifers began to rise and recover. Water levels in the Chicot and Evangeline aquifers rose as much as 200 and 240 ft. by 2015.[12] In 1976, about 27.4 Mgal/d were withdrawn from the aquifer system, and by 2000, withdrawals had decreased to about 4.12 Mgal/d, or about an 85-percent reduction since 1976. By 2010, withdrawals had decreased to about 0.626 Mgal/d, or about a 98-percent decrease since 1976.[13] (Figure 17.2)

Figure 17.2: Groundwater Withdrawals in Galveston County

[Groundwater withdrawal values are in million gallons per day]

Year	Harris County[1]	Galveston County[1]	Fort Bend County[2]	Montgomery County[2, 3]	Brazoria County[2]
1976	428.9	27.4	16.0	7.84	18.0
1990	363.4	4.56	62.6	24.9	15.4
2000	337.8	4.12	86.5	43.6	26.0
2001	289.6	1.63	74.6	40.3	21.7
2002	276.9	1.03	78.7	42.7	21.5
2003	276.5	1.01	80.5	47.0	21.7
2004	233.6	0.692	82.0	47.0	24.1
2005	295.8	0.820	100.5	58.8	24.8
2006	246.6	0.751	94.2	59.6	31.5
2007	213.8	0.630	79.1	54.0	34.6
2008	256.4	0.783	101.1	64.7	49.2
2009	246.9	1.21	111.3	64.1	43.2
2010	227.1	0.626	99.8	64.2	24.7

[1]Greg Lakey, Harris-Galveston Subsidence District, written commun., 2012.

[2]Bill Billingsley, Texas Water Development Board, written commun., 2012.

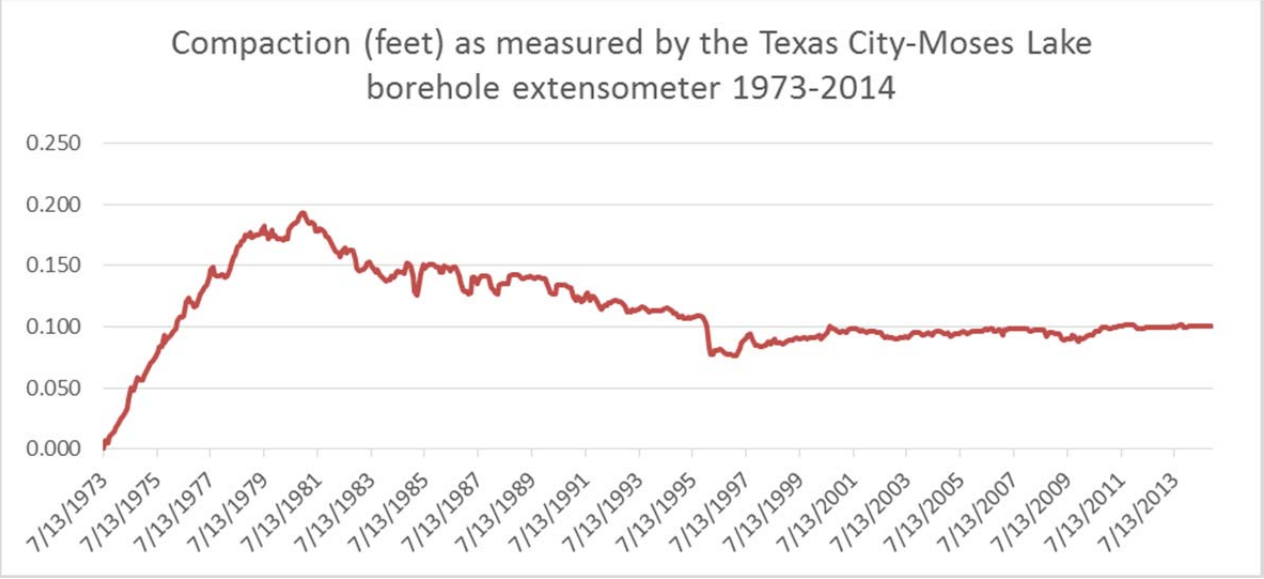
[3]Samantha Reiter, Lone Star Groundwater Conservation District, written commun., 2012.

[12] Kasmarak, Mark C. "Water-Level Altitudes 2015 and Water Level Changes in the Chicot, Evangeline, and Jasper Aquifers and Compaction 1973-2014 in the Chicot and Evangeline Aquifers, Houston Galveston Region, Texas." 2015. Retrieved online January 2016: https://pubs.er.usgs.gov/publication/sim3337

[13] Kasmarek, Mark C. 2013

Figure 17.3 illustrates that as groundwater withdrawals decreased in Galveston County, rates of compaction decreased. While Texas City is not one of the participating jurisdictions it is proximal and the extensometer there was one of the first installed in 1973; this location offers a reasonable reference point with a rich amount of historical data. Compaction at this location increased to almost 0.2 ft. from 1973 to 1980 and has tapered to approximately 0.1 ft. in recent years.

Figure 17.3: Compaction



17.2 Location

Historical data from 1906 to 2000 shows the greatest rates of subsidence in the eastern portion of the Harris-Galveston Subsidence District along the Houston Bay Ship Channel (Figure 17.4). Rates of subsidence after the implementation of the HGSD are decreasing in areas where groundwater withdrawals are regulated to the south and east of Houston and increasing in the north and west where businesses and residents still rely on groundwater (Figures 17.5 and 17.6).

Figure 17.4: Subsidence 1906-2000

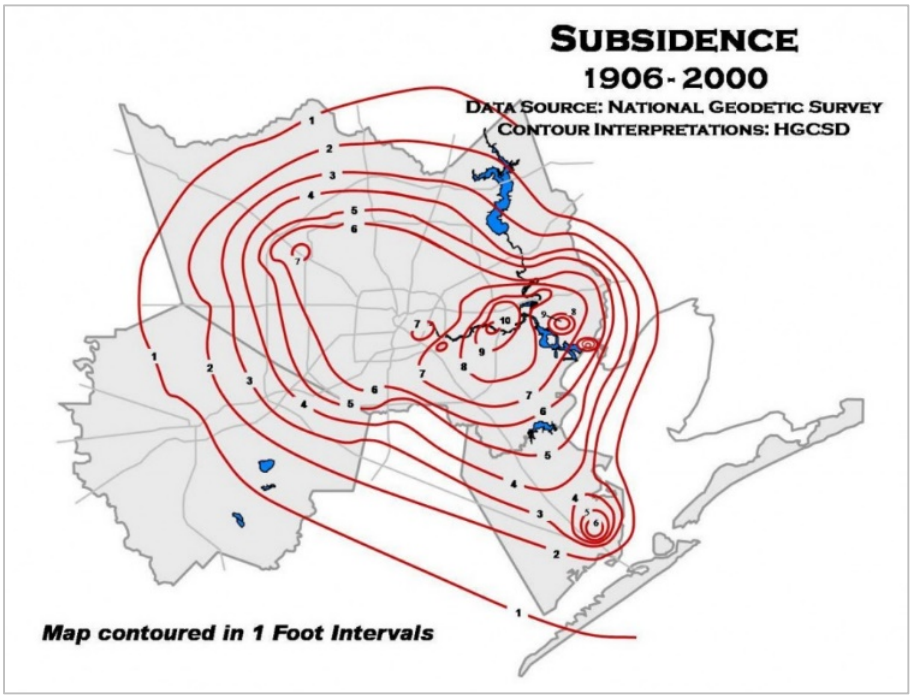


Figure 17.5: Subsidence in Feet 1978-2000

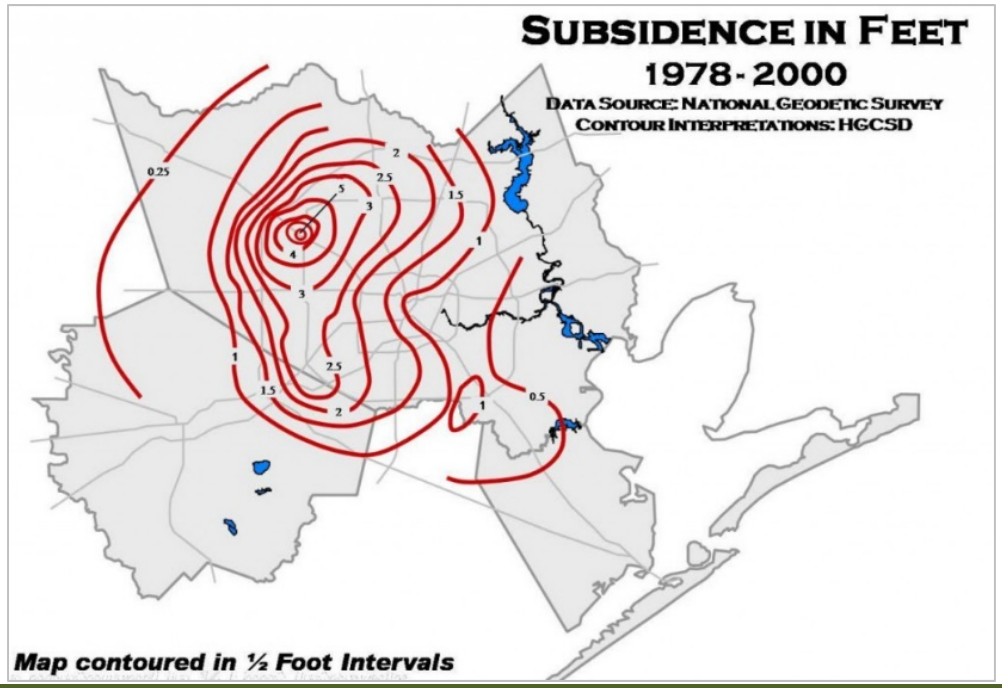
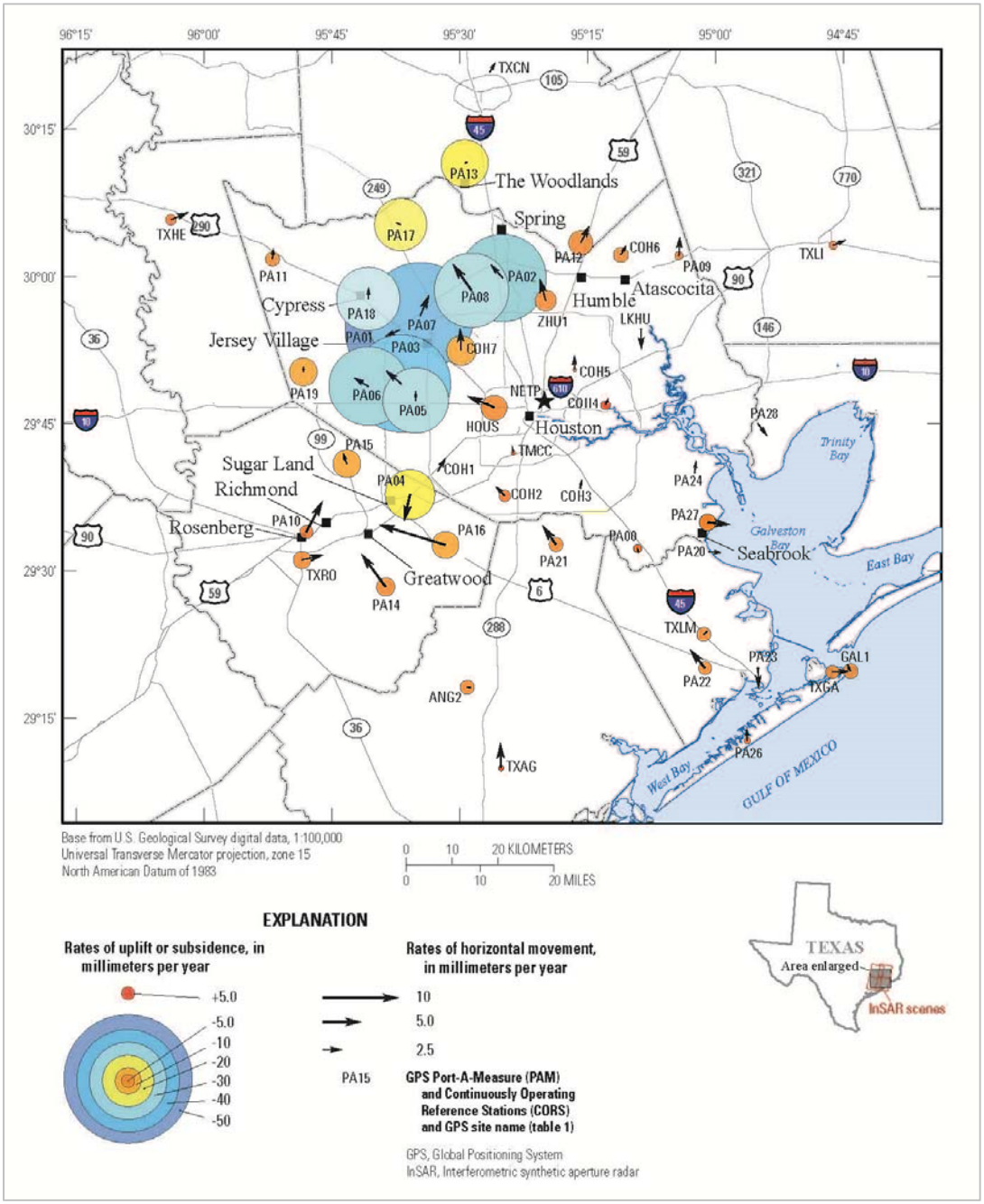


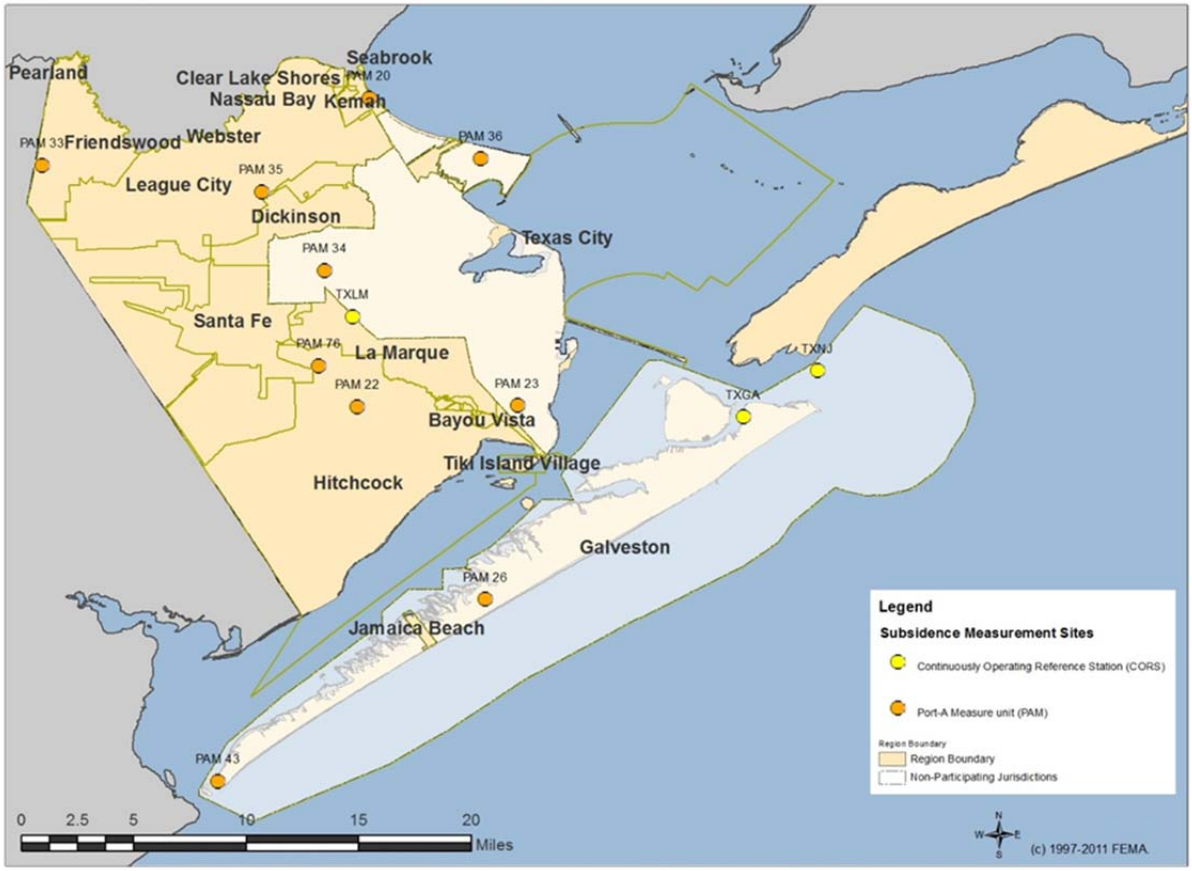
Figure 17.6: Subsidence 1993-2010



Source: 1993-2010 Galloway 1999 as modified by Kasmarek 2015

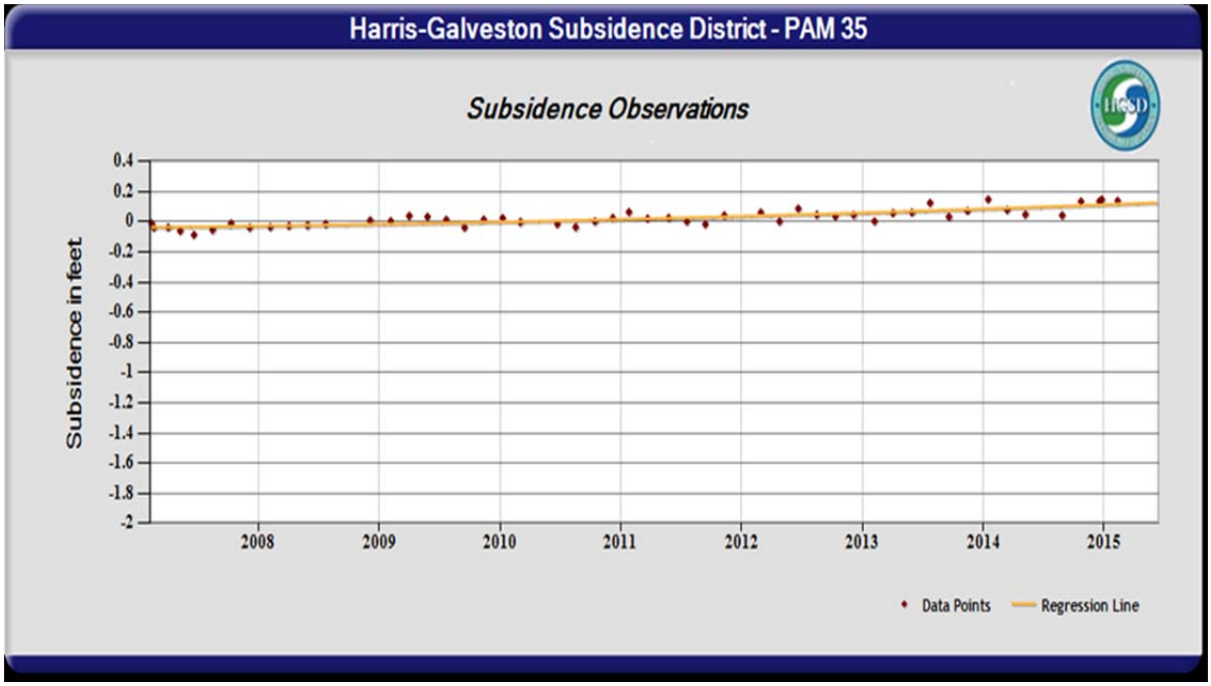
In addition to extensometers installed in 1973, Galveston County has 3 fixed GPS monitoring stations (CORS) and 10 portable measurement units (PAM) measuring subsidence. The location of these units is illustrated in Figure (17.7).[14] In review of 2014-2015 data from the Harris-Galveston Subsidence District the area subsidence rates recorded by local sensors ranged from a 0.5 inch increase (PAM 35-League City) to a one inch decrease (TXNJ-near Bolivar Peninsula). Figure 17.8 provides the charted data for these two sites.

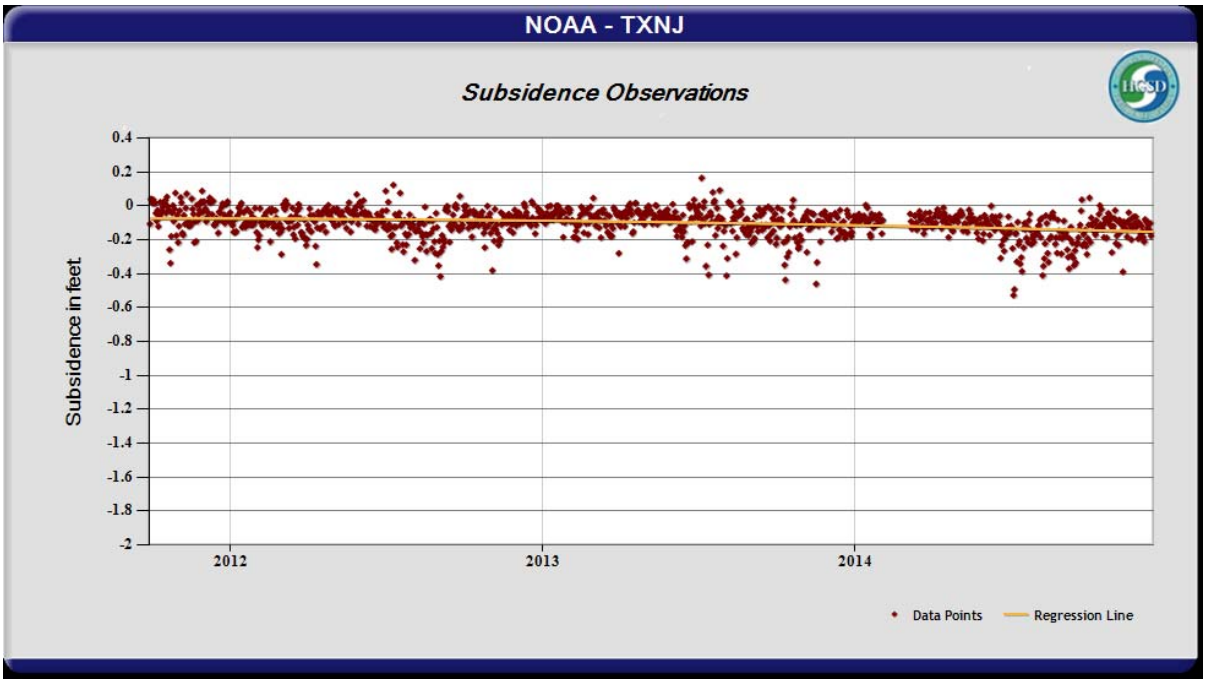
Figure 17.7: Subsidence Measure Sites



[14] Data retrieved online January 2016: http://hgsubsidence.org/subsidence-data/

73 *Figure 17.8: Subsidence Observations- PAM 35 and TXNJ*

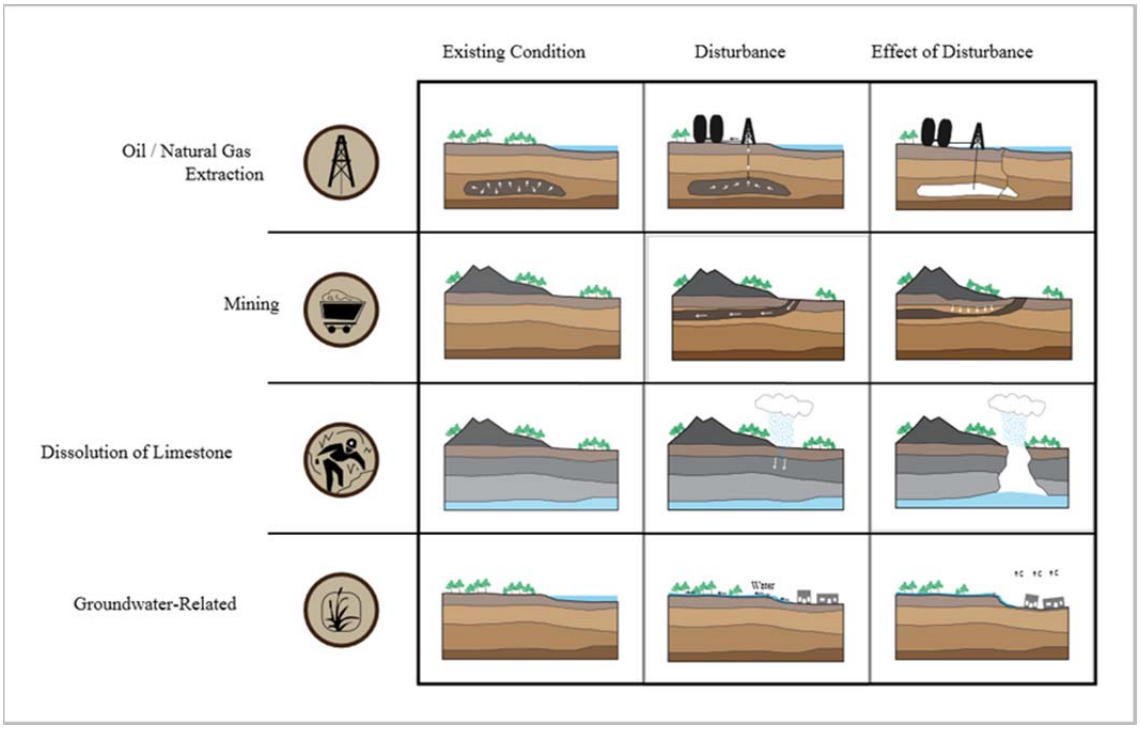




17.3 Extent

Land subsidence is measured by rates of elevation loss. The extent of land subsidence in the area from 1906 to 2000 ranges from approximatley 1-6 feet. The types of ground subsidence is provided in Figure 17.9.

Figure 17.9: Types of Ground Subsidence



Source: http://en.wikipedia.org/wiki/File:Wiki_Image_Rev1.svg

17.4 Historical Occurrences

Subsidence is a continuous hazard, and its effects are intimately intertwined with those of other natural forces and episodic hazardous events. Rates of subsidence have decreased, but its effects continue to compound. There is one reported subsidence event dated June 2000 in the Houston-Galveston area. According to the State of Texas Hazard Mitigation Plan, 2013 update, early oil and gas production and a long history of groundwater pumping in the Houston-Galveston area created severe and costly coastal flooding hazards and affected a critical environmental resource – the Galveston Bay estuary.

17.5 Probability of Future Events

Rates of subsidence have decreased dramatically in line with the curtailing of water removal from the hazard is identified as unlikely (event possible in the next 10 years). Subsidence may continue to develop from other types of below ground withdrawals or from other natural processes.

17.6 Vulnerability Assessment

The decrease in land surface elevation contributes to: [15] [16] [17]

- Saltwater inundation of coastal areas
- Increase in the frequency and extent of flooding
- Damage to infrastructure including protrusion above land surface of wells and other fixed infrastructure, Gradient reversals resulting in ponding and/or backflow of sewage and stormwater runoff,
- Activation or acceleration of the movement of geologic faults resulting in visible surface fracturing, surface offsets, and property damage.
- Exaggerated flooding by tidal surges and heavy rains attendant to hurricanes
- Gradient change in open channels which can lead to channel erosion and sediment deposit
- Conversion of emergent wetlands to open water and barren flats. This causes bay shorelines to become more susceptible to erosion by wave action
- Significant loss of submerged aquatic vegetation

Estimates of the financial impact of subsistence are vague. "Many millions of dollars" are spent reclaiming land submerged by tidal water, elevating structures such as buildings, wharves and roadways, constructing levees to protect against tidal inundation and to repair damage due to fault movement. An estimate of the average annual cost to property owners from 1969 to 1974 for the HGSD was $31,000,000 (measured in 1975 dollars). Due to the decrease in rates of subsidence, this cost may be much lower today. Costs to relocate or fortify industrial facilities would likely exceed those estimates. [18]

17.7 Impact

The severity of subsidence impacts are considered to be limited in the short term since they generally result in no physical injuries and rarely shut down critical facilities and services. Financial repercussions to property should be researched further.

15 Kasmarek, Mark C. 2015
16 Coplin, Laura 2007
17 Subsidence.org
18 Coplin, Laura 2007

Mitigation Strategy

Table 17.1 provides a summary of the mitigation actions identified by jurisdiction's who could be impacted by land Subsidence events. Details for these actions are provided in Section 24.

Table 17.1: Mitigation Actions – Land Subsidence

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2006-1: Continue efforts on public information and awareness for all hazards	BC-2016-7: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation
Clear Lake Shores	CLS-2016-1: Implement public awareness campaigns for all hazards	CLS-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Hitchcock	H-2011-1: Provide public awareness and information at community events (food bank) and city website regarding all hazards	H-2016-4: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2016-5: Continue to enforce/improve regulations and permit requirements to promote hazard mitigation strategies
Galveston County	GC-2006-12: Incorporate GIS system into emergency planning and operations	GC-2011-6: Continue efforts on public information and awareness for all hazards

18.0 Earthquake

18.1 Description

Geologic hazards are events or incidents that involve seismic or non-seismic ground failures such as earthquakes, tsunami, and volcano. The occurrence of geologic hazards is often interrelated with other natural phenomena. Texas earthquakes are the result of movement along a natural fault. The type of fault that Texas earthquakes come from is a "normal" fault. Gulf Margin normal faults are numerous and approximately 12 KM below the surface. These faults move at less than 0.2mm/year.

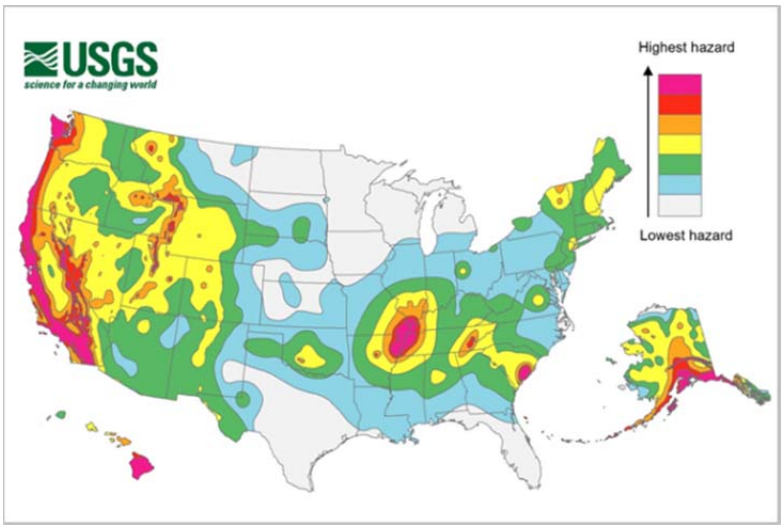
The Texas Bureau of Economic Geology studies earthquakes and reports that they do occur in Texas and neighboring regions although they have not been a major danger to Texans historically. Current monitoring cannot provide accurate estimates of potential damage or loss of life due to earthquakes. Earthquakes in coastal Texas are so deep, move so little, and so slowly that they may not cause much of a rumble.

The State of Texas included earthquake as a potential hazard for Region 1 only in their 2013 Hazard Mitigation Plan. The GCHMC considered this hazard with a majority of the participating jurisdictions agreeing the probability of a future impact is highly unlikely. However the jurisdictions of Bayou Vista, Clear Lake Shores, Kemah, La Marque, Santa Fe, and Tiki Island ranked earthquake as a low hazard and felt it should be recognized in this plan without the development of mitigation strategies.

18.2 Location

The USGS Seismic Hazard Map shown in Figure 18.1 indicates the majority of Texas, including the Galveston County, is considered as a low hazard risk area.

Figure 18.1: USGS Seismic Hazard Map



18.3 Extent

The Modified Mercalli Intensity Scale is used to classify the intensity of earthquakes by magnitude is shown in Table 18.1.

Table 18.2: Intensity Scale and Definitions

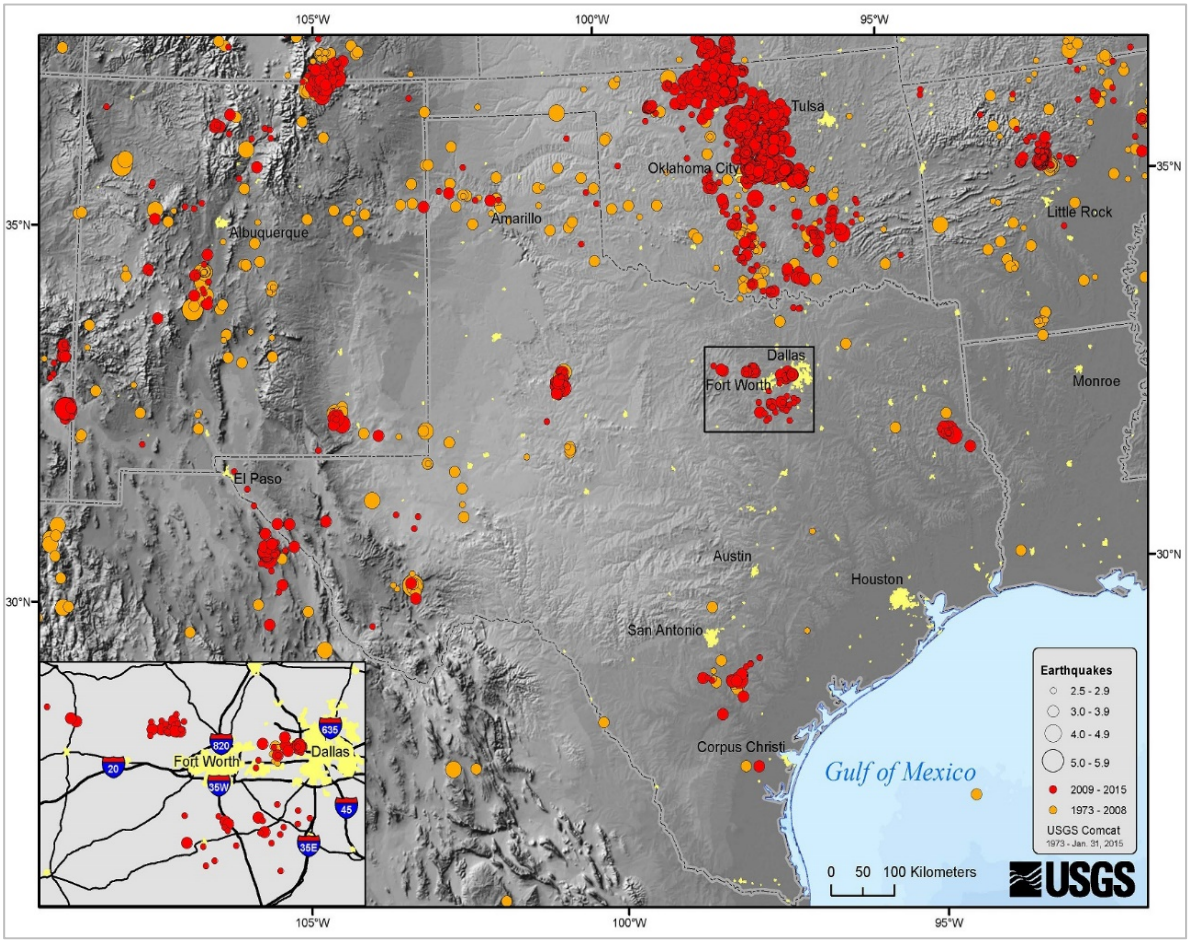
Magnitude	Modified Mercalli Intensity
1.0 – 3.0	I
3.0 – 3.9	II - III
4.0 – 4.9	IV - V
5.0 – 5.9	VI - VII
6.0 – 6.9	VII - IX
7.0 and Higher	VIII or Higher
Intensity Definitions	
I - Not felt except by a very few under especially favorable conditions.	
II - Felt only by a few persons at rest, especially on upper floors of buildings.	
III - Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations are similar to the passing of a truck. Duration estimated.	
IV - Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation is like a heavy truck striking building. Standing motor cars rocked noticeably	
V - Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	
VI - Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage is slight.	
VII - Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	
VIII - Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage is great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	
IX - Damage considerable in specially designed structures; well–designed, frame structures thrown out of plumb. Damage is great in substantial buildings, with partial collapse. Buildings shifted off foundations.	
X - Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	
XI - Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.	
XII - Damage total. Lines of sight and level are distorted. Objects are thrown into the air.	

Source: USGS Earthquake Hazards Program

18.4 Historical Occurrences

Since 1882, 17 earthquakes have been reported throughout Texas but none were recorded in Galveston County. Figure 18.2 shows the locations of earthquake activity from 1973 – 2015 confirm there is no evidence of seismic activity.

Figure 18.2: USGS: Seismicity Map 1973-2015

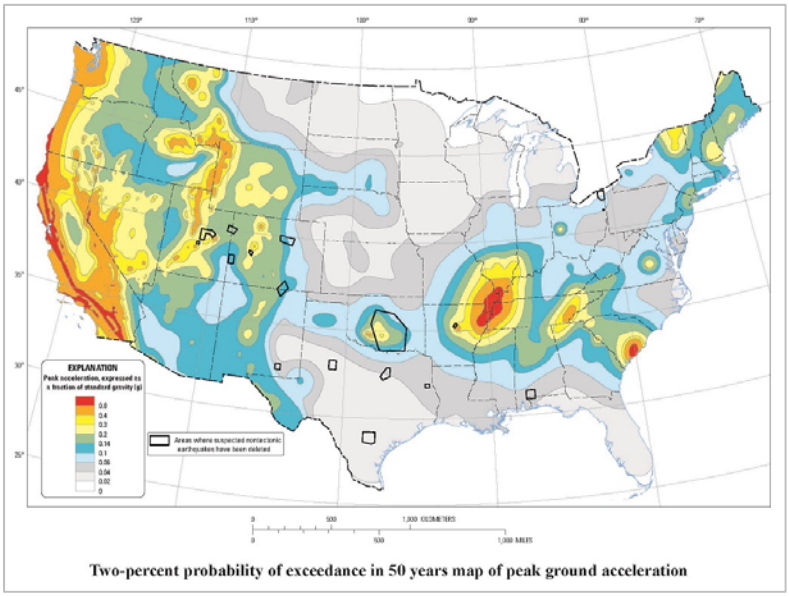


Source: USGS

18.5 Probability of Future Events

The National Seismic Hazard Maps are derived from seismic hazard curves calculated on a grid of sites across the United States that describe the annual frequency of exceeding a set of ground motions. Figure 18.3 depicts probabilistic ground motions with a 2 percent probability of exceedance. The earthquake hazard has a very low probability of occurrence within the Galveston County study area with peak acceleration values in the planning area less than 0.02g.

Figure 18.3: Two percent probability of exceedance-50 years (USGS, 2014)



Source: USGS

18.6 Vulnerability Assessment

No records of property losses due to earthquakes for the Galveston County area exist. While the entire building stock for the planning area would be subject to any earthquake activity, the potential for tremors and their potential impacts are extremely low so annualized losses are considered to be negligible.

18.7 Impact

The earthquake hazard would likely have a minimal impact to the planning area given the distal locations of the sources (epicenters).

19.0 Dam and Levee Failure

19.1 Description

Dam

Dams are water storage, control, or diversion structures that impound water upstream in reservoirs. Dam failure can take several forms, including a collapse of, or breach in, the structure. While most dams have storage volumes small enough that failures have few or no repercussions, dams storing large amounts can cause significant flooding downstream. Dam failures can result from any one, or a combination, of the following causes:

- Prolonged periods of rainfall and flooding, which cause most failures;
- Inadequate spillway capacity, resulting in excess overtopping of the embankment;
- Internal erosion caused by embankment or foundation leakage or piping;
- Improper maintenance, including failure to remove trees, repair internal seepage problems, or maintain gates, valves, and other operational components;
- Improper design or use of improper construction materials;
- Failure of upstream dams in the same drainage basin;
- Landslides into reservoirs, which cause surges that result in overtopping;
- High winds, which can cause significant wave action and result in substantial erosion; and
- Destructive acts of terrorism.

Benefits provided by dams include water supplies for drinking, irrigation and industrial uses; flood control; hydroelectric power; recreation; and navigation. At the same time, dams also represent a risk to public safety. Dams require ongoing maintenance, monitoring, safety inspections, and sometimes even rehabilitation to continue safe service.

In the event of a dam failure, the energy of the water stored behind the dam is capable of causing rapid and unexpected flooding downstream, resulting in loss of life and great property damage. A devastating effect on water supply and power generation could be expected as well. The terrorist attacks of September 11, 2001, generated increased focus on protecting the country's infrastructure, including the safety of dams.

Levee

Levees (also "floodwalls") are human-made structures designed to contain, control or deflect the flow of water to provide protection from temporary flooding. Levees usually protect from seasonal flooding, and may be subject to water loading for periods of only a few days or weeks each year.

Many of the nation's levees were first put in place by farmers to protect agricultural areas from frequent flooding. They date back as much as 150 years, but in that time, land use has changed and development has taken place where these farms were once located. Levees are earthen berms and/or concrete walls built to keep storm surge or other water from flooding the land behind it and can decay over time. Accurate mapping of the risks of flooding behind levees depends on knowing the condition and level of protection the levees provide.

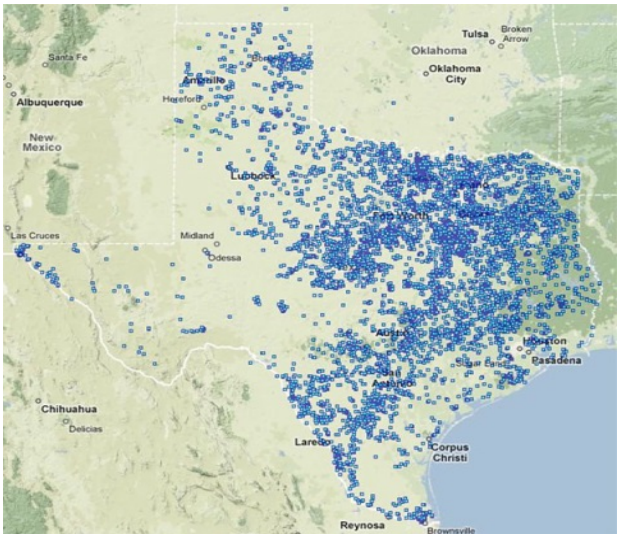
19.2 Location

Dam

The state of Texas currently lists 7,126 non-federal dams. According to the American Society of Civil Engineers-Texas Section Report Card (2012), there are 1,046 high hazard dams in Texas. The state of Texas has more dams than any other state in the Union (See Figure 19.1).

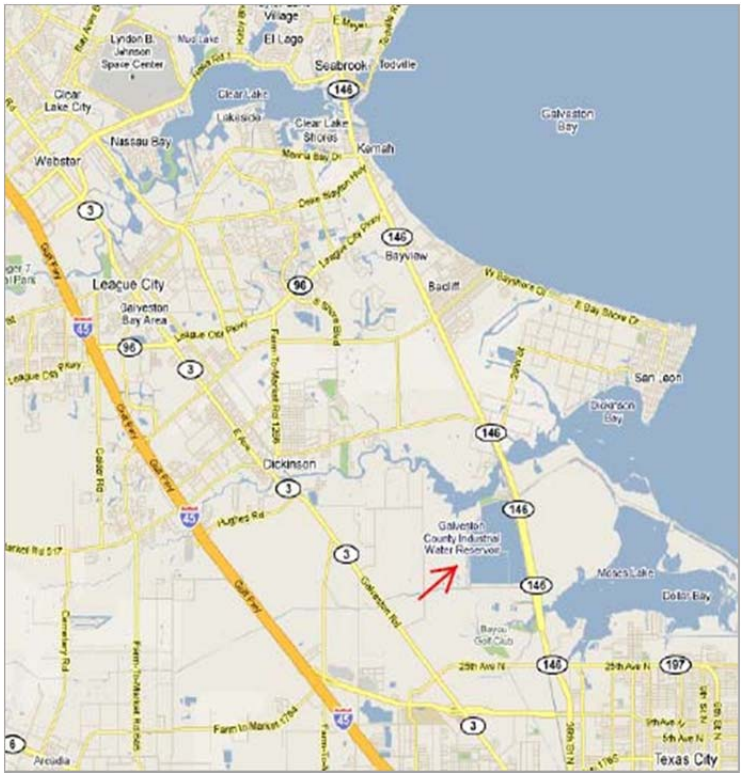
According to the National Inventory of Dams, there is one major dam in Galveston County, which is the Galveston County Water Reservoir Dam located at Dickinson Bayou in Texas City (Figure 19.2). This dam, operated and maintained by the Gulf Coast Water Authority, is classified as a "High" hazard dam. Although Texas City is not part of this plan, the neighboring jurisdictions could be impacted should this dam experience a breach.

Figure 19.1: Location of Texas Dams



Source: USACE

Figure 19.2: Galveston County Water Reservoir Dam - Dickinson Bayou in Texas City

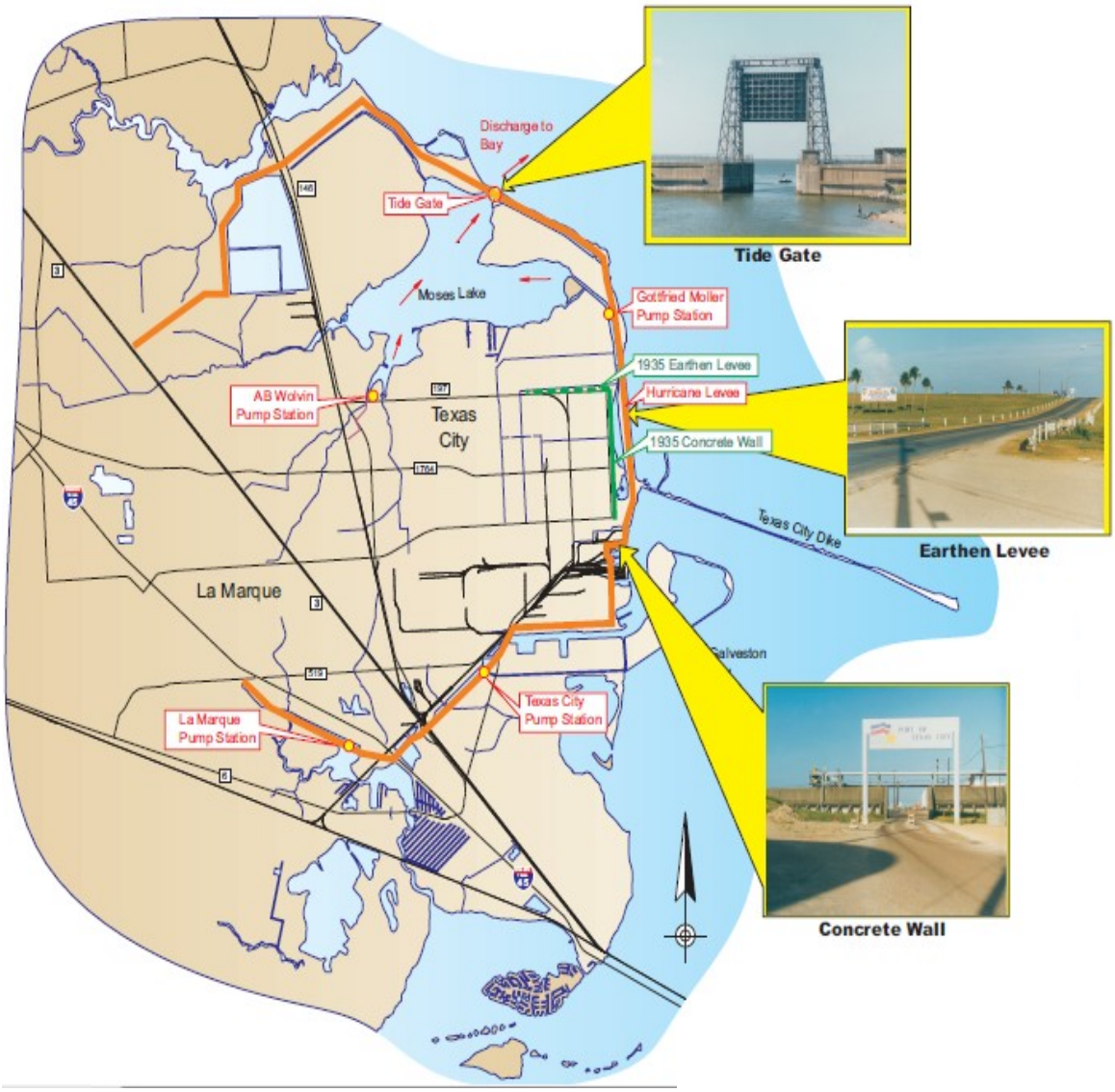


Levee

The Galveston County hurricane flood protection levee protects the cities of Texas City and La Marque and their more than 50,000 residents and almost $7.5 billion of property, which represents more than 40 percent of Galveston County's tax base.

The levee is comprised of 15.7 miles of an earthen berm and 1.3 miles of concrete wall, offering a total of 17 miles of protection. Hurricane flood protection efforts in the Texas City area began in 1928 when some 13,500 feet of earthen levees were constructed by Galveston County in the general area of the port and industrial section of Texas City. These levees reached an elevation of about 14.5 feet. In 1932, construction began on an additional 8,300 foot long concrete wall and a 3,800 foot long earthen levee. Both of these structures were built to an elevation of 12.5 feet. The Texas City/La Marque Hurricane Flood Protection Levee has numerous appurtenant structures. The project is designed to provide protection for about 36 square miles of residential and industrial development from tropical hurricanes of magnitudes up to and including a Standard Project Hurricane Tide of 15 feet. The location and potential impact for the levee are displayed in Figure 19.3.

Figure 19.3: Map of the Texas City/La Marque Hurricane Flood Protection Levee



19.3 Extent

Dam

Effective January 1, 2009, the Texas Commission on Environmental Quality (TCEQ) adopted the revised dam classifications as shown in Table 19.1.

Table 19.1: Dam Classifications Effective January 1, 2009[1]

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, and Lifeline Losses
Low	None expected	Minimal economic loss
Significant	Probable (1 to 6)	Economic loss appreciable
High	Loss of life expected (7 or more).	Economic loss excessive

Source: Texas Commission on Environmental Quality

The new classifications place a greater impact on high and significant hazard dams. Now a significant classification indicates a probable loss of life, whereas before no loss of life was expected in the event of dam failure. A High Hazard dam breach is now indicative of an expected loss of life of seven or more persons versus a probable chance in pre-2008 classifications.

Levee

For levees in the federal system, FEMA relies on the expertise of the USACE and the levee inventory they are developing to determine the appropriate range of flood risk designation to use in re-mapping flood risk on the Flood Insurance Rate Map (FIRM). Information for the inventory is coordinated with the local community and levee owners. For levees not in the federal system, FEMA will coordinate with the impacted community and the levee owner.

While levees reduce the chance of flooding from certain designed events, no levee completely eliminates the risks associated with flooding as levees are designed to provide a specific level of protection and can be overtopped or fail during flood events that exceed the design storm. Table 19.2 depicts the range of protection that levees provide.

[1] Title 30 of the Texas Administrative Code, Chapter 299, subchapter B Rule §299.14

Table 19.2: Levee Classifications/Range of Protection

Classification	Description	Area of Protection/Inundation
Accredited Levees	If a levee meets the criteria and the necessary data and documentation are provided to FEMA, the FIRM will show the area behind the levee as protected from the base flood and it will be mapped as a moderate-risk zone.	Area protected on FIRM/DFIRM – shaded Zone X (area of low to moderate risk)
Provisionally Accredited Levees	If community officials and levee owners reasonably believe a levee system provides protection from the base flood but documentation is not promptly available, this interim designation will allow up to two years for communities to submit documentation and levee certification to FEMA.	Area protected by levee on DFIRM will be mapped as shaded Zone X
Non-accredited	If the levee does not meet the regulatory protection criteria of 44 CFR Section 65.10, then the FIRM will show the area behind the levee as a high-risk zone, or SFHA.	The area of inundation will be shown as a Zone A or AE

The Texas City levee is considered to be an Accredited Levee, designed to protect to the one percent flood event. Therefore, the levee can protect against a storm surge range up to 15 feet with waves reaching eight feet high.

19.4 Historical Occurrences

Due to the nature of their construction, both levees and dams are susceptible to decay and deterioration over time and require regular and proper maintenance. However, to date, there has been no historical occurrence of dam or levee failure in Galveston County. In fact, the Texas City/La Marque Hurricane Flood Protection Levee performed as expected and was not damaged during Hurricane Ike in 2008.

19.5 Probability of Future Events

Based on the limited number of high and significant hazard dams for the county, and the lack of historical incidents or previous occurrences of dam failure for the area, the probability of a future occurrence of dam failure is unlikely, with an event possible in the next ten years.

While Bolivar Peninsula was devastated during Hurricane Ike, the Hurricane and Flood Protection Levee in Galveston County held strong and fared well. Currently, the levee protects Texas City and La Marque from a 15 foot storm surge plus the additional height of waves on top of the surge. This

is equivalent to a strong category 3 or low category 4 storm. Therefore the probability of a future occurrence for a levee failure is unlikely, with an event possible in the next ten years.

19.6 Vulnerability Assessment

Dam Failure

Although Texas City is not participating in this plan, the potential threat of the dam should be addressed. The Cities of Clear Lake Shores, La Marque and Kemah have raised concerns over the operation of the flood gates on the water reservoir. It is believed that potential misoperation could exacerbate high tides and cause flooding in the lower areas. Failure of Galveston County's dam may result in the loss of seven or more lives or three or more habitable structures in the breach inundation area downstream of the dam, or excessive economic loss, located primarily in Clear Lake Shores, La Marque or Kemah, where failure would be expected to cause extensive damage to: public facilities and utilities; industrial and commercial facilities; public main highways; or railroads used as a major transportation system.

Due to matters of national security and information, which cannot be released by the TCEQ, particularized dollar losses in terms of annualized loss-estimates for dam failures are not available. Therefore, a breakdown is not available for potential dollar losses of critical facilities, infrastructure, and lifelines, or hazardous-materials facilities.

Levee Failure

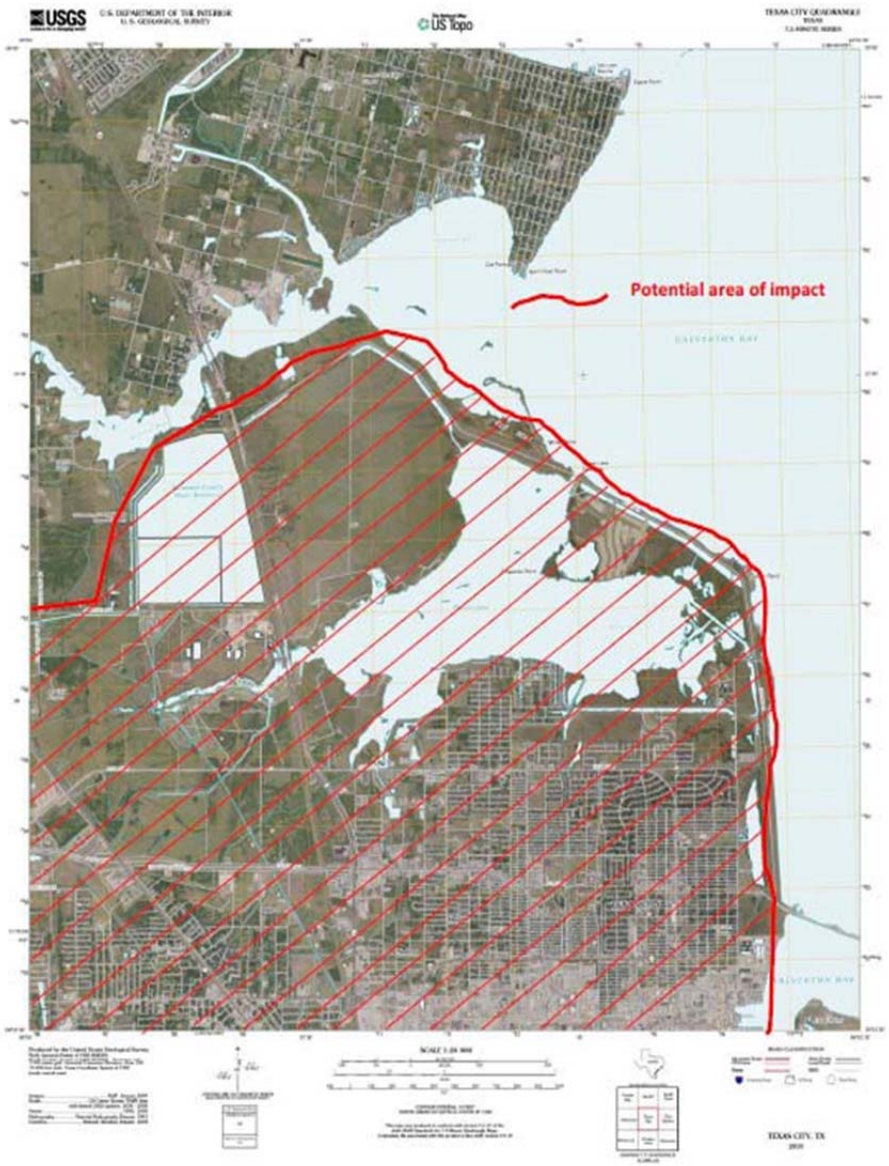
When levees fail, they fail catastrophically. The flooding may be much more intense and damaging than if the levee was not there. No levee system will provide full protection from floods. Levees are designed to provide a specific level of protection, and they can be overtopped in larger flood events. People need to be aware of the risks they face living behind levees - including levees credited as providing protection from the one percent annual chance flood.

Hurricane Ike was a test of the Hurricane and Flood Protection Levee's vulnerability, and Galveston County and its partners remain concerned about the long-term stability of the levee since it protects to only a 15-foot storm surge.

A levee failure could result in the shutdown of critical facilities for weeks, injuries and even fatalities dependent on the degree of hurricane or flood event. Due to the importance of the region in the overall economy, particularly with regard to supplying our Nation with fuel, Galveston County and adjacent communities and partners are reconsidering whether they should be protected by a levee that will withstand a 20-foot storm surge.

Since an inundation map is not available for the Texas City Dam, a topographic map showing the general area of impact in the event of a dam failure is provided as Figure 19.5.

Figure 19.5: USGS Topographic Map – Area of Impact – Texas City Dam



19.7 Impact

Dam Failure

Failure of a major dam for the County is an unlikely event as the only high hazard dam is located outside of the planning area. However, major industrial, commercial, and residential infrastructure and facilities are in the immediate area and immediately downstream of the dam and effects of major misoperation of the floodgates would be felt immediately by densely populated areas and major petroleum refineries and chemical manufacturing plants. If it occurred for the dam in Texas City, the impact on participating jurisdictions in this Plan would be minor, meaning injuries or illness would not result in permanent disability, critical facilities could be shut down for more than a week, and more than ten percent of property could be destroyed or suffer major damage.

Levee Failure

Although there has not been a previous occurrence of a levee failure in the area, the potential impact would be major. Critical facilities could be shut down for weeks and more than 25 percent of property could be destroyed, including some of the nation's refineries. Area refineries have the capacity to satisfy more than 10 percent of the gasoline demand in the U.S. – enough to fully fuel 21 cars every second. The risk associated with levee failure would also affect other industrial companies behind the levee that produce electricity and steam for the Texas City complex. The Mainland Medical Center serves the industrial complex and remains particularly important when dealing with potential injuries resulting from the work with chemicals and volatile substances. All told, the impact from levee failure would affect over 50,000 residents, almost $7.5 billion in property, and roughly five percent of the nation's oil refining capacity. In addition to these figures, over 5,000 people are employed in the area including more than 2,000 independent contractors at any one time.

Mitigation Strategy

Table 19.3 provides a summary of the mitigation actions identified by jurisdiction's that could be impacted by a dam/levee failure. Details for these actions are provided in Section 24.

Table 19.3: Mitigation Actions – Dam and Levee Failure

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Clear Lake Shores	CLS-2006-2: Implement stormwater management practices	CLS-2016-1: Implement public awareness campaigns for all hazards
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2011-10: Develop program to integrate with the Harris County Flood Control District for the purpose of optimizing the operation of the flood gates at second cut outlet.
La Marque	LM-2011-15: Increase the height of the existing levee wall system to withstand a Category 5 storm surge	LM-2011-19: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2006-12: Incorporate GIS System into emergency planning and operations	GC-2011-6: Continue efforts on public information and awareness for all hazards

20.0 Expansive Soils

20.1 Description

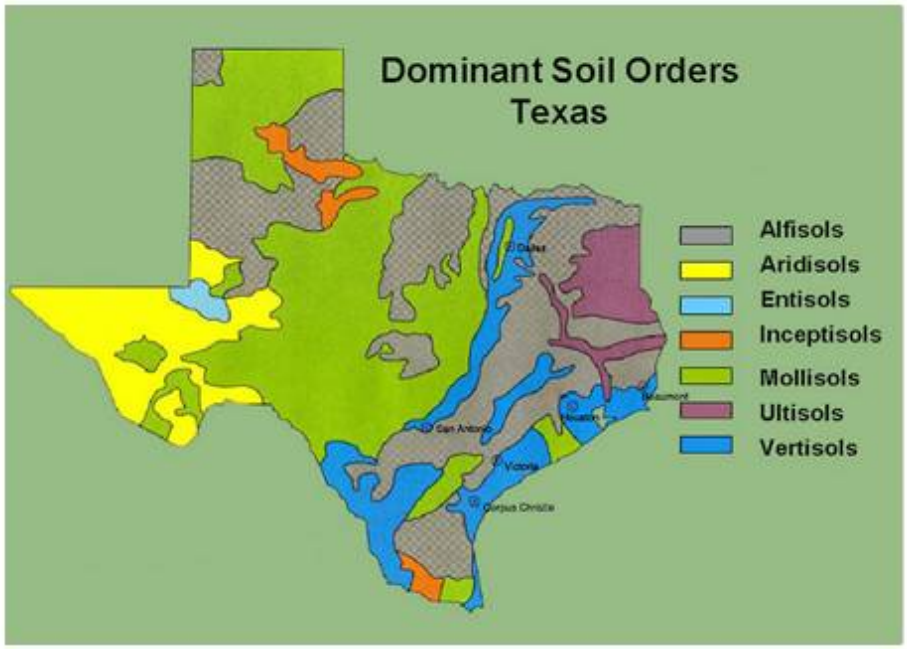
Expansive soils are soils that expand when water is added, and shrink when they dry out. This continuous change in soil volume can cause structures to move unevenly and crack and roads and sidewalks to buckle. Soils with a high clay content exhibit high expansive properties. Slab on grade construction is the most susceptible to damage from expansive clays.

20.2 Location

The primary area of expansive soils in Texas is well inland from the Galveston County area. However, the planning area is underlain by soils with clays of high swelling (Figure 20-1 Blue <50 percent of high swelling soils).

According to USDA soil survey data, the dominant soil type is vertisols which are characterized by the presence of a mineral in the clay called smectite; this mineral swells when moist and shrinks when dry.

Figure 20-1 Soil Orders of Texas



Source: USDA Natural Resources Conservation Service

20.3 Extent

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from moist to a dry state. It is an expression of the volume change as a percentage change for the soil. Soil extensibility ratings over 9 percent are considered to be very high. According to report data gathered from the USDA (Web Report v13, September 2015) the area soil has a range of extensibility from 1.5 to 17 percent.

20.4 Historical Occurrences

Losses due to expansive soils may be captured within a broader scope of disaster damage. This data is not typically broken out, and therefore, records for losses across the area are not available.

20.5 Probability of Future Events

Galveston County receives approximately 50 inches of rain annually. Given the high average annual rainfall and the areas propensity for drought, expansive soils will likely continue to impact the planning area.

20.6 Vulnerability Assessment

According to the State of Texas 2013 Hazard Mitigation Plan, damages caused by expansive soils are higher on slab-on-grade foundations as opposed to pier and beam construction.

20.7 Impact

The severity of expansive soil is considered to be limited since data related to local impacts to life safety and structures is limited.

Due to the fact that there is no relevant documentation of damages caused by expansive soils within the planning area, it is not realistic to develop mitigation actions to address this hazard. Furthermore, there is no code or special treatment requirements for foundation construction that could be enforced by the participating jurisdictions.

21.0 Pipeline Failure

21.1 Description

Fuel pipeline breach or pipeline failure addresses the rare, but serious hazard of an oil or natural gas pipeline. Natural gas pipelines transport natural gas, and oil or liquid petroleum pipelines transport crude oil and refined products from crude oils, such as gasoline, home heating oil, jet fuel and kerosene in addition to liquefied propane, ethylene, butane and some petrochemical products. Sometimes oil pipelines are also used to transport liquefied gasses, such as carbon dioxide.

Pipeline failure is a rare occurrence but has the potential to cause extensive property damage and loss of life. Pipelines have caused fires and explosions that killed more than 200 people and injured more than 1,000 people nationwide and 50 people in Texas in the last decade.

21.2 Location

Figures 21.1 and 21.2 on the following pages show the locations of gas and oil pipelines throughout Galveston County. It is important to note that due to scale, some pipelines cannot be seen on maps where one pipeline runs directly over another or where pipelines appear too close together to be visible on the map.

If any of these energy pipelines were to rupture, such an event could endanger property and lives in the immediate area. Immediate impacts can occur within a half mile area and secondary impacts within a mile of the incident. Therefore, due to the location of both oil and gas pipelines in the county, each participating jurisdiction faces a moderate to high risk, except Jamaica Beach.

Figure 21.1: Location of Gas Pipelines in Galveston County

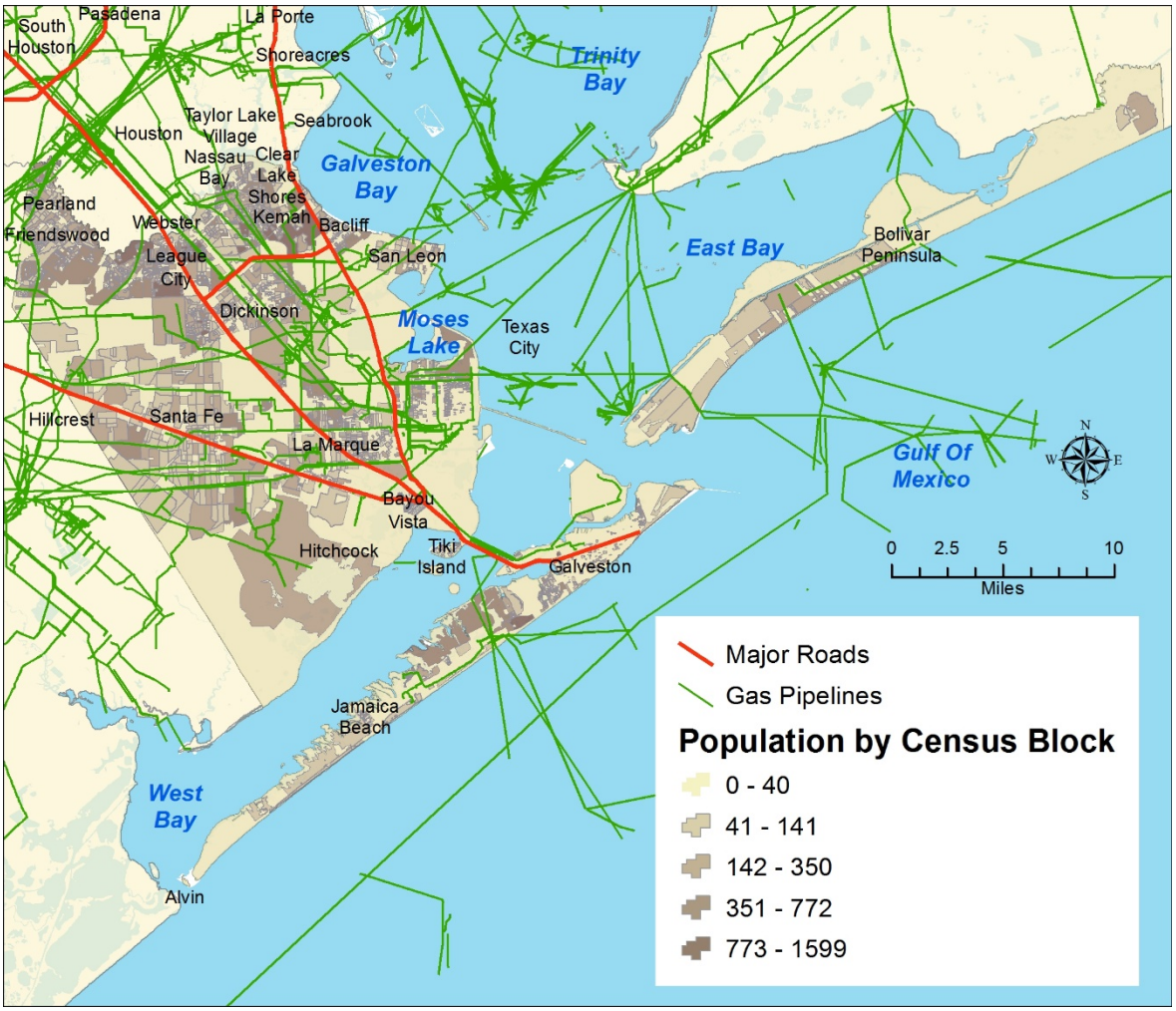
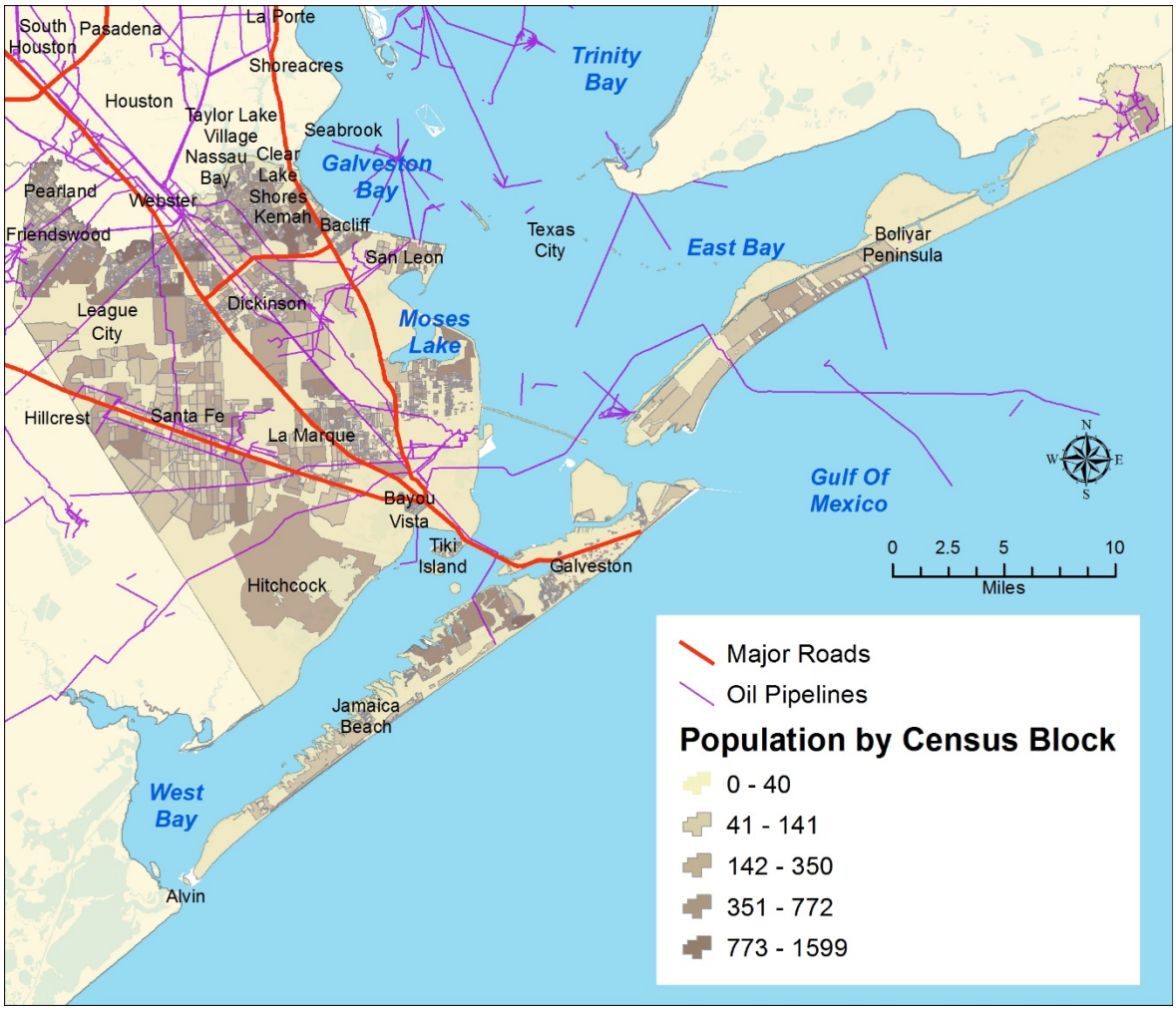


Figure 21.2: Location of Oil Pipelines in Galveston County



21.3 Historical Occurrences

The causes of pipeline failures can range from internal issues such as corrosion or material defects to outside forces such as natural hazards and intentional destruction by humans. A records request was issued to the State of Texas Railroad Commission by the County for reported incidents from June 2008 to current with no results provided. Since no reported additional incidents were made available to the planning team, the data provided in the previous plan for the participating jurisdictions within this plan update are being brought forward in Table 21.1.

Table 21.1: Historical Pipeline Accidents (Gas and Oil Combined) (2003-2008)

Nearest Jurisdiction	Incident Date	Operator	Death	Injury	$ Operator Property Damage
Bacliff	01/09/2004	Centerpoint Energy Entex	0	0	5,024
Hitchcock	08/29/2005	Centerpoint Energy Entex	0	0	0
San Leon	05/17/2006	Unknown O&G	0	0	0
San Leon	05/17/2006	National Onshore, LP	0	0	0
Santa Fe	10/26/2006	Hunt Petroleum	0	0	0
Smith Point	01/06/2007	Tekoil & Gas Gulf Coast, LLC	0	0	0
Bolivar	03/11/2007	Masters Resources	0	0	0
Clear Lake	05/15/2007	Buckeye Gulf Coast Pipelines, LP	0	0	950
Kemah	11/26/2007	Centerpoint Energy Entex	0	0	0
Kemah	12/01/2007	Centerpoint Energy Entex	0	0	0
Offshore (Kemah)	02/17/2008	Tekoil And Gas Gulf Coast, LLC	0	0	0
Port Bolivar	04/15/2008	Tekoil And Gas Gulf Coast, LLC	0	0	0
Port Bolivar	05/29/2008	Tekoil And Gas Gulf Coast, LLC	0	0	0
Total			0	0	5,974

Source: 2011-2016 Galveston County Hazard Mitigation Plan (State of Texas Railroad Commission)

21.4 Vulnerability Assessment

Table 21.2 below provides the estimated population, number of parcels, and improved value of parcels for the participating jurisdictions. This data was used to determine the number of people, buildings, and value of exposure at risk from gas and oil pipelines, respectively as shown in Tables 21.3 and 21.4. However, many pipelines run through less densely populated areas, reducing risk, unlike pipelines that run through heavily populated areas. The content analysis for gas pipelines consists of liquid petroleum gas and natural gas and the content analysis for oil pipelines consists of crude oil and natural gas liquids. The primary area of impact for both types of pipeline incident is a 0.5-mile buffer, and the secondary area of impact is a one-mile buffer.

Table 21.2: Participating Jurisdictions Population and Parcel Data

Jurisdiction	Total Estimated Population	Total Estimated Number of Parcels	Improved Value of Parcels
Bayou Vista	1,537	1,324	$225,154,990
Clear Lake Shores	1,069	1,051	$243,448,194
Friendswood	26,364	10,853	$3,085,164,965
Hitchcock	6,961	6,337	$460,075,283
Jamaica Beach	983	1,590	$338,227,637
Kemah	2,906	1,221	$294,986,165
La Marque	14,543	8,972	$827,263,553
League City	82,353	35,762	$8,164,064,546
Santa Fe	12,814	6,457	$845,974,919
Tiki Island	966	1,254	$445,402,231
Galveston county Unincorporated	40,244	34,756	$2,931,109,729
Total	190,740	109,577	$17,860,872,212

Source: State of Texas Railroad Commission GIS Analysis

Table 21.3: Potential Impact Due to Gas Pipeline Accidents by Jurisdiction

Jurisdiction	Immediate Impact (1/2 Mile Buffer)			Immediate Impact (1 Mile Buffer)		
	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	887	$146,189,210	1,537	1,324	$225,154,990
Clear Lake Shores	0	30	$59,849,930	798	645	$161,619,404
Friendswood	15,429	5,296	$1,400,395,655	19,165	6,895	$1,826,862,524
Hitchcock	6,873	5,203	$356,355,861	6,961	6,078	$447,346,263
Jamaica Beach	0	0	0	0	0	0
Kemah	2,855	1,025	$232,444,023	2,906	1,221	$294,986,165
La Marque	12,455	7,599	$698,068,626	14,543	8,972	$827,263,553
League City	12,455	7,599	$698,068,626	76,237	31,186	$7,122,124,061
Santa Fe	12,458	5,561	$781,439,894	12,814	6,457	$845,974,919
Tiki Island	147	100	$19,812,460	654	622	$220,244,388
Galveston County Unincorporated	32,871	20,885	$1,845,773,633	39,505	28,362	$2,508,817,097
Total	143,544	67,384	$10,258,022,029	175,120	91,762	$14,480,393,364

Source: State of Texas Railroad Commission GIS Analysis

Table 21.4: Potential Impact Due to Oil Pipeline Accidents by Jurisdiction

Jurisdiction	Immediate Impact (1/2 Mile Buffer)			Immediate Impact (1 Mile Buffer)		
	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	550	20	$1,765,500	1,537	1,276	$218,096,26
Clear Lake Shores	416	332	$71,534,113	1,069	1,033	$215,796,274
Friendswood	20,995	7,007	$1,991,112,967	25,974	10,053	$2,853,377,850
Hitchcock	5,236	2,987	$215,393,808	6,691	5,897	$406,097,877
Jamaica Beach	0	0	0	0	0	0
Kemah	114	225	$61,302,390	1,324	488	$155,216,580
La Marque	9,377	5,266	$395,565,887	13,629	7,776	$669,998,361
League City	54,932	18,755	$3,883,029,144	70,331	27,656	$6,047,921,952
Santa Fe	11,405	5,112	$659,829,283	12,164	5,835	$757,794,134
Tiki Island	147	123	$27,084,788	716	746	$265,865,318
Galveston County Unincorporated	24,361	11,705	$1,061,589,974	32,106	20,919	$1,939,414,820
Total	127,533	51,532	$8,368,207,854	165,811	81,679	$13,528,979,426

Source: State of Texas Railroad Commission GIS Analysis

Mitigation Strategy

Table 21.5 provides a summary of the mitigation actions identified by jurisdiction's who could be impacted by pipeline failure. Details for these actions are provided in Section 24.

Table 21.5: Mitigation Actions – Pipeline Failure

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2011-20: Implement a plan for minimizing damage due to pipeline breach or failure	BV-2006-1: Continue efforts on public information and awareness for all hazards
Clear Lake Shores	CLS-2011-8: Conduct mass notifications for pipeline breach or release of hazardous materials emergencies related to in-place protection and/or evacuation	CLS-2011-9: Participate in pipeline group training pertaining to responding to pipeline emergencies, evacuation, in-place protection for residents
Friendswood	F-2016-17: Continue to participate in maintaining the Pipeline Integrity Management Resource Reporting in High Consequence Areas (HCA) through the National Pipeline Mapping System (NPMS)	F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards
Hitchcock	H-2011-1: Provide public awareness materials and information at community events (food bank) and city website regarding all hazards	H-2016-3: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2016-5¨ Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County
La Marque	LM: 2011-19: Continue efforts on public information and awareness for all hazards	LM-2016-4: Develop Critical Infrastructure and Key Resources database (CIKR)
League City	LC-2005-9: Update local mitigation plan to include pipeline and hazardous materials incidents	LC-2016-6: Public outreach and education-all hazards
Santa Fe	SF-2016-10: Develop Critical Infrastructure and Key Resources database (CIKR)	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-8: Purchase new Emergency Notification System (ENS)	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2006-12: Incorporate GIS system into emergency planning and operations	GC-2011-6: Continue efforts on public information and awareness for all hazards

22.0 Hazardous Material Incidents

22.1 Description

A hazardous material is any biological, chemical, or physical agent with the potential to cause harm to the environment or humans on its own or when combined with other factors or materials. Hazardous materials are monitored and recorded by the Environmental Protection Agency (EPA) through the Toxics Release Inventory (TRI), which is a publicly available database that contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities. This inventory was established under the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) and expanded by the Pollution Prevention Act of 1990.

Each year, facilities that meet certain activity thresholds must report their releases and other waste management activities for listed toxic chemicals to the EPA and their state or tribal entity. A facility must report these activities if it meets the following three criteria:

- The facility falls within one of the following industrial categories: manufacturing; metal mining; coal mining; electric generating facilities that combust coal and/or oil; chemical wholesale distributors; petroleum terminals and bulk storage facilities; Resource Conservation and Recovery Act (RCRA) Subtitle C Treatment, Storage, and Disposal (TSD) facilities; and solvent recovery services;
- Has 10 or more full-time employee equivalents; and
- Manufactures or processes more than 25,000 pounds or uses more than 10,000 pounds of any listed chemical during the calendar year. Persistent, bioaccumulative, and toxic (PBT) chemicals are subject to different thresholds of 10 pounds, 100 pounds or 0.1 grams depending on the chemical.

Tier 2 data is a publicly available database from the Texas Department of State Health Services Tier 2 Chemical Reporting Program. Under the community right-to-know program laws upheld at the state and federal level, all facilities that store significant quantities of hazardous chemicals must share this information with state and local emergency responders and planners. Facilities in Texas share this information by filing annual hazardous chemical inventories with the state, Local Emergency Planning Committees (LEPCs), and local fire departments. The Texas Tier 2 Reports contain facility identification information and detailed chemical data about hazardous chemicals stored at the facility.

A facility must report chemicals if it meets the following criteria:

- Any company using chemicals that could present a physical or health hazard must report them, according to Tier 2 requirements.
- If an industry has an Occupational Safety and Health Administration (OSHA) deemed hazardous chemical that exceeds the appropriate threshold at any point in time, then the chemical must be reported. These chemicals may be on the list of 356 Extremely Hazardous Substances (EHS) or one of the 650,000 reportable hazardous substances (not on the EHS list). This reporting format is for a "snapshot in time". EHS chemicals have to be reported if the quantity is either greater than 500 pounds, or if the Threshold Planning Quantity (TPQ) amount is less than 500 pounds.

22.2 Location

Figure 22.1 shows the locations of TRI and Tier 2 sites in the Galveston County study region, and Figures 22.2 through 22.10 provides jurisdictional-level locations of the TRI and Tier 2. [1]

For fixed-site analysis, only locations with geo-referenced data available were analyzed. Circular buffers are drawn around each hazardous material site to delineate the areas of impact. Two sizes of buffers, 500 and 2,500 meters, are assumed in respect to the different levels of effect--primary and secondary. For mobile analysis, the major roads (Interstate Highway, US Highway, State Highway) and railroads are chosen to be routes where hazardous material is allowed. The buffer along the roads is drawn with the same size as fixed site analysis. Census block data was used to estimate exposure.

[1] Of the 249 Tier 2 sites available for analysis, 40 do not have latitude and longitude coordinates; this means that approximately 16% of the Tier 2 sites in Galveston County are not reflected in the GIS analysis or in the maps provided in this section.

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Figure 22.1: Galveston County TRI and Tier 2 Facilities

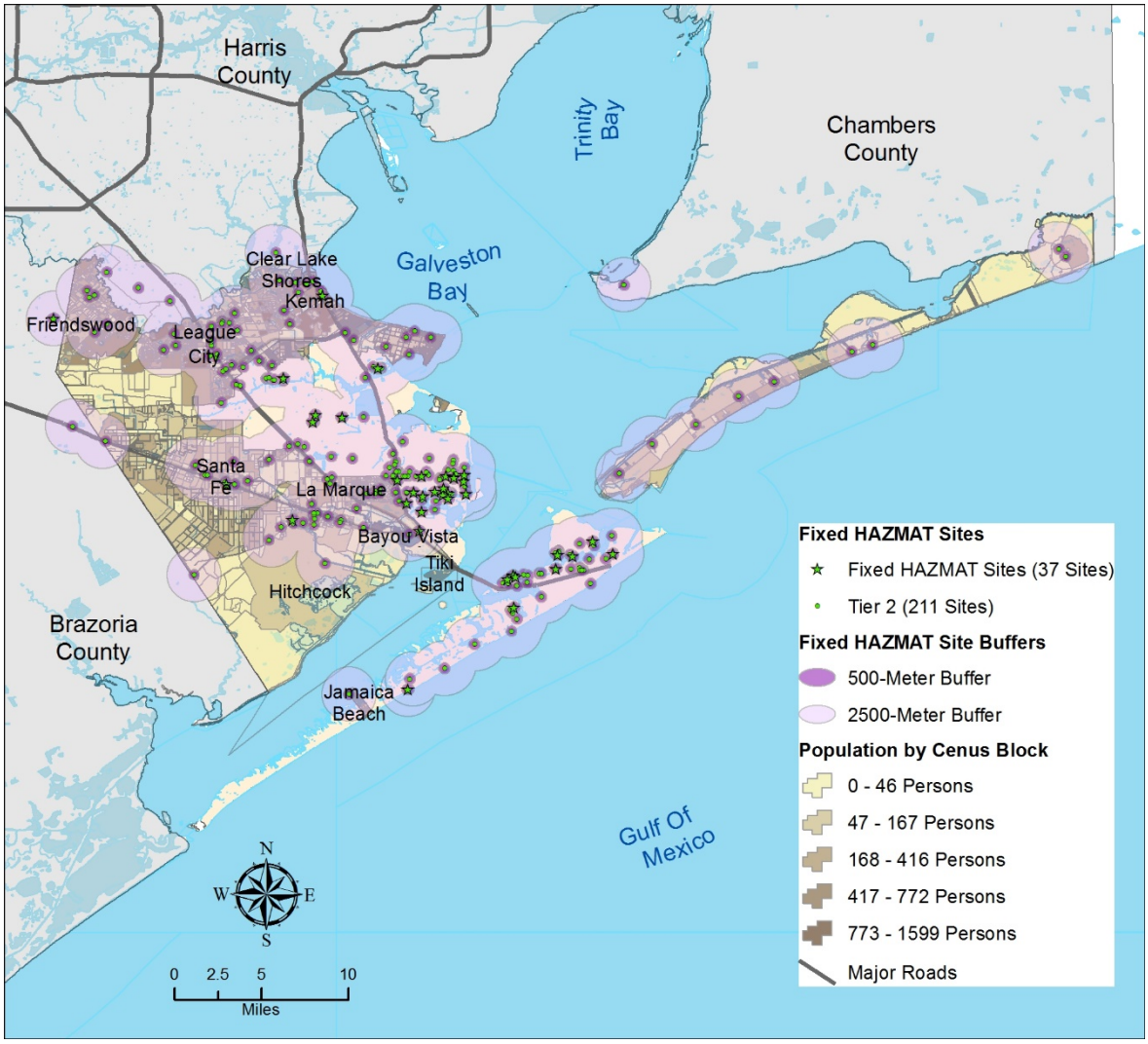


Figure 22.2: Bayou Vista TRI and Tier 2 Facilities with Hazard Area Buffers

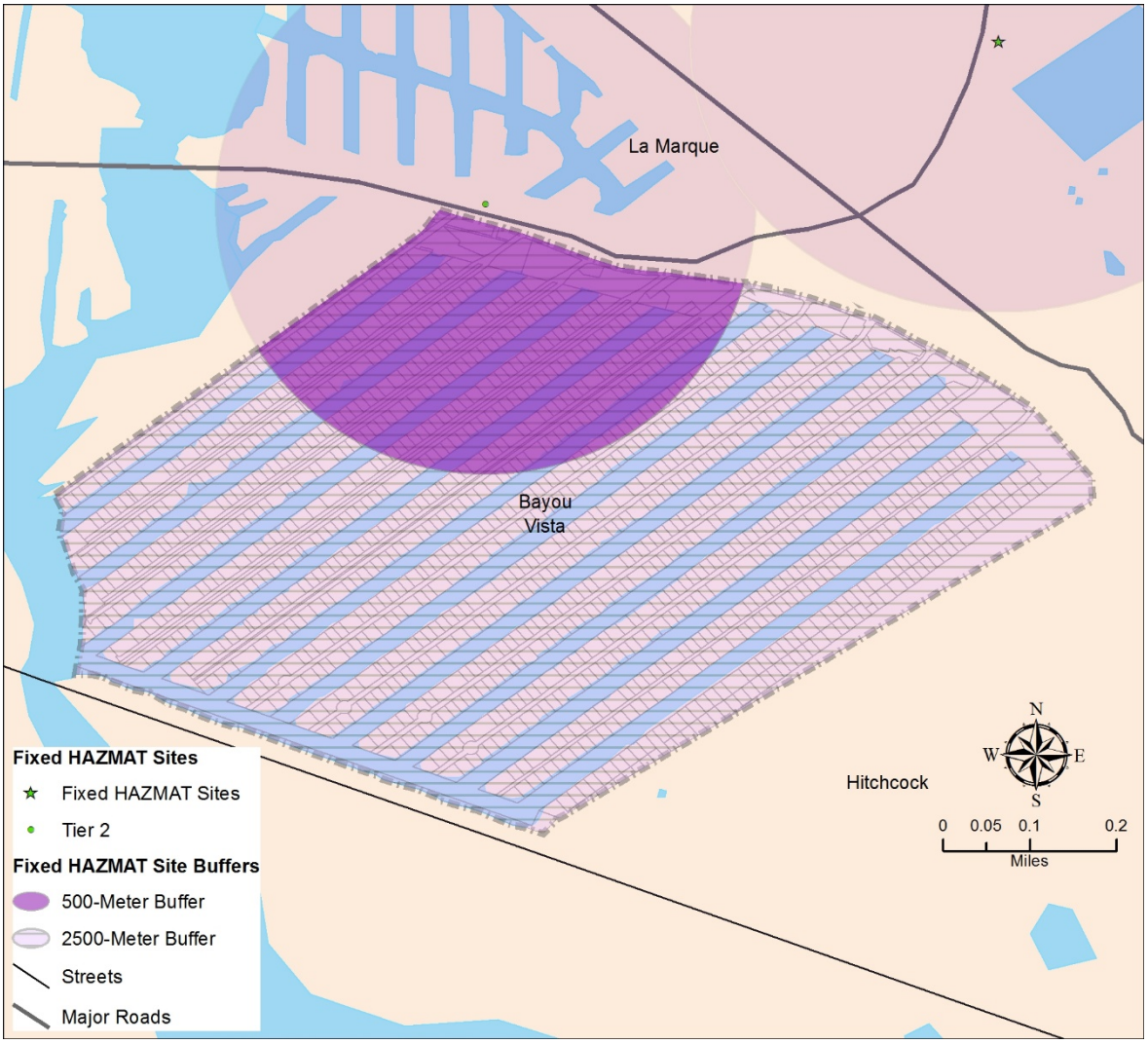


Figure 22.3: Clear Lake Shores TRI and Tier 2 Facilities with Hazard Area Buffers

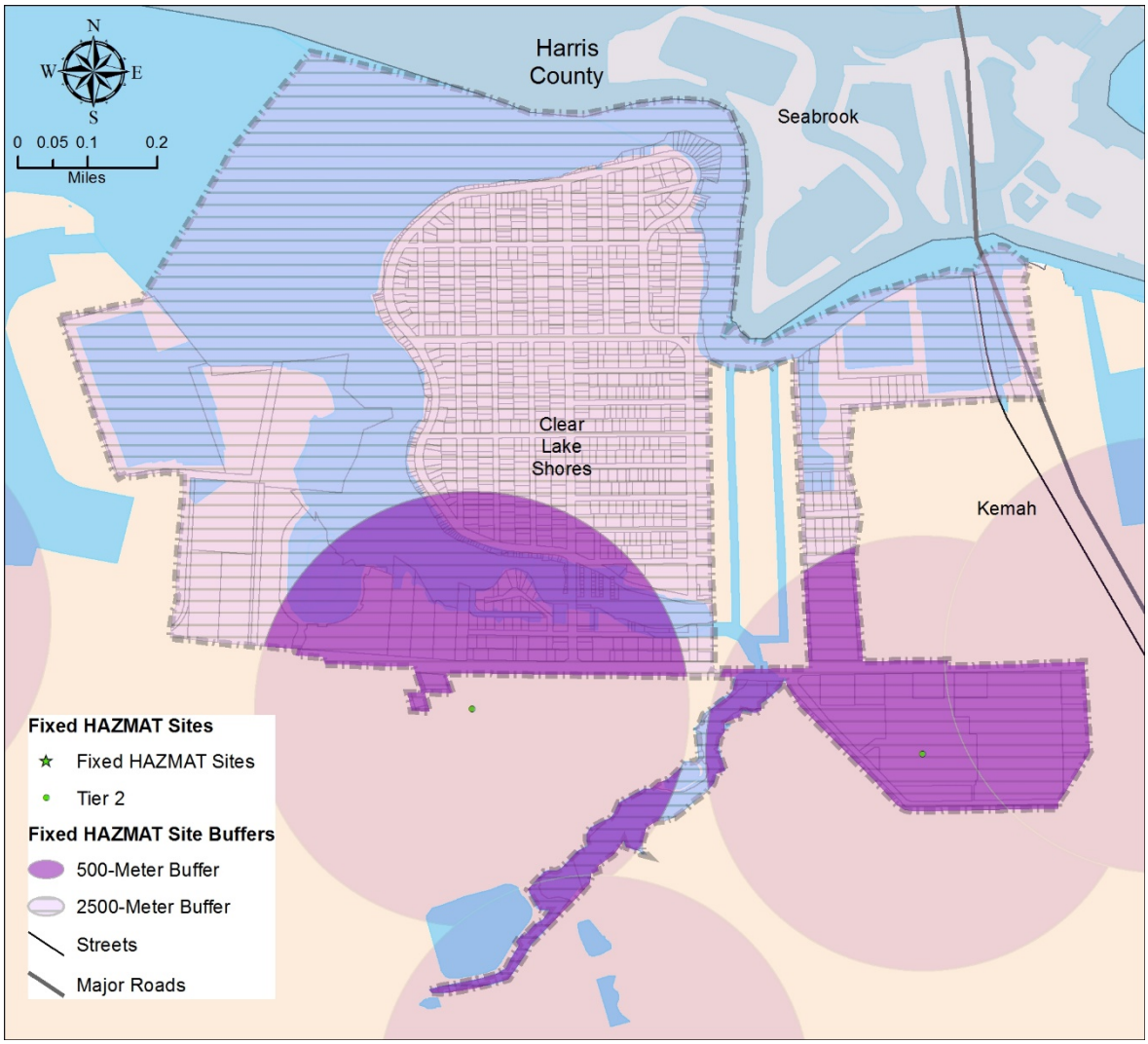
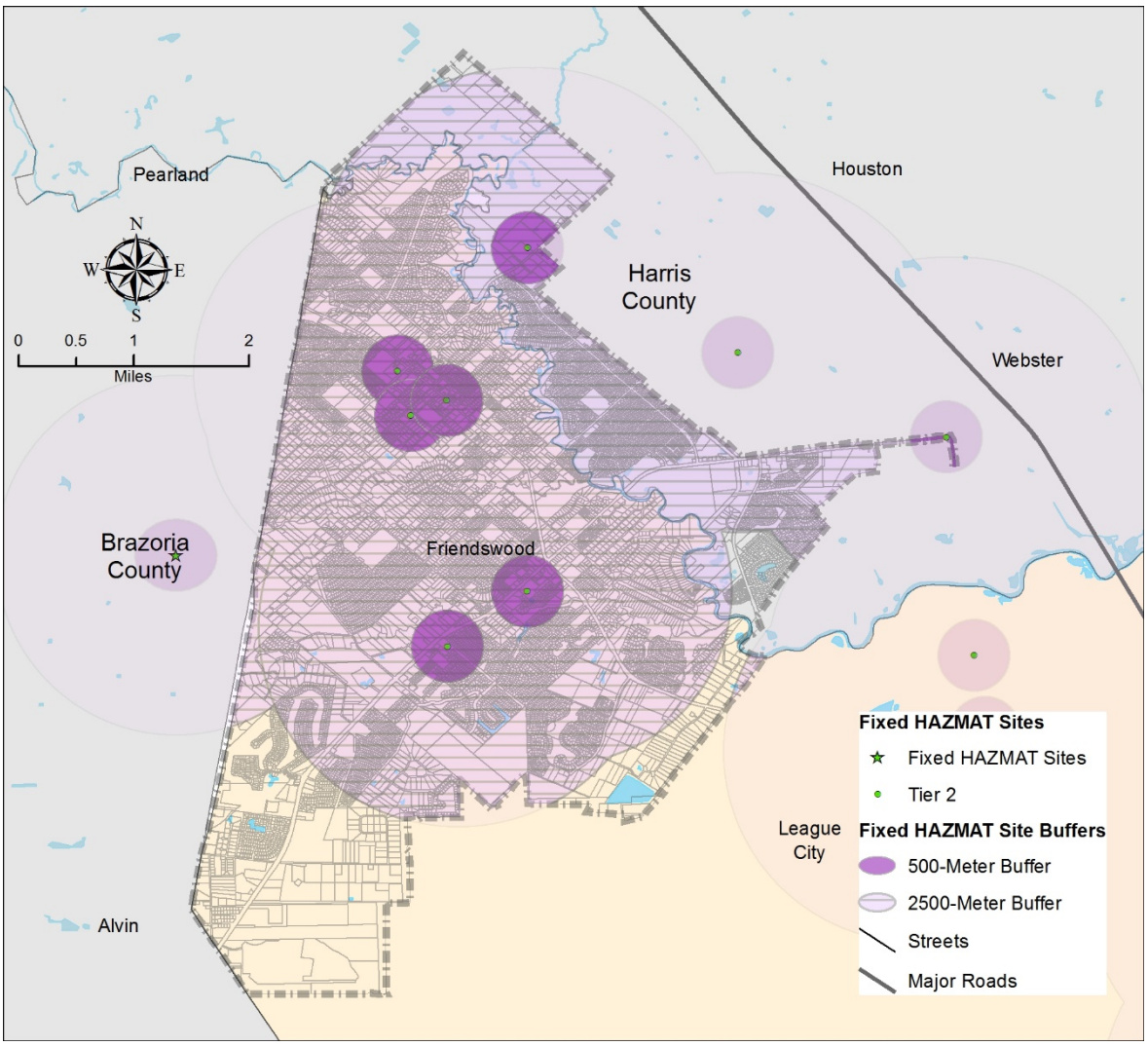
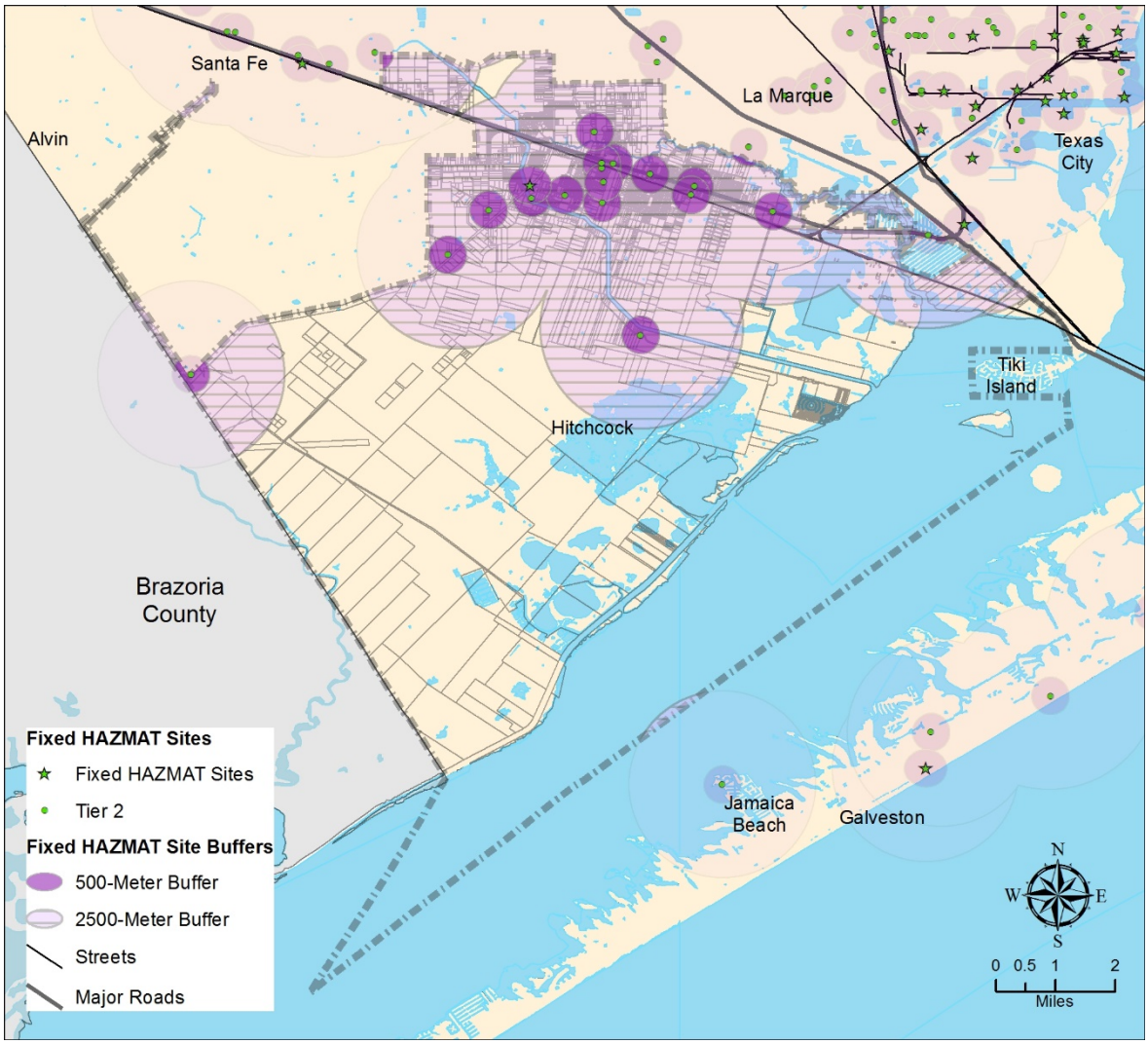


Figure 22.4: Friendswood TRI and Tier 2 Facilities with Hazard Area Buffers



60 *Figure 22.5: Hitchcock TRI and Tier 2 Facilities with Hazard Area Buffers*



61

Figure 22.6: Jamaica Beach TRI and Tier 2 Facilities with Hazard Area Buffers

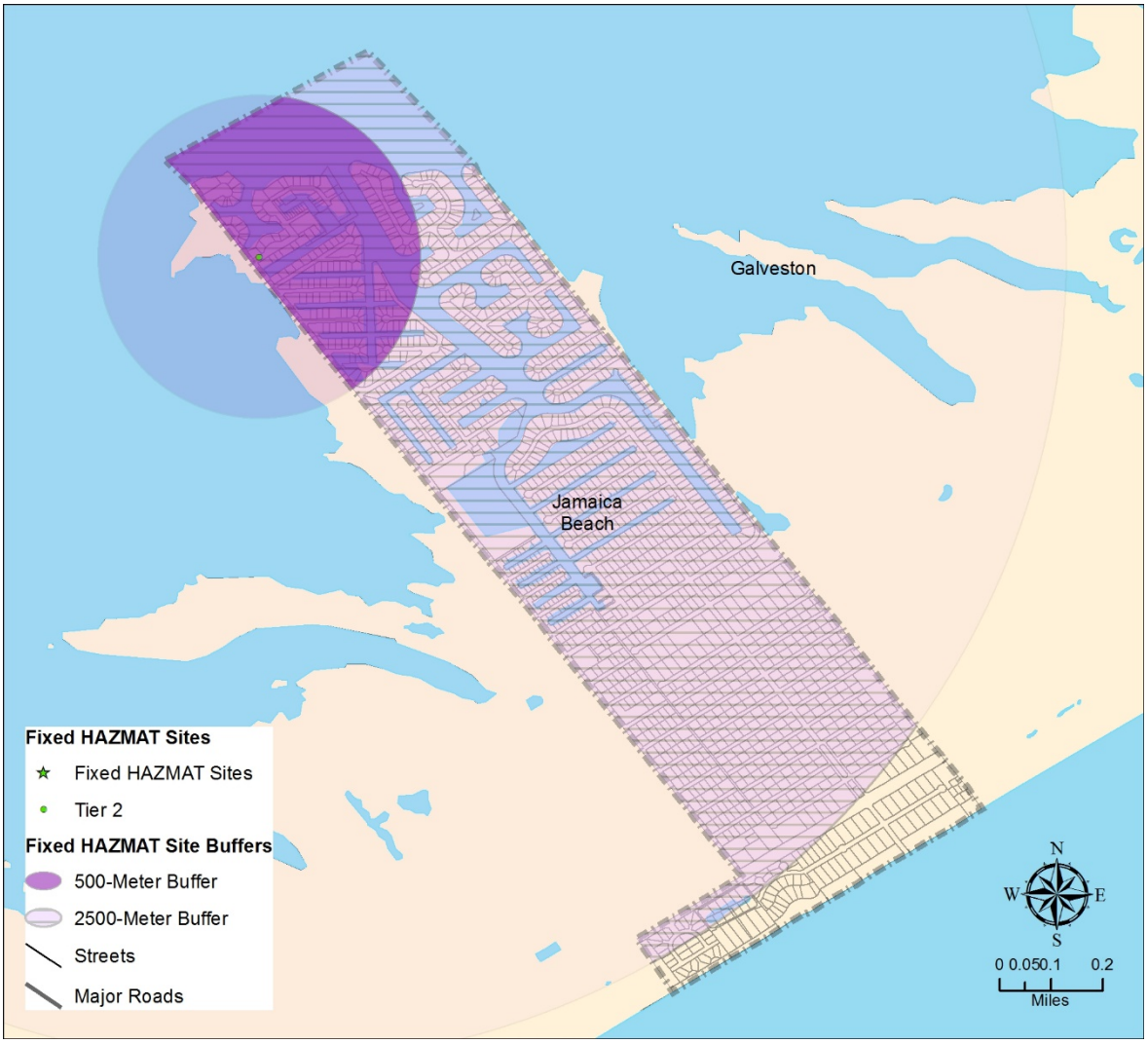


Figure 22.7: Kemah TRI and Tier 2 Facilities with Hazard Area Buffers

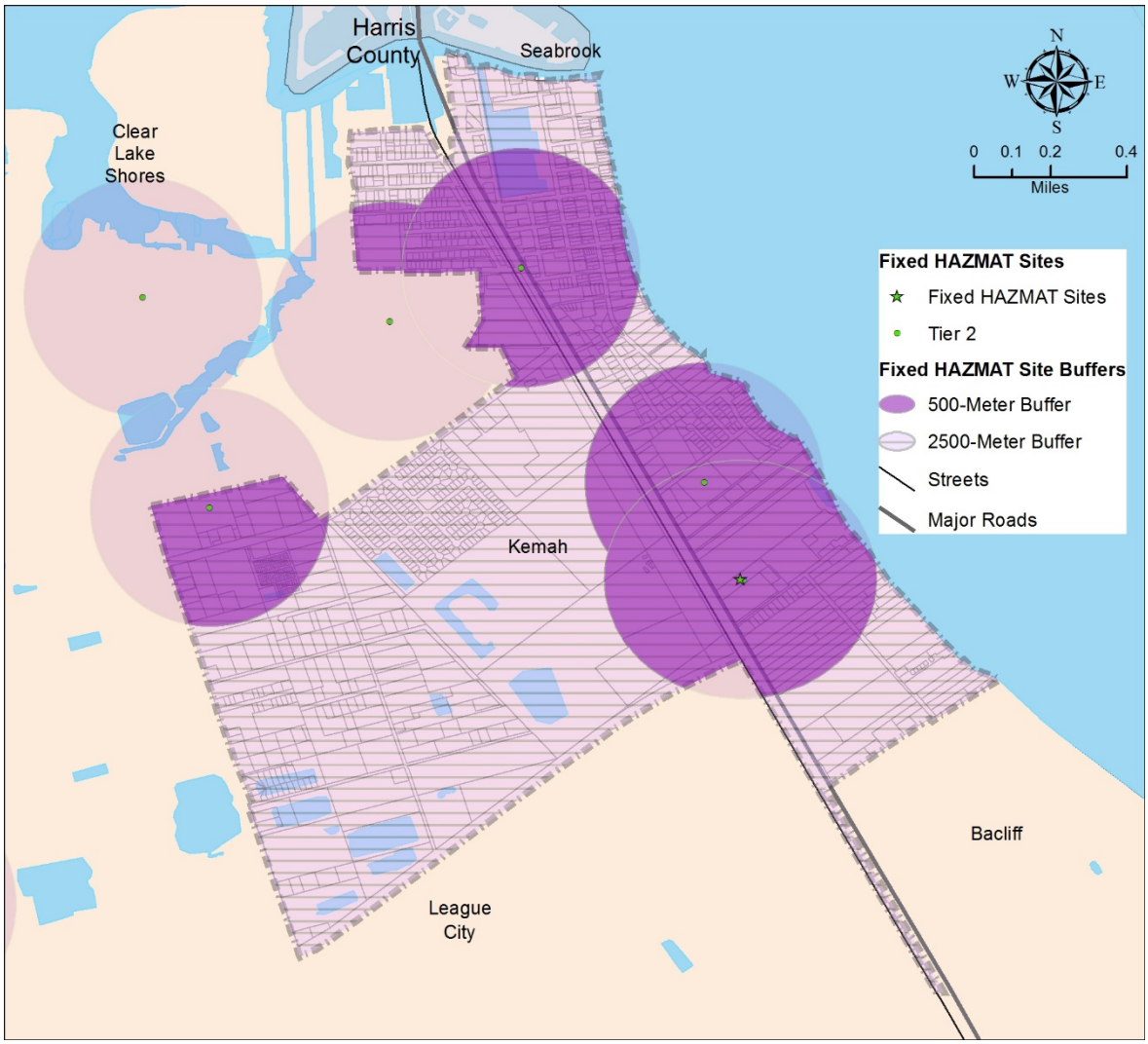


Figure 22.8: La Marque TRI and Tier 2 Facilities with Hazard Area Buffer

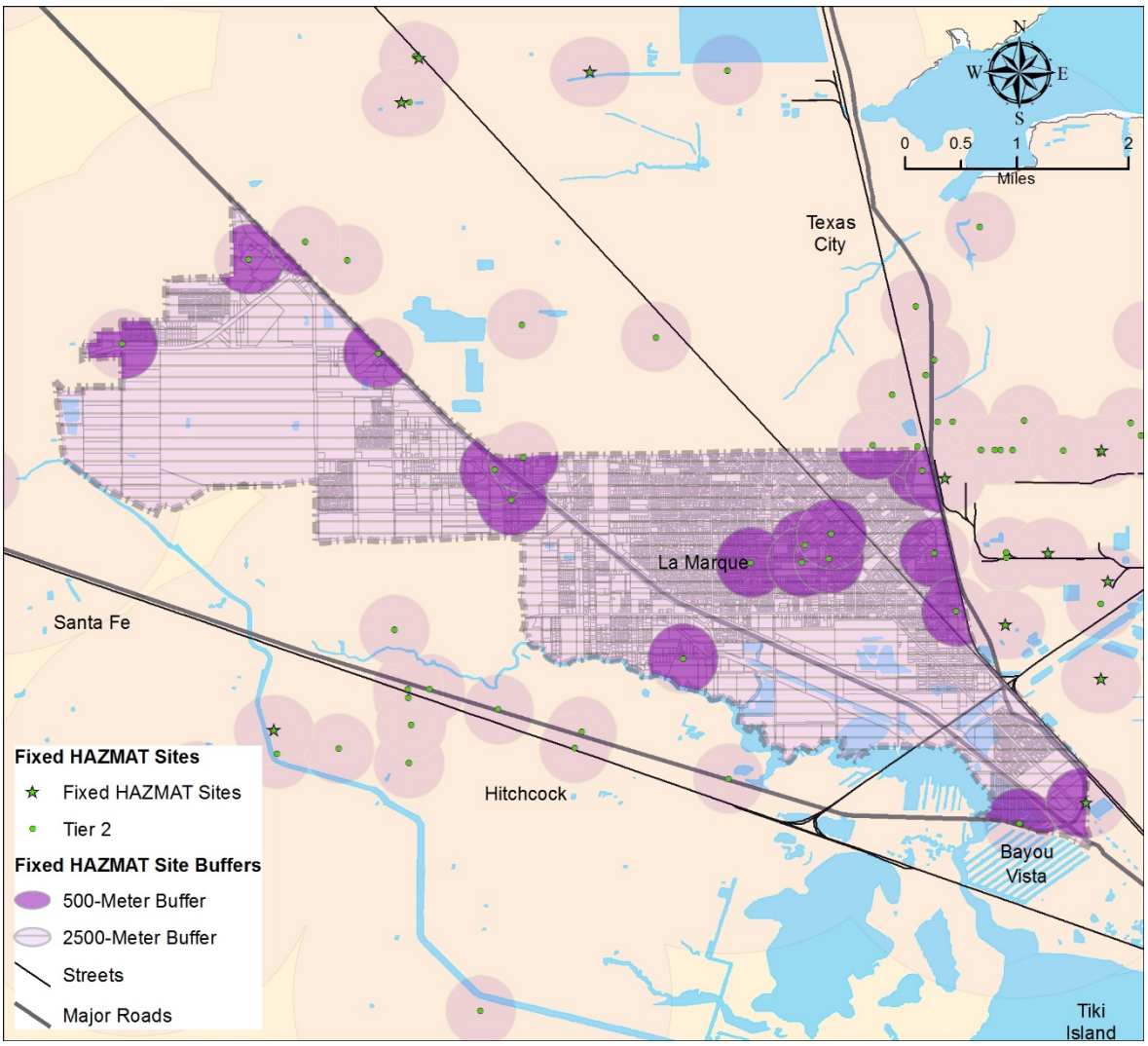


Figure 22.9: League City TRI and Tier 2 Facilities with Hazard Area Buffers

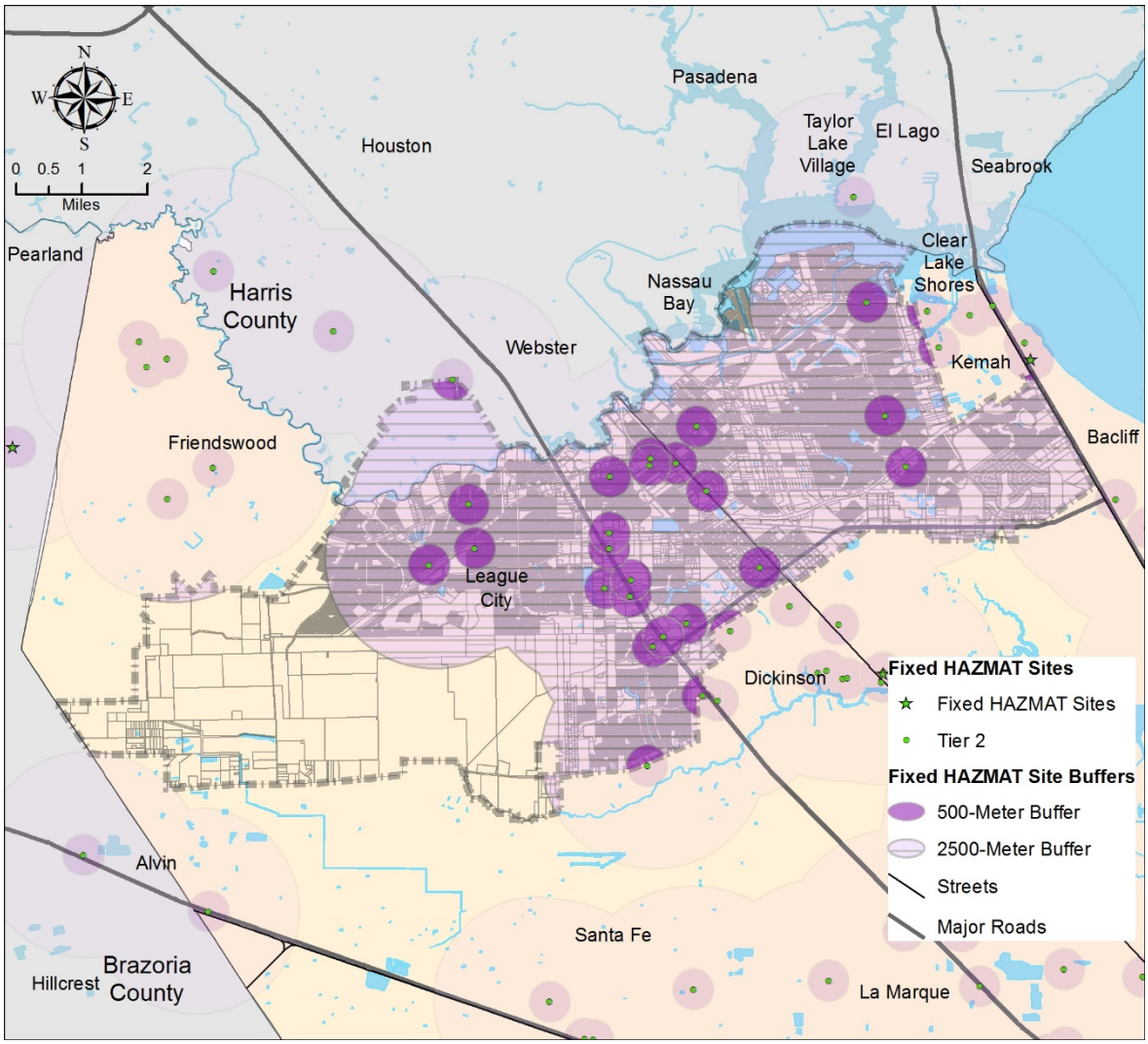


Figure 22.10: Santa Fe TRI and Tier 2 Facilities with Hazard Area Buffers

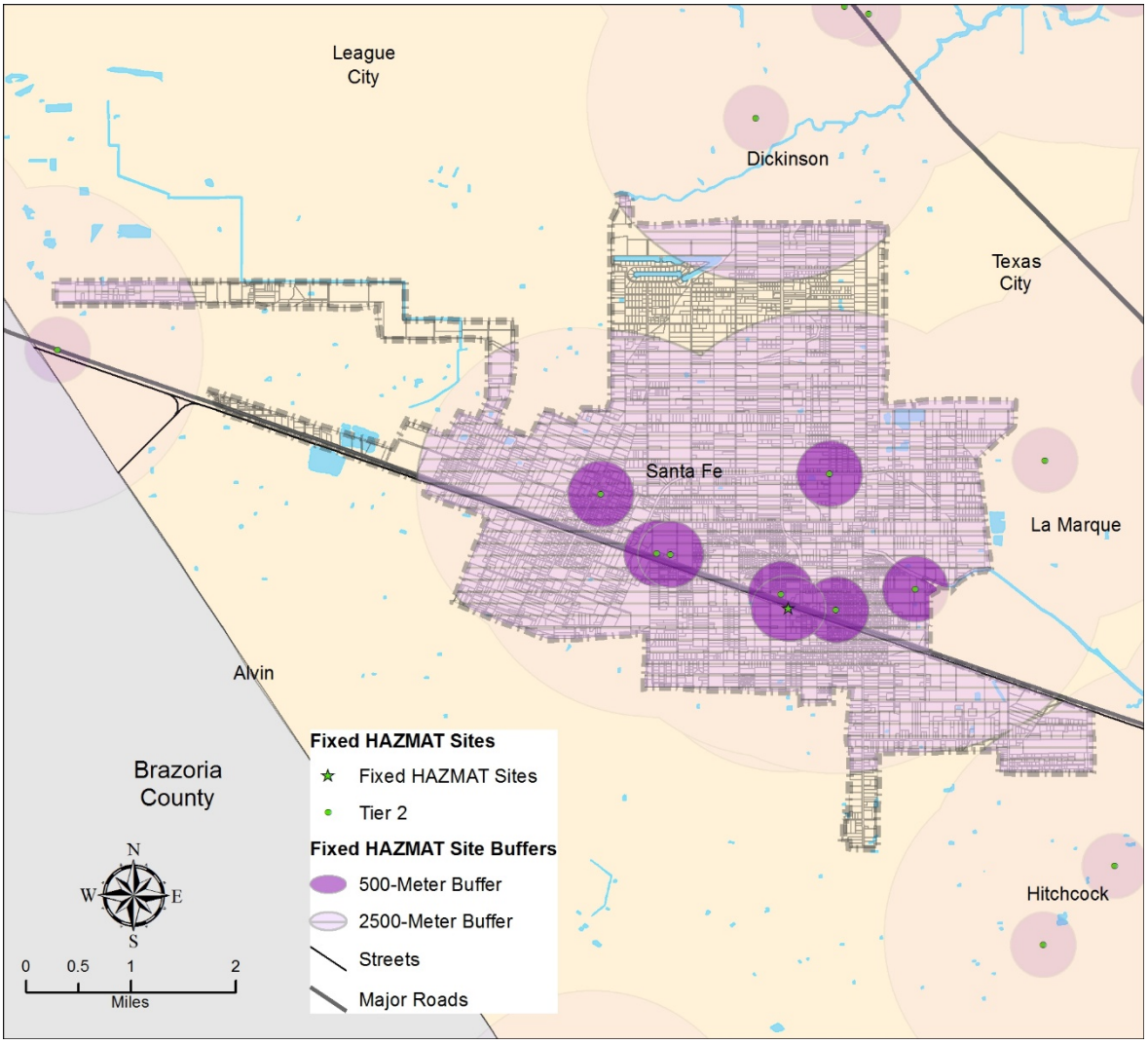
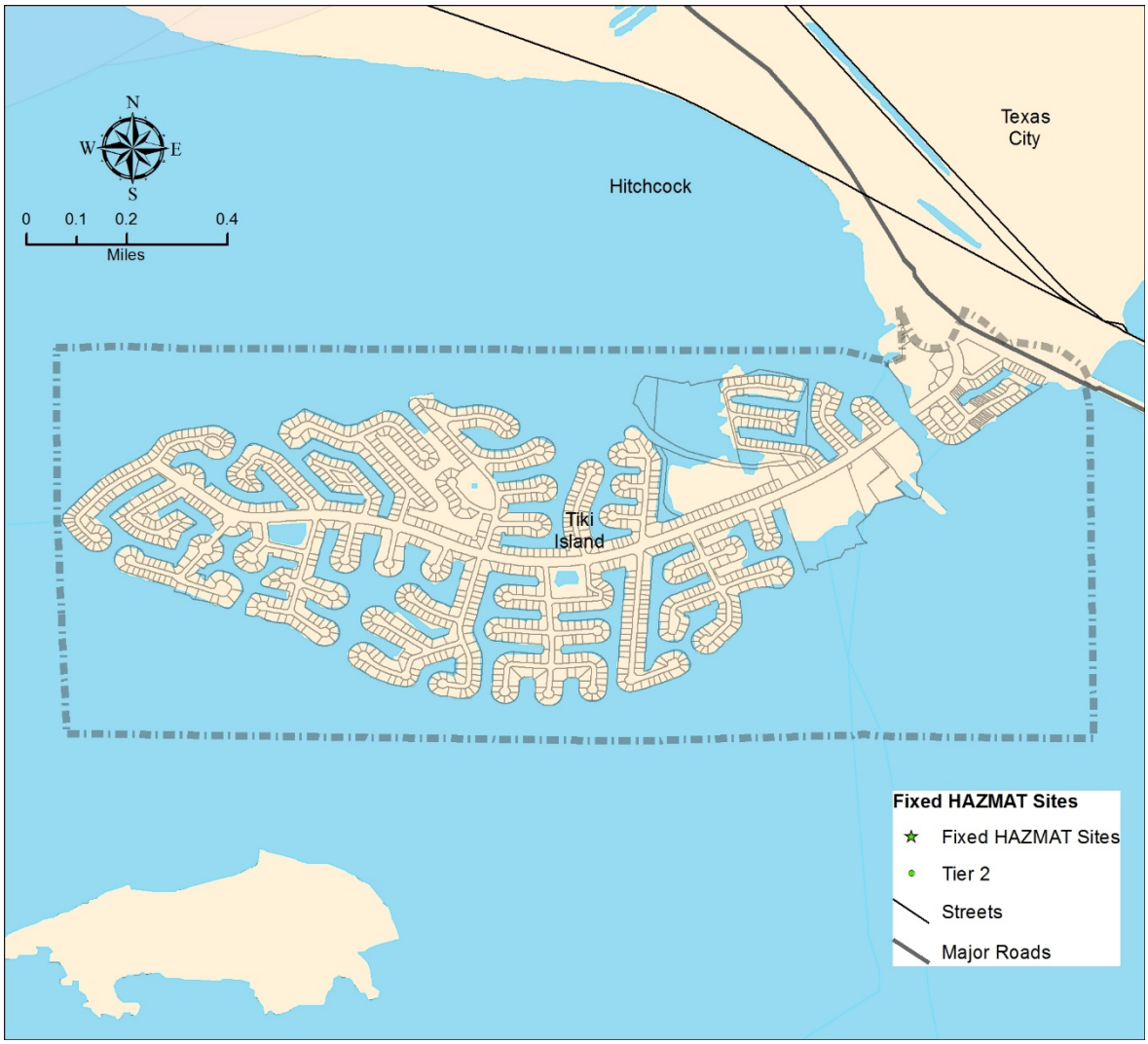


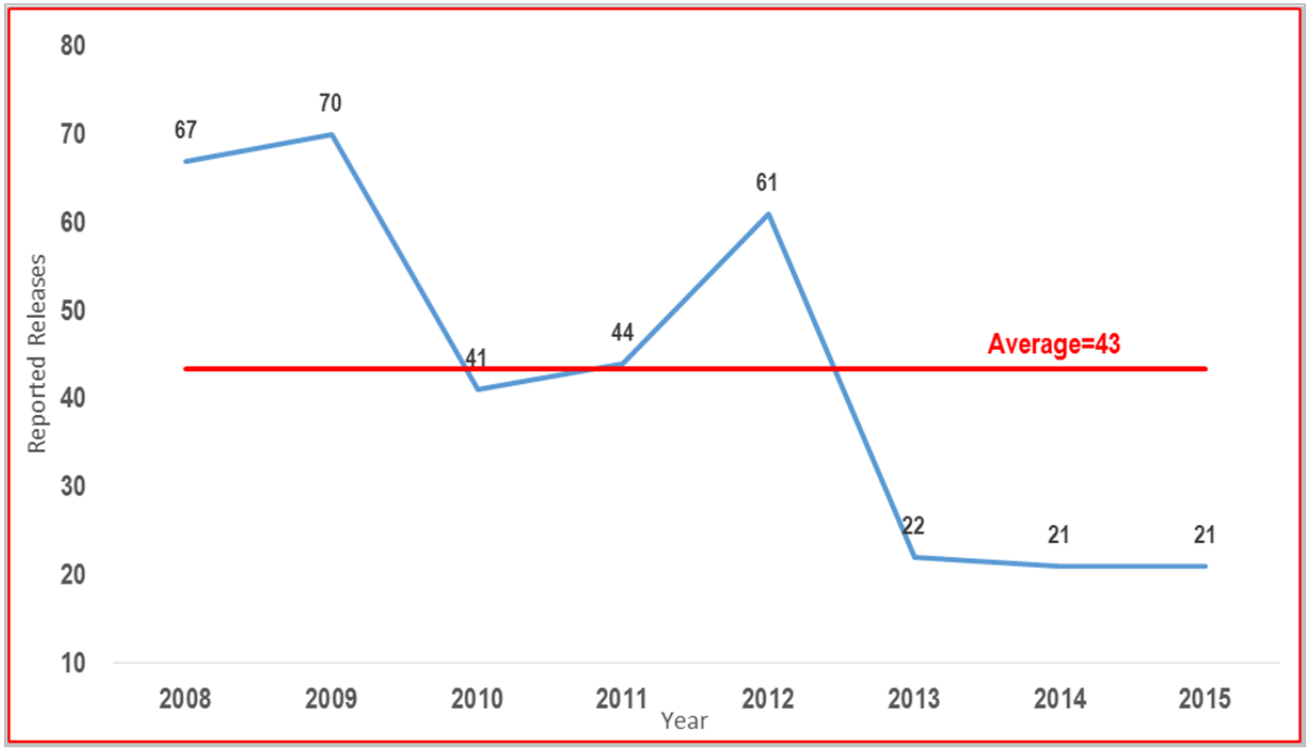
Figure 22.11: Village of Tiki Island TRI and Tier 2 Facilities



22.3 Historical Occurrences

Figure 22.12 illustrates the historical toxic release accidents in Galveston County as reported by the Texas Commission on Environmental Quality (TCEQ).

Figure 22.12: Toxic Release Accidents (2008-2015)



Source: TCEQ Reported Releases

22.4 Extent and Impact

Hazardous materials or toxic releases can have a substantial impact on communities. Such events can cause multiple deaths, completely shut down facilities for 30 days or more, and cause more than 50 percent of affected properties to be destroyed or suffer major damage. In a hazardous materials incident, solid, liquid and/or gaseous contaminants may be released from fixed or mobile containers. Weather conditions would directly affect how the hazard develops. The micro-meteorological effects on buildings and terrain can alter travel patterns and duration of agents. Shielding in the form of permanent shelter can protect people from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire and containment

features can substantially increase damage from a hazardous materials release. The duration of a hazardous materials incident can range from hours to days. Warning time is minimal to none.

22.5 Vulnerability Assessment

Table 22.1 below provides the estimated population, number of parcels, and improved value of parcels for the participating jurisdictions. This data was used to estimate the toxic release exposure of people and parcels by jurisdiction for fixed sites using census block data and is shown in Table 22.2. Refer to Figures 22.1 to 22.11 for a graphic representation of the buffer zones by jurisdiction.

Table 22.1: Estimated Exposure of People and Parcels by Jurisdiction
Fixed Site Toxic Release

Jurisdiction	Total Estimated Population	Total Estimated No. of Parcels	Improved Value of Parcels
Bayou Vista	1,537	1,324	$225,154,990
Clear Lake Shores	1,069	1,051	$243,448,194
Friendswood	26,364	10,853	$3,085,164,965
Hitchcock	6,961	6,337	$460,075,283
Jamaica Beach	983	1,590	$338,227,637
Kemah	2,906	1,221	$294,986,165
La Marque	14,543	8,972	$827,263,553
League City	82,353	35,762	$8,164,064,546
Santa Fe	12,814	6,457	$845,974,919
Tiki Island	966	1,254	$445,402,231
Galveston County Unincorporated	40,244	34,756	$2,931,109,729
Total	190,740	109,577	$17,860,872,212

Table 22.2: Estimated Exposure of People and Parcels by Jurisdiction – Highway and Rail Fixed Site Toxic Release

Jurisdiction	Immediate Impact (500 meter Buffer)			Secondary Impact (2,500 meter Buffer)		
	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	700	345	$51,759,650	1,537	1,324	$225,154,990
Clear Lake Shores	473	278	$88,570,561	1,069	1,051	$243,448,194
Friendswood	5,810	1,265	$398,315,589	25,000	10,096	$2,883,865,929
Hitchcock	4,741	2,121	$154,898,690	6,909	5,681	$362,575,698
Jamaica Beach	143	248	$85,488,362	979	1,583	$337,880,487
Kemah	2,719	669	$177,170,746	2,906	1,221	$294,986,165
La Marque	7,335	2,649	$332,783,125	14,543	8,972	$827,263,553
League City	32,395	5,982	$1,466,018,317	82,279	34,578	$7,979,752,638
Santa Fe	4,783	1,196	$169,798,020	12,027	5,825	$751,192,664
Tiki Island	0	0	$0	0	0	$0
Galveston County Unincorporated	13,187	5,692	$433,664,694	35,282	27,227	$2,313,411,254
Total	72,286	20,445	$3,358,467,754	182,531	97,558	$16,219,531,572

Source: GIS Analysis

Figures 22.13 and 22.14 illustrate the 500-meter and 2,500-meter buffers for the two components that comprise the mobile site toxic release hazard: highway and rail. While Table 22.3 shows combined results for both highway and rail, it is meaningful to map the two separately due to the proximity of the rail lines with three of the four main highways present in the study area. Primary and secondary impact distances were selected based on guidance from FEMA Publication 426 and engineering judgment. Because many sites containing hazardous materials are located in densely populated areas, there are population and structures that could be susceptible to a release from more than one site.

Figure 22.13: Mobile HAZMAT Analysis Buffers - Highway

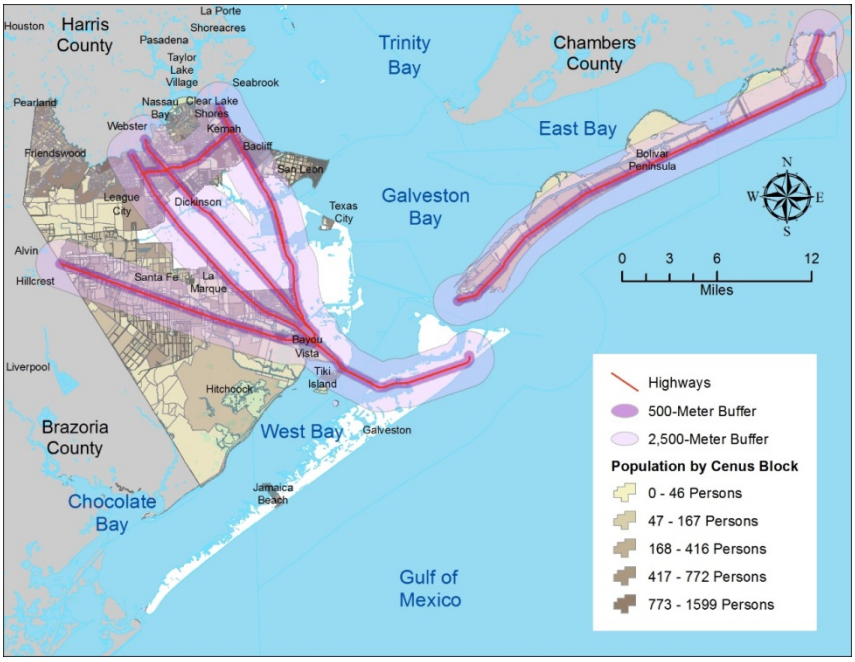


Figure 22.14: Mobile HAZMAT Analysis Buffers - Rail

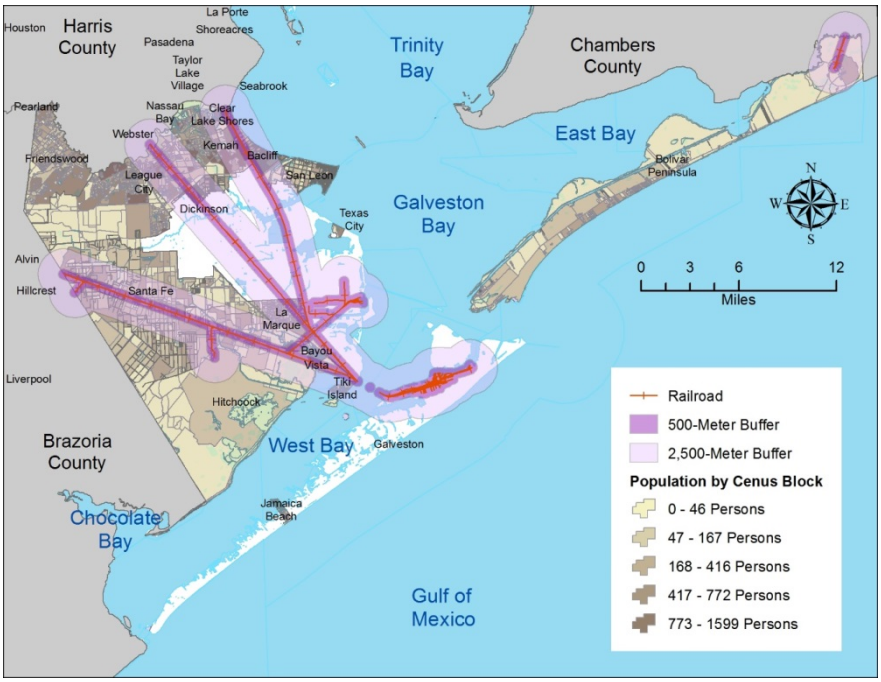


Table 22.3: Estimated Exposure of People and Parcels by Jurisdiction – Highway and Rail Mobile Toxic Release

Jurisdiction	Immediate Impact (500 meter Buffer)			Secondary Impact (2,500 meter Buffer)		
	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	1,537	1,232	$208,384,140	1,537	1,324	$225,154,990
Clear Lake Shores	42	79	$45,077,153	1,069	1,051	$243,448,194
Friendswood	0	0	$0	0	0	$0
Hitchcock	5,511	3,234	$191,425,729	6,905	5,517	$353,574,278
Jamaica Beach	0	0	$0	0	0	$0
Kemah	2,745	747	$218,752,635	2,906	1,221	$294,986,165
La Marque	8,646	4,364	$401,481,123	14,543	8,933	$825,903,743
League City	21,945	6,288	$1,634,230,356	64,213	25,119	$5,672,253,097
Santa Fe	6,776	2,060	$278,065,546	11,546	5,297	$666,302,718
Tiki Island	180	138	$32,695,768	966	1,254	$445,402,231
Galveston County Unincorporated	14,950	12,522	$933,500,405	31,120	26,537	$2,236,772,263
Total	62,332	30,664	$3,943,612,855	134,805	76,253	$10,963,797,679

Source: GIS Analysis

Figure 22.15 illustrates the areas that could be affected by a toxic release in the Gulf Intracoastal Waterway. The data provided in Table 22.4 provides the estimated exposure of people and parcels by jurisdiction for the immediate and secondary impact areas.

Figure 22.15: Mobile HAZMAT Analysis Buffers - Gulf Intracoastal Waterway

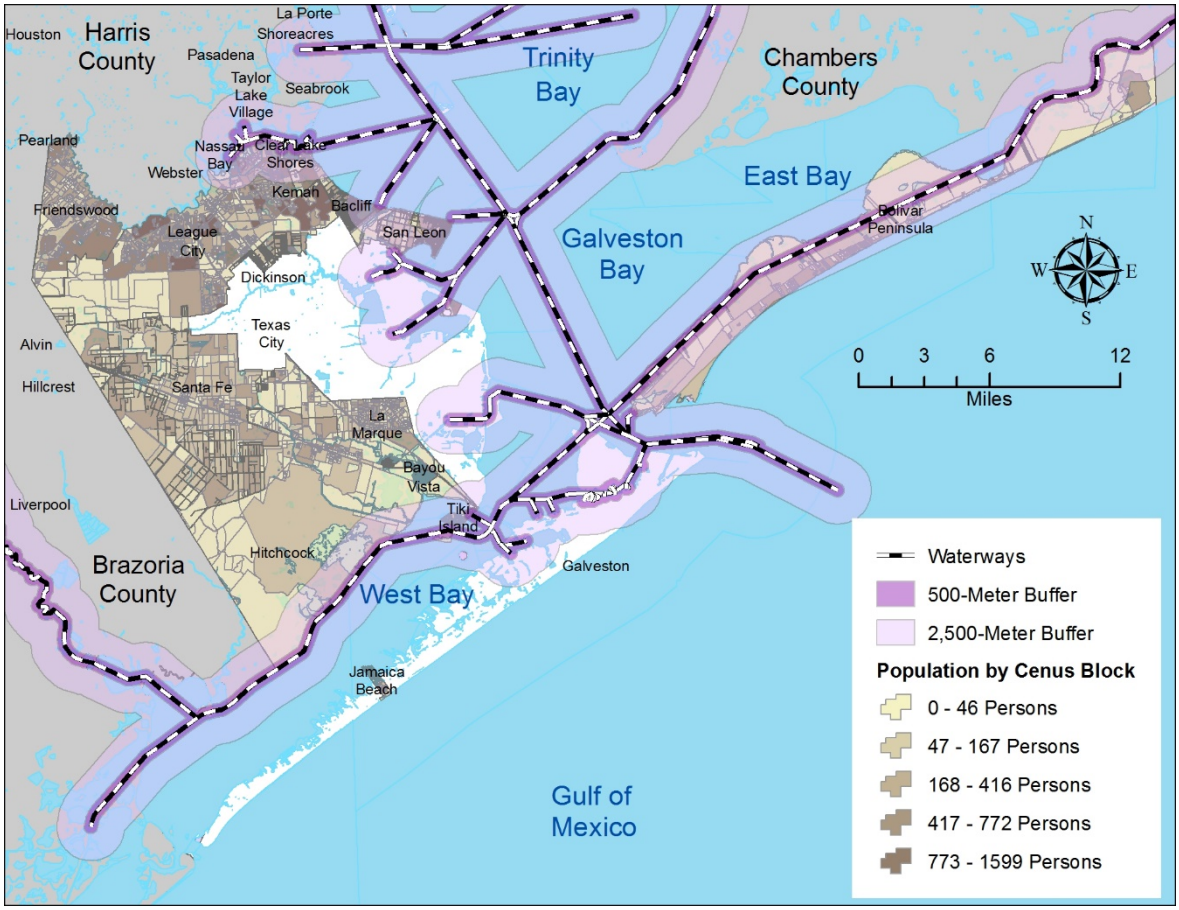


Table 22.4: Estimated Exposure of People and Parcels by Jurisdiction - Gulf Intracoastal Waterway Mobile Site Toxic Release

Jurisdiction	Immediate Impact (500 meter Buffer)			Secondary Impact (2,500 meter Buffer)		
	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk	No. of People at Risk	No. of Parcels at Risk	Value of Parcels at Risk
Bayou Vista	0	0	$0	0	0	$0
Clear Lake Shores	874	760	$154,145,703	1,069	1,051	$243,448,194
Friendswood	0	0	$0	0	0	$0
Hitchcock	153	141	$18,390,196	186	566	$90,851,331
Jamaica Beach	0	0	$0	0	0	$0
Kemah	86	165	$53,352,660	1,736	1,091	$275,293,646
La Marque	0	0	$0	0	0	$0
League City	3,351	728	$262,310,986	15,912	5,605	$1,608,185,198
Santa Fe	0	0	$0	0	0	$0
Tiki Island	220	195	$44,654,678	966	1,254	$445,402,231
Galveston County Unincorporated	2,579	2,821	$190,696,497	13,768	23,606	$1,843,423,723
Total	**7,263**	**4,810**	**$723,550,720**	**33,637**	**33,173**	**$4,506,604,323**

Source: GIS Analysis

Mitigation Strategy

Table 22.5 provides a summary of the mitigation actions identified by jurisdiction's who could be impacted by hazardous material incidents. Details for these actions are provided in Section 24.

Table 22.5: Mitigation Actions – Hazard Material Incidents

Jurisdiction	Mitigation Action 1	Mitigation Action 2
Bayou Vista	BV-2011-20: Implement a plan for minimizing damage due to pipeline breach or failure	BV-2006-1: Continue efforts on public information and awareness for all hazards
Clear Lake Shores	CLS-2011-8: Conduct mass notifications for pipeline breach or release of hazardous materials emergencies related to in-place protection and/or evacuation	CLS-2011-9: Participate in pipeline group training pertaining to responding to pipeline emergencies, evacuation, in-place protection for residents
Hitchcock	H-2011-1: Provide public awareness materials and information at community events (food bank) and city website regarding all hazards	H-2016-3: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County
Kemah	K-2006-1: Continue efforts on public information and awareness for all hazards	K-2016-5¨ Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County
La Marque	LM: 2011-19: Continue efforts on public information and awareness for all hazards	LM-2016-4: Develop Critical Infrastructure and Key Resources database (CIKR)
League City	LC-2005-9: Update local mitigation plan to include pipeline and hazardous materials incidents	LC-2016-6: Public outreach and education-all hazards
Santa Fe	SF-2016-10: Develop Critical Infrastructure and Key Resources database (CIKR)	SF-2016-16: Continue efforts on public information and awareness for all hazards
Tiki Island	TI-2011-8: Purchase new Emergency Notification System (ENS)	TI-2016-4: Continue efforts on public information and awareness for all hazards
Galveston County	GC-2006-12: Incorporate GIS system into emergency planning and operations	GC-2011-6: Continue efforts on public information and awareness for all hazards

23.0 Capability Assessment

23.1 Overview

The purpose of conducting a capability assessment is to determine the ability of the participating jurisdictions to implement a mitigation strategy.[1] As in any planning process, it is important to determine what actions are feasible, based on an understanding of those departments tasked with their implementation. More specifically, the capability assessment helps to determine what mitigation actions are practical and likely to be implemented over time given the fiscal, technical, administrative and political framework of the community. It also provides an opportunity to assess existing plans, policies and processes in place. A careful analysis was conducted to detect any existing gaps, shortfalls or weaknesses within existing government activities that could exacerbate community vulnerability. The assessment also highlights positive measures already in place, which should continue to be supported through future mitigation efforts.

23.2 Conducting the Capability Assessment

Prior to the kickoff meeting, a detailed *Capability Assessment Survey* was distributed to each participating jurisdiction. The survey was based on the Disaster Mitigation Act of 2000 which requires that local governments review and incorporate, if appropriate, existing plans, studies, reports and technical information into their hazard mitigation plans. The survey provided a list of existing local plans, policies, programs or ordinances that typically contribute to and/or hinder the ability to implement hazard mitigation actions. Other indicators included information related to each jurisdiction's fiscal, administrative and technical capabilities, such as access to local budgetary and personnel resources for mitigation purposes.

Through the review process of the Galveston County 2011-2016 plan, the planning team saw an opportunity to expand the information presented in the assessment survey to allow for a comprehensive approach in capturing more levels of each jurisdiction's capabilities. Listed below is a summary of the additional information provided in the planning and regulatory category along with a list of the new categories introduced in this plan update. Details for each category are provided throughout this section. The survey results and scoring methodology are provided in section 23.3.

[1] While the Interim Final Rule for implementing the Disaster Mitigation Act of 2000 does not require a local capability assessment to be completed for local hazard mitigation plans, we believe that it is it a critical step to develop a mitigation strategy that meets the needs of each jurisdiction while taking into account their own unique abilities. However, the Rule does state that a community's mitigation strategy should be "based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools" (44 CFR, Part 201.6(c)(3)).

- Planning and Regulatory Capability - added land use plan, community wildfire protection plan, fire department rating, site plan review, and the community rating system (Tables 23-1 and 23-2)
- Administrative and Technical Capability – new to 2016-2020 update (Table 23-3)
- Fiscal Capability – new to 2016-2020 update (Table 23-4)
- Education and Outreach – new to 2016-2020 update (Table 23-5)

Planning and Regulatory Capability

Planning and regulatory capability is based on the implementation of plans, ordinances and programs that demonstrate a local jurisdiction's commitment to guiding and managing growth, development and redevelopment in a responsible manner, while maintaining the general welfare of the community. It includes emergency response and mitigation planning, comprehensive land use planning and transportation planning, in addition to the enforcement of zoning or subdivision ordinances and building codes that regulate how land is developed and structures are built, as well as protecting environmental, historic and cultural resources in the community. These planning initiatives generally present significant opportunities to integrate hazard mitigation principles and practices into the local decision making process.

This assessment is designed to provide a general overview of the key planning and regulatory tools or programs in place or under development, along with their potential effect on loss reduction. This information will help identify opportunities to address existing gaps, weaknesses or conflicts with other initiatives in addition to integrating the implementation of this Plan with existing planning mechanisms where appropriate. Tables 23.1 and 23.2 represent the capabilities of each participating jurisdiction. Planning and regulatory capabilities indicated with a bold "**X**" have been updated or developed since the previous plan.

51 *Table 23.1: Planning Capabilities*

Jurisdiction	General Planning							Hazard/Emergency Management Planning								Floodplain Management		
	Comprehensive / Master Plan	Land Use Plan	Economic Development Plan	Historic Preservation Plan	Natural Resource Plan	Open Space Plan	Capital Improvements Plan	Hazard Mitigation Plan	Community Wildfire Protection Plan	Drought Plan/Ordinance	Emergency Operations Plan	Post Disaster Plan	Disaster Recovery Plan	Continuity of Operations Plan	Evacuation Plan	Stormwater Management /Drainage Master Plan	Floodplain Management Plan	Flood Response Plan
Galveston County	X		X	X	X	X	X	X		X	X	X	X		X	X	X	X
Bayou Vista							X	X		X	X	X			X	X	X	X
Clear Lake Shores	X	X	X			X		X			X	X	X	X	X	X	X	X
Friendswood	X	X	X			X	X	X		X	X	X	X	X	X	X		
Hitchcock								X			X		X	X	X			
Jamaica Beach	X							X			X				X		X	
Kemah		X			X			X		X	X		X	X	X	X	X	X
La Marque	X		X			X	X	X	X	X	X	X	X		X	X	X	
League City	X	X	X	X		X	X	X		X	X		X		X	X	X	X
Santa Fe	X	X	X				X				X		X			X	X	
Tiki Island	X		X				X	X			X		X		X		X	

52 *Table 23.2: Regulatory Capabilities*

Jurisdiction	Building Codes (Year)	Fire Department ISO (Rating)	Site Plan Review	Zoning Ordinance	Subdivision Regulation	Flood Damage Prevention Ordinance	National Flood Insurance Program	Community Rating System (Rating)
Galveston County				X	X	X	X	
Bayou Vista	2014	7		X	X	X	X	
Clear Lake Shores	2015	4	X	X	X	X	X	
Friendswood	2009	3	X	X	X	X	X	5
Hitchcock	2003			X	X		X	
Jamaica Beach	2012	3		X	X	X	X	
Kemah	2009	4	X	X	X	X	X	5
La Marque	2003	3		X	X	X	X	
League City	2009	3	X	X	X	X	X	6
Santa Fe	2012	5	X	X	X	X	X	
Tiki Island	2009	6	X	X	X	X	X	8

General Planning

The implementation of hazard mitigation activities often involves stakeholders beyond the emergency management profession. Stakeholders may include local planners, public works officials, economic development specialists and others. As a result, the questions asked in the Local Capability Assessment Survey regarding general planning capabilities were designed to measure the degree to which mitigation is integrated into other planning efforts. Descriptions of the plans and regulatory programs listed in the survey are provided below.

Comprehensive Plan

A comprehensive plan establishes the overall vision for a community and helps to guide municipal decision making.

Land Use Plan

A land-use plan provides a vision for the future possibilities of development in neighborhoods, districts, cities, or any defined planning area.

Capital Improvements Plan

A capital improvement plan guides the scheduling of spending on public improvements. A capital improvement plan can serve as an important mechanism to guide future development away from identified hazard areas. Limiting public spending in hazardous areas is one of the most effective long- term mitigation actions available to local governments.

Economic Development Plan

An economic development plan serves as a road map for economic development decision making, based on the collection of statistical data, historical perspective, and human potential.

Historic Preservation Plan

A historic preservation plan is intended to preserve historic structures or districts within a community. An often overlooked aspect of the historic preservation plan is the assessment of buildings and sites located in areas subject to natural hazards to include the identification of the most effective way to reduce future damages.[2] This may involve retrofitting or relocation techniques that account for the need to protect buildings that do not meet current building standards or are within a historic district that cannot easily be relocated out of a hazard-prone area.

[2] See Protecting the Past from Natural Disasters. 1989. Nelson, Carl. National Trust for Historic Preservation: Washington, D.C.

Natural Resource Protection Plans

Natural Resource Protection plans provide recommendations for how to best protect the sustainability of natural resources.

Open Space Management Plans

Open Space Management plans describe a process and recommend strategies and solutions for handling open space issues for outdoor recreational or open habitat areas of land.

Hazard/ Emergency Management Plans

Hazard mitigation is widely recognized as one of the four primary "phases" of emergency management. Other phases include preparedness, response and recovery. In reality, each phase is interconnected with hazard mitigation as Figure 23.1 suggests. Planning for each phase is a critical part of a comprehensive emergency management program and a key to the successful implementation of hazard mitigation actions. As a result, the *Local Capability Assessment Survey* asks several questions across a range of emergency management plans in order to assess the jurisdiction's willingness to plan and their level of technical proficiency.

Figure 23.1 – Emergency Management Cycle

Hazard Mitigation Plan

A hazard mitigation plan represents a community's blueprint for how they intend to reduce the impact of natural and human-caused hazards on people and the built environment. Elements of a hazard mitigation plan include a risk assessment, capability assessment and mitigation strategy.

For this plan update, the cities of Dickinson, Galveston, and Texas City opted not to participate in the county multi-jurisdictional plan update. Santa Fe has joined this planning initiative and apparently has not been included in any previous hazard mitigation plan.

Community Wildfire Protection Plan

The community wildfire protection plan is a strategic plan that identifies wild land fire issues facing the community and outlines prioritized mitigation actions. This plan is not applicable to the Galveston County planning area.

Drought Plan

A drought plan provides a framework for an integrated approach to minimize the impacts of drought on its people and resources. It outlines both long-term and short-term measures that can be used to prepare for, respond to, and mitigate the effects of drought.

Emergency Management or Operations Plan

An emergency operations plan outlines the responsibilities of those responding to an emergency or disaster and the means by which resources are deployed.

Disaster Recovery Plan

A disaster recovery plan serves to guide the physical, social, environmental and economic recovery of a community, including the physical reconstruction process following a disaster.

Continuity of Operation Plan (COOP)

A continuity of operation plan establishes a clear chain of command, line of succession, and plans for backup or alternate emergency facilities in case of an extreme emergency or disaster.

Evacuation Plan

An evacuation plan provides a planned response to and support capabilities for population protection, which include coordination, public notification, resource management and the implementation of protection actions such as evacuation, shelter-in-place, and refuge of last resort. It identifies measures bused by the community to mitigate safety issues during evacuations and assist with the repopulation of areas affected by disaster.

Floodplain Management Capability

Flooding represents the greatest natural hazard facing the nation and Galveston County. At the same time, the tools available to reduce the impacts associated with flooding are among the most developed when compared to other hazard-specific mitigation techniques.

Stormwater Management Plan

A stormwater management plan is designed to address flooding associated with stormwater runoff. The stormwater management plan is typically focused on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding.

Floodplain Management Plan

A floodplain management plan provides a framework for action regarding the corrective and preventative measures in place to reduce flood-related impacts.

Flood Response Plan

A Flood Response plan addresses future flood events in terms of proactive remediation measures to minimize flood hardships and losses.

Regulatory Programs

Zoning Ordinances

Zoning represents the means by which land use is controlled by local governments. As part of a community's police power, zoning is used to protect the public health, safety and welfare. A zoning ordinance is the mechanism through which zoning is typically implemented. Since zoning regulations enable municipal governments to limit the type and density of development, it can serve as a powerful tool when applied in identified hazard areas.

Subdivision Ordinances

A subdivision ordinance is intended to regulate the development of housing, commercial, industrial or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development.

Building Codes, Permitting and Inspections

Building codes regulate construction standards. Decisions regarding the adoption of building codes, the type of permitting process required both before and after a disaster, and the enforcement of

inspection protocols all affect the level of hazard risk faced by a community. With the exception of the county, all jurisdictions reported the enforcement of building codes.[3]

Flood Damage Prevention Ordinance

A local Flood Damage Prevention Ordinance is a tool used by counties and municipalities to regulate the type of construction that occurs in the floodplain.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) provides specific regulatory measures that enable officials to determine where and how growth occurs relevant to flood hazards. The NFIP is a voluntary program but is strongly encouraged by FEMA as a means to implement sustainable solutions.

Community Rating System (CRS)

The Community Rating System (CRS) is a voluntary program under the NFIP. The goals of the CRS are to reduce flood damages to insurable property, strengthen and support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management.

It should be noted that four communities participate in the CRS program. In 2014, Santa Fe applied for the program but was not able to attain the minimum 500 points. Despite Friendswood's effort to improve their CRS rating to 4, the grading criteria have made pursuing their goal costlier.

Administrative and Technical Capability

Administrative capability was evaluated by reviewing county and municipal staffing and the existing organizational structure found across local government to implement mitigation strategies.

Technical capability can be defined as possessing the skills and tools needed to improve decision-making, including the development of sound mitigation actions. Technical capability can be measured across three primary elements: 1) geographic information systems (GIS) and database management; 2) grants management; and 3) professional and knowledge-based staff.

The analysis of the responses to the capability assessment survey indicated that the administrative and technical capabilities for the majority of the jurisdictions are adequate.

Table 23.3 provides a summary of the Administrative and Technical capabilities.

[3] Counties do not have the authority to adopt building codes, unless needed for fire safety for certain public and commercial buildings (See Chapter 233, Section 233.032 of the Texas Local Government Code).

Table 23.3: Administrative and Technical Capabilities

Jurisdiction	Planning Commission	Participation in Emergency Management Committee (LEPC or other)	Maintenance program to reduce risk (i.e., tree trimming, clearing drainage systems)	Mutual Aid Compacts	Building Inspection Department	Floodplain Manager	Emergency Manager	Community Planner	Civil Engineer	GIS Coordinator	Warning Systems / Services (i.e., reverse 911 / outdoor warning systems)	Grant Writing Capabilities
Galveston County		X	X	X	X	X	X		X	X		X
Bayou Vista		X	X	X	X		X		X*		X	X
Clear Lake Shores	X	X	X	X	X	X	X	X			X	X
Friendswood	X	X	X	X	X	X	X	X	X	X*	X	X*
Hitchcock					X	X	X					
Jamaica Beach	X			X	X	X	X				X	
Kemah		X	X	X	X		X	X			X	X
La Marque	X	X	X	X	X	X	X	X	X*	X*	X	X*
League City	X	X	X	X	X	X	X	X	X	X	X	X
Santa Fe	X	X	X	X	X	X	X	X				
Tiki Island	X	X	X	X	X	X	X	X			X	

Note: *Contracted services

Fiscal Capability

The ability to take action is often closely associated with the amount of money available to implement policies and projects. This may take the form of grants received or state and locally based revenue. The cost associated with the mitigation policy and project implementation varies widely. In some cases, policies are tied primarily to staff time or administrative costs associated with the creation and monitoring of a given program. In other cases, direct expenses are linked to an actual project, such as the acquisition of flood-prone homes, which can require a substantial commitment from local, state, and federal funding sources. A discussion of potential funding sources relevant to mitigation projects and activities are presented in Section 25 – Mitigation Strategies.

The analysis of the responses to the capability assessment survey indicated that there is a moderate fiscal capability at the county and larger municipal levels while smaller communities are limited financially.

Recommendation: When considering the effect of fiscal capability on the implementation of policies and projects, jurisdictions should ask themselves the following questions:

- Does this action require monetary commitment or staff resources?
- Can we combine resources with other counties, municipalities, or other agencies to address identified problems?
- Are we willing to commit local revenue on a sustained or a one-time basis action?

Table 23.4 provides a summary of the results of the Fiscal Capabilities.

Table 23.4: Fiscal Capabilities

Jurisdiction	Capital Improvements Project Funding	Authority to levy taxes for specific purposes	Fees for water, sewer, gas, or electric services	Impact fees for new development	Stormwater utility fee	Incur debt through general obligation bonds or tax bonds	Incur debt through private activities	Community Development Block Grant (CDBG)	Other federal funding programs	State funding programs
Galveston County		X	X		X			X	X	X
Bayou Vista	X	X							X	X
Clear Lake Shores	X					X		X	X	X
Friendswood	X	X	X	X		X			X	
Hitchcock			X					X		
Jamaica Beach						X		X		
Kemah										
La Marque	X	X	X			X		X	X	X
League City	X	X	X	X		X	X	X	X	X
Santa Fe	X	X				X		X		
Tiki Island						X		X	X	

Education and Outreach Capability

This type of local capability refers to education and outreach programs and methods already in place that could be used to implement mitigation activities and communicate hazard–related information. Examples include natural disaster or safety-related school programs, participation in community programs such as StormReady; and activities conducted as part of hazard awareness campaigns such as private/public partnership meetings to discuss disaster preparedness.

The analysis of the responses to the capability assessment survey indicated that there is a moderate fiscal capability at the county and larger municipal levels while the small communities are somewhat limited and tend to rely on the county to provide outreach and educational programs and timely information to their residents.

Table 23.5 provides a summary of the Education and Outreach Capabilities.

Table 23.5: Education and Outreach Capabilities

Jurisdiction	Local citizen groups or non-profit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Ongoing public education or information programs (e.g. responsible water use, fire safety, household preparedness, environmental education)	Natural disaster or safety-related school programs	StormReady® Certification	Firewise Community Certification	Public / Private partnership initiatives addressing disaster-related issues
Galveston County	X	X	X	X		X
Bayou Vista	X	X				
Clear Lake Shores	X	X				X
Friendswood	X	X	X	X		X
Hitchcock						
Jamaica Beach		X		X		X
Kemah						
La Marque		X	X			
League City		X	X			X
Santa Fe						
Tiki Island	X	X				X

23.3 Conclusions

In order to form an assessment of local capabilities, a quantitative scoring methodology was designed and applied to the results of the assessment survey. A point system was established to provide an overall ranking of limited, moderate, and high. Each capability provided by the jurisdiction received a scoring value of 1 with an additional point given to community's whose building codes are 2008 and greater, fire department rating is greater than 6, and they participate in the CRS program.

Table 23.6 shows the results of the Capability Assessment using the designed scoring methodology based on a maximum point value of 57 as defined below.

- High – score of 57 to 38
- Moderate – score of 37 to 18
- Limited – score of 17 to 0

Table 23.6: Results of Capability Assessment by Jurisdiction

Jurisdiction	Planning / Regulatory	Administrative / Technical	Fiscal	Education and Outreach	Overall Capability	Rating
	Maximum Point Value					
	29	12	10	6	57	
Galveston County	22	9	6	5	42	High
Bayou Vista	16	8	4	2	30	Moderate
Clear Lake Shores	22	10	5	3	40	High
Friendswood	24	12	6	5	47	High
Hitchcock	8	3	2	0	13	Limited
Jamaica Beach	13	6	2	1	22	Moderate
Kemah	22	8	0	0	30	Moderate
La Marque	20	12	7	2	41	High
League City	25	12	9	3	49	High
Santa Fe	15	8	4	0	27	Moderate
Tiki Island	19	9	3	3	34	Moderate

24.0 Mitigation Strategy

The mitigation strategy section of the previously approved Galveston County 2011-2016 plan has been restructured to coordinate the information for mitigation goals, an update on the mitigation actions from previous planning cycle, and a listing of the current mitigation actions.

24.1 Update on Previous Plan's Mitigation Actions

Prior to the kick off meeting, a listing of the mitigation actions identified in the previous plans for each jurisdiction were sent to their designated GCHMC member to review the progress made with their respective officials. A project status category was selected based on the following definitions:

- Ongoing – Actions that are continually implemented as appropriate by the jurisdiction.
- In Progress – Actions that are currently being implemented but are not yet complete.
- Delayed – Actions that were not able to be implemented due to various issues such as funding constraints, lack of support, construction delays, etc.
- No longer required – Actions that cannot be implemented for various reasons such as outside of their capabilities, issues no longer relevant, etc.
- Completed – Actions that have been satisfied according to the description provided. The completion date is also noted.

The actions categorized as ongoing, in progress, and delayed are included with details in Section 24.3 Mitigation Action Plans - 2016 to 2020.

Tables 24.1 to 24.10 provide a summary by jurisdiction of the accomplishments made on the mitigation actions plans identified in the previous plan.

Previous Mitigation Action Table Reference

Jurisdiction	*Table Number*	*Page Number*
Galveston County	*24.1*	*24-2*
Bayou Vista	*24.2*	*24-5*
Clear Lake Shores	*24.3*	*24-7*
Friendswood	*24.4*	*24-9*
Hitchcock	*24.5*	*24-16*

Jurisdiction	*Table Number*	*Page Number*
Jamaica Beach	*24.6*	*24-19*
Kemah	*24.7*	*24-20*
La Marque	*24.8*	*24-22*
League City	*24.9*	*24-24*
Tiki Village	*24.10*	*24-26*

*Santa Fe was not a part of the previous Galveston County plan and therefore there are no previous mitigation actions to report on.

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Table 24.1: Galveston County

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
Galv. Co (Past Action) 3: Remove exposed concrete and rebar on 60 miles of public beach					X	2011	
Galv. Co (Past Action) 7: Implement aggressive beach nourishment program to address critical erosion areas				X			This action is outside of the authority of the County.
Galv. Co (Past Action) 8: Elevate coastal Roadway (Hwy. 87) to ease evacuation and reduce damages					X	2011	
Galv. Co (Past Action) 11: Develop Debris Management Plan					X	2014	
Galv. Co (Past Action) 12: Incorporate GIS System into emergency planning and operations	X						
Galv. Co (Past Action) 13: Join the Community Rating System (CRS)				X			Unable to fulfill the requirements for participating in the CRS program
Galv. Co (Past Action) 14: Evaluate areas with limited evacuation capacity and pursue improvements					X	2015	
Galv. Co-1: Develop a comprehensive drainage plan for unincorporated areas to mitigate flooding that occurs due to flat terrain					X	2012	
Galv. Co-2: Conduct dune restoration projects o Bolivar Peninsula for CBRA and non-CBRA areas				X			This action is outside of the authority of the County.
Galv. Co-3: Routinely clear debris including tree limbs from drainage and roadside ditches deposited by weather events such as hurricane, winter storm, flood and tornado - unincorporated areas of county	X						
Galv. Co 4: Determine locations of special needs population and develop an evacuation plan for urban fire. Once plan is approved notify affected facilities and the public of the plan process and procedures involving a disaster. unincorporated areas of county					X	2011	

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
Galv. Co. 5: Develop procedures including chain of command and responsible parties to carry out NIMS guidelines on specific group/persons responsible for implementing alarm systems or specifying alternate shelter locations during a disaster. Document these guidelines in an emergency operations plan - unincorporated areas of county					X	2013	
Galv. Co 6: Disseminate information to the public on drought, extreme heat tornado Wildfire, and other safety and health issues. - unincorporated areas of county	X						
Galv. Co 7: Construct parallel break waters. Bolivar Peninsula in the non-CBRA zones				X			This action is outside of the authority and capability of the County.
Galv. Co 8: Meet National Weather Service (NWS) criteria and apply to be designated as Storm Ready County and Storm Ready Communities					X	2015	
Galv. Co 9: Design and construct a multi-purpose EMS facility for Crystal Beach and High Island area residents		X					
Galv. Co 10: Harden critical facilities by purchasing equipment and installing emergency backup power at Bayview Municipal Utility District lift stations, operations center, and wastewater treatment facility		X					
Galv. Co 11: Determine locations of special needs population and develop an evacuation plan. Once plan is approved notify affected facilities and the public of the plan process and procedures involving a disaster.					X	2011	
Galv. Co 12: Disseminate information to the public on safety issues and health concerns for extreme heat as it affects the elderly and those that work outdoors.				X			Combined with Action GC-2011-6
Galv. Co 13: Disseminate information to the public on drought, water conservation tips during drought, and xeriscape landscaping plants.				X			Combined with Action GC-2011-6
Galv. Co. 14: Install emergency generator at Bayview Municipal Utility District lift stations, operations center, and wastewater treatment facility					X	2012	

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
Galv. Co. 15: Routinely clear debris including tree limbs from drainage and roadside ditches deposited by weather events such as tornado.				X			Combined with action GC-2011-3
Galv. Co 16: Routinely clear debris including tree limbs from drainage and roadside ditches deposited by weather events such as hailstorm.				X			Combined with action GC-2011-3
Galv. Co 17: Develop procedures including chain of command and responsible parties to carry out NIMS guidelines on specific group/persons responsible for implementing alarm systems or specifying alternate shelter locations during a disaster. Document these guidelines in an emergency operations plan					X	2013	
Galv. Co 18: Routinely clear debris including tree limbs from drainage and roadside ditches deposited by weather events such as hurricane wind				X			Combined with action GC-2011-3
Galv. Co 19: Disseminate information to the public on drought, including ways to reduce and conserve water, protect pets, and landscaping for drought-resistant plants.				X			Combined with Action GC-2011-6
Galv. Co 20: Provide residents and business owners in vicinity of the existing levee system information regarding evacuation routes and procedures in the event of a levee breach				X			Galveston County maintains levee but cities notify their citizens on updates
Galv. Co 21: Initiate a new Corp of Engineers study of the Texas City Hurricane Flood Protection Project to improve the current levee system to provide protection from a Category 5 storm.		X					
Galv. Co 22: Provide residents and business owners in vicinity of the existing levee system information regarding the availability of NFIP flood insurance				X			This action is outside of the authority and capability of the County.
Galv. Co 23: Develop procedures for mass notification of citizens and merchants to development of winter storms possibilities					X	2012	
Galv. Co 24: Develop a drought contingency plan					X	2012	

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Table 24.2: Bayou Vista

Action	Ongoing	In Progress	Relayed	No Longer Required	Completed	Completion Date	Comment
BV (Past Action) 1: Provide website information to citizens regarding weather alerts and departmental phone listings with personnel contact information	X						
BV (Past Action) 2: Conduct outreach efforts, including Hurricane and Disaster Awareness Booths at the city fair and other public events				X			Combined with BV-2006-1
BV (Past Action) 3: Conduct town meetings to inform citizens and city officials of the procedures for disaster preparedness, mitigation, and recovery.				X			Combined with BV-2006-1
BV 1: Purchase and install generators:18 KW (NG) Aluminum/Automatic Transfer Switch-(Guardian) to protect the submersible lift station pumps by elevating the lift station roof, electric control panels, and lift station well to 7 feet through the use of a generator secured above a higher flood level. At the following lift stations: Pompano, Bonita, Omega Bay, Lakeside, Bayou Vista					X	2009	
BV 2: Purchase and install Natural Gas Generators-3 Phase w/V10 engine 130 KW for Water Plant 3035 Highway 6					X	2009	
BV 3: Purchase and install Natural Gas Generators-3 Phase w/V10 engine 150 KW Wastewater Plant 3031 Highway 6					X	2009	
BV 4: Implement drainage improvement program to reduce standing water and runoff, and reduce minor flooding for residents located in District No.12			X				Pending funding
BV 5: Install fire danger rating/burn ban signs				X			Not applicable to the area. Uncertain why this was included in previous plan
BV 6: Implement Stormwater management plan to improve drainage during flood and other weather events; clean and repair storm sewer system			X				Pending funding
BV 7: Develop Master Drainage Plan to assist in reducing flooding through increased lowest finish floor requirements			X				Pending funding

Action	Ongoing	In Progress	Relayed	No Longer Required	Completed	Completion Date	Comment
BV 8: Reconstruct storm sewers system and upgrade existing storm sewer system			X				Pending funding
BV 9: Implement water conservation measures	X						
BV 10: Upgrade existing storm sewer construction projects to mitigate flood-related impacts such as tsunami				X			This action is included in BV-2011-8
BV 11: Implement best management practices for securing windblown debris in canals as part of an ongoing Canal Debris Management Plan.	X						
BV 12: Develop and implement a plan for canal dredging to reduce sediment deposited during storm events, reducing access in canals	X						
BV 13: Repair, upgrade or replace Water and Sewer infrastructure for 175 connections as needed in original Bayou Vista area	X						
BV 14: Construct new 12"-10"-8" water lines and 10 additional fire hydrants				X			Not feasible
BV 15: Implement water conservation awareness campaign for residents	X						
BV 16: Install a deflective shield over two (2) clarifiers Wastewater Treatment Plant 3031 Highway 6			X				Pending funding
BV 17: Implement a plan for shutting down water and sewer system during fire events Wastewater Treatment Plant 3031 Highway 6	X						
BV 18: Secure funding to construct a barn to house and protect tractors, and other large equipment and sewer machine Wastewater Treatment Plant 3031 Highway 6					X	2009	
BV 19: Implement a plan for the hardening the water system during freeze events Water Plant 3035 Highway 6	X						
BV 20: Implement a plan for minimizing damage due to pipeline breach or failure	X						
BV 21: Identify and implement all public buildings and critical facilities for floodproofing and hardening needs			X				Pending funding

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Table 24.3: Clear Lake Shores

Action	Ongoing	In Progress	Relayed	No Longer Required	Completed	Completion Date	Comment
CLS (Past Action) 2: Implement stormwater management practices	X						
CLS 1: Promote awareness and implement mass notification system of dam flooding due to failure of flood gates to open - Harris County Flood Dam Gate in Seabrook, TX				X			Restructured under action CLS-2016-1.
CLS 2: Review drought plan with local water district WCID 12 and implement a plan to address drought	X						
CLS 3: Implement a program of mass notification in the event of a Wildfire through the City's website or telephone alert system.				X			Wildfires are not applicable to Clear Lake Shores
CLS 4: Educate and alert citizens on the dangers of flooding. Inform residents of the benefits of the National Flood Insurance Program and purchase of flood insurance	X						
CLS 5: Repair bridge footings - Clear Lake Road Bridge					X	2010	
CLS 6: Purchase Storm shutters for public buildings (community clubhouse)					X	2010	
CLS 7: Work with the National Weather Service to promote safety from weather related threats to local schools				X			There are no schools in Clear Lake Shores
CLS 8: Conduct mass notification for pipeline breach or release of hazardous materials emergencies related to in-place protection and/or evacuation	X						
CLS 9: Participate in pipeline group training pertaining to responding to pipeline emergencies, evacuation, in-place protection of residents	X						
CLS 10: Develop a Wildfire contingency plan				X			Wildfires are not applicable to Clear Lake Shores
CLS 11: Adopt routine fire hydrant program to update or replace old or inoperable fire hydrants				X			Clear Lake Shores does not own any hydrants. These are maintained by Kemah Fire Dept.

Action	Ongoing	In Progress	Relayed	No Longer Required	Completed	Completion Date	Comment
CLS 12: Develop mass notification system to warn citizens of threat of a severe winters storm					X	UNK	Notification systems have been in place-date of implementation is not known. Restructured under action CLS-2016-1 to address notification procedures
CLS 13: Develop and implement the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS) program to citizens, conduct meetings to explain voluntary position and sign up residents to become official observers					X	UNK	Notification systems have been in place-date of implementation is not known. Restructured under action CLS-2016-1 to address notification procedures
CLS 14: Apply for grant assistance in establishing an independent Building Inspector position					X	UNK	The city has had a building inspector – uncertain why this action was created.
CLS 15: Develop mutual aid agreement with Harris County Flood Control to strengthen the flood gate operation. Harris County Flood Control gate in Seabrook, Texas				X			Uncertain why this action was created – not applicable
CLS 16: Review current building codes and periodically review code and update accordingly	X						2015 IBC adopted January 2016
CLS 17: Review drought plan with local water district WCID 12 and implement a plan to address water conservation measures	X						
CLS 18: Implement a public awareness plan to address extreme temperature with emphasis on health and safety issues for the elderly that may not have air conditioning and those that work outdoors				X			Restructured under action CLS-2016-1 to address notification procedures
CLS 19: Work with the National Weather Service to promote safety from weather related threats to local schools				X			No Schools in Clear Lake Shores

UNK = Unknown date

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Table 24.4: Friendswood

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
F-2009-1: COMMUNITY RATING SYSTEM RECERTIFICATION (2003 AND 2009 MITIGATION PLANS) FLOOD EVENTS – FLOOD PLAIN MANAGEMENT							
• Maintain current CRS Rating of 5	X						CRS Rating was downgraded in Summer of 2015 to a CRS Rating of 7.
• Conduct activities to obtain CRS Rating of 4	X						CRS Rating was downgraded in Summer of 2015 to a CRS Rating of 7.
• Review/Update city's floodplain regulations/ordinances as appropriate.	X						
• Review/update city's Regional Drainage Plan	X						
• Coordinate/cooperate with Harris County Flood Control District and USACE with regard to Clear Creek Federal Flood Protection Project.	X						
• Require elevation certificates on all construction plans submitted for development.	X						
• Maintain annual progress records of all repetitive loss properties.	X						All RL/SRL properties are maintained in a database in-house, and verified against NFIP/FEMA records on a routine basis.
• Continue adherence to the open space requirements	X						
• Continue annual outreach projects for structures located within the SFHA	X						
• Continue to implement the drainage system maintenance program.	X						
• Continue to encourage residents participate in the NFIP	X						
MASTER DRAINAGE PLAN (2003 AND 2009 MITIGATION PLANS) FLOOD EVENTS – FLOOD PLAIN MANAGEMENT							
• Sun Meadow Relief Storm Sewer, Phase I & II					X	2005	
• Mission Estates Outfall					X	2006	
• Melody Lane/Willowick Projects, Phase II					X	2006	Coordination with GCCDD (Wegner Ditch – Tributary 2)

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
• Annalea/Whitehall/Kings Park Drainage – Phase I					X	2004	
• Clover Acres Drainage					X	2007	
• FM 518 Drainage, Phase I					X	2010	
• Glenshannon Drainage, Phase I					X	2008	
• West Shadow Bend/Woodlawn, Drainage Phase I					X	2004	
F-2009-2: ELEVATION, RELOCATION & ACQUISITION DATABASE MAINTENANCE (2003 & 2009 MITIGATION PLANS) FLOOD EVENTS – FLOOD PLAIN MANAGEMENT							
• Maintain Base Flood Elevations (BFE) on the remaining 181 properties	X						14 properties mitigated 2013-2014
• Research funding sources to assist property owners with elevation, relocation and/or buyout of repetitive loss properties	X						
F-2009-3: PUBLIC WARNING SYSTEM (2003 AND 2009 MITIGATION PLANS) SEVERE THUNDERSTORM/HAIL/LIGHTNING							
• First Call Notification System	X						
• Harris County Neighborhood Early Warning System (NEWS)	X						
• Friendswood Information Radio 1650 AM	X						
• KTRH 740 AM	X						
• TV – City of Friendswood PEG Channel 17	X						
• E-mail Alerts	X						
• Outdoor Warning Siren System	X						
• Storm Spotters	X						
UPGRADE PUBLIC WATER SYSTEM (2003 AND 2009 MITIGATION PLANS) SEVERE THUNDERSTORM/HAIL/LIGHTNING							
• **WATER PLANT #1 – REHABILITATION** ✓ Sandblasting & painting of both ground storage tanks ✓ Minor equipment repairs & replacement					X	2012	2009-2013 CIP

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
• **WATER PLANT #2 – REHABILITATION** ✓ Replacement of control room, chemical room, conversion of pumps and ground storage tank ✓ Replace all vales and piping as necessary ✓ Replace fencing surrounding the tank	X						2009-2013 CIP
• **WATER PLANT #5 – REHABILITATION** ✓ Replaced elevated tank & ground storage tanks with concrete tanks ✓ Installed emergency generator ✓ Increase storage capacity					X	2013	2009-2013 CIP
• **WATER PLANT #6 – REHABILITATION** ✓ Installed 500,000 gallon steel water tank & new pump house ✓ Installed emergency generator					X	2014	2009-2013 CIP
• **WATER WELL #7 -REHABILITATION** ✓ Replacement of control room, chemical room, conversion of pumps and ground water storage ✓ Replace all values/piping as necessary ✓ Replace existing 210,000 tank with 500,000 gallon steel unit					X	2014	2009-2013 CIP
• Purchased additional 6 MGD surface water from City of Houston					X	2013	Cost $16,250,000
• Added 30 fire hydrants					X	2014	
• Installed PVC transmission lines to replace large sections of old water lines; strategic connections and increased certain line sizes to improve pressure and water quality					X	2009	
DEVELOP CONTINUITY OF OPERATIONS PLANS FOR CRITICAL FACILITIES **SEVERE THUNDERSTORM/HAIL/LIGHTNING**							

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
• Lift Station #2 – Rehabilitation Project ✓ Replacement of control room, chemical room, conversion of pumps & probable replacement of ground storage tank. ✓ Replacement of valves & piping as necessary ✓ Replace existing fence					X	2009	2009-2013 CIP
• Surface Water Station #2 ✓ Auxiliary Power supply					X	2012	2009-2013 CIP
• Blackhawk Regional Treatment Plant rehabilitation and generator				X			Reorganization of authority
• Install/provide back-up generator to maintain operations at all city lift stations • Install/provide back-up generator to maintain operations of water wells					X	2012	• 35 lift stations and 8 surface water stations have natural gas back-up generators installed. • CDBG funding was utilized following Hurricane Ike, 2008
• Lift station #27 and Blackhawk Regional Treatment Plant Generators			X				Pending award of funding
CRITICAL FACILITIES PROTECTION (2003 AND 2009 MITIGATION PLANS) HURRICANE/TROPICAL STORM							
• Generator installation for auxiliary power at the Public Library, City Hall and Activities Building					X	2011	Homeland Security Disaster Recovery Grant funding utilized
• Protective Window Covering (Film) for City Hall, Public Safety Building, Library, Activities Building, 4 Fire Stations.					X	2011	CDBG grant funding was utilized
HURRICANE PUBLIC EDUCATION CAMPAIGN (2003 AND 2009 MITIGATION PLANS)							

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
• Design/develop a hurricane guide to include ✓ evacuation procedures/routes & re-entry procedures utilizing the H-GAC zip-zone evacuation map ✓ preparing homes to withstand storm damage ✓ prepare a survival kit ✓ health safety guidelines ✓ power outages ✓ debris removal ✓ permitting process	X						• Public education programs are offered to all residents through area schools, nursing homes, elderly living centers, civic groups, homeowner's associations, etc. • Printed publications are made available at City Hall, Library, and Activities Building and homeowner's associations. • This will be carried over to the 2009 Mitigation Plan to ensure all new residents to the area have sufficient educational materials for self- protection. This action has been restructured under F-2016-18
SHELTER-IN-PLACE PUBLIC EDUCATION CAMPAIGN (2003 AND 2009 MITIGATION PLANS) **TORNADO**							
• Design/develop a public awareness flyer for shelter-in-place procedures • Schedule presentations with all critical and vulnerable facilities within the city (to include schools, day cares, nursing homes, elderly living facilities, etc.) • Distribute flyer to all residents within the city through "Focus on Friendswood" newsletter, utility billing, etc. • Post information in city PEG Channel • Pre-record messages for broadcast over Friendswood Information Radio 1650 AM • Post information on city's website	X						This action has been restructured under F-2016-18
CRITICAL FACILITIES PROTECTION (2003 AND 2009 MITIGATION PLANS) **TORNADO**							
• Auxiliary Power ✓ Fire Station #1 ✓ Fire Station #2 ✓ Fire Station #3 ✓ City Hall ✓ Library					X	2011	Homeland Security Disaster Recovery Grant funding utilized
F-2009-4: MAJOR THOROUGHFARE PLANNING (2003 AND 2009 MITIGATION PLANS) **HAZARDOUS MATERIALS**							

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
Brittany Bay Blvd (continuation of LC PKWY) – Phase I (east portion to SH 146)	X						Included in CIP for 2018 • $6.5 million
Brittany Bay Blvd (continuation of LC PKWY) – Phase II (west portion to Pearland PKWY)	X						Included in CIP for 2018 • $6.5 million
GIS MAPPING & HAZUS HAZARDOUS MATERIALS							
• Equipment (computers and plotters) • Staff (salaries, benefits, etc.)				X			Unable to obtain software and maintain capabilities to operate within the city's IT protocols
DEVELOP A DROUGHT CONTINGENCY PLAN							
• The main emphasis of this project is to conserve the available water supply and protect the integrity of water supply facilities, with particular regard for domestic water use, sanitation and fire protection. • Protect and preserve public health, welfare and safety and minimize the adverse impacts of water supply shortages or other water supply emergency operations. • Conserve existing water supplies. • Protect integrity of water supply facilities. • Ensure continual water supply. • Provide sufficient supply of water for emergency response usage.					X	2010	
DEVELOP PUBLIC EDUCATION CAMPAIGN (2009 MITIGATION PLAN) DROUGHT PUBLIC SERVICE ANNOUNCEMENTS (PSA) Main emphasis of this project is to ensure that the citizens of Friendswood are informed of the potential danger of existing weather conditions, and to ensure they have information to protect themselves and their property.							

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
• Ensure the public is aware of the potential dangers posed by drought conditions. • Ensure water conservation methodologies are available to all residential and commercial properties within the city. • Ensure articles are available for publication in local newspapers, "Focus on Friendswood", PEG Channel 17, at the beginning of the summer season, and during times of extended drought conditions. • Ensure residential and commercial populations are informed of drought conditions, solutions to conserve water and protect property and people. • Ensure the integrity of the city's water supplies are maintained on a consistent basis.	X						This action has been restructured under F-2016-18
SUBSIDENCE • The city purchases treated water from the City of Houston. • The city owns and operates 2 water booster stations and 6 ground water plants. • The purchased water provides the majority of the demand and averages over 90% of the usage.							
• The city has purchased 12 million gallons/day surface water from the City of Houston.					X	2014	At this capacity, this supply will serve up to 57,000 people. This capacity will sustain the city to total build-out status.
• Review and amend, if necessary, the Water Conservation Plan and the Storm Water Management Program.	X						This action has been restructured under F-2009-5
DEVELOP A PUBLIC EDUCATION CAMPAIGN (2009 MITIGATION PLAN) SUBSIDENCE • Promote community awareness of subsidence risks and effects by providing materials to property developers and home builders when building permit applications are made. • Ensure property owners are aware of changes to base flood elevations to enhance awareness to potential for flooding.							
• Develop informational pamphlets to be distributed to all property developers and home builders at the building application phase of the process	X						This action has been restructured under F-2016-18
• During the plan review process, ensure that all city building codes and floodplain management regulations are adhered to by the developer/builder.	X						

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comments
• Increase awareness of the history of subsidence in the area. • Increase awareness and knowledge of the necessity to changes in base flood elevation requirements. • Minimize effects from flooding hazards.	X						
WINTER STORM PUBLIC EDUCATION CAMPAIGN (2009 MITIGATION PLAN)							
• Develop informational materials for use on city's local PEG Channel to inform the public of predicted temperature fluctuations; the importance protecting outside pipes from cold temperatures; and the need to bring pets indoors out of the inclement weather.	X						This action has been restructured under F-2016-18
• Develop PSA to be utilized on the following modes of transmission ✓ 1650 AM Radio Station ✓ City's mass email system ✓ City's website ✓ Facebook ✓ Twitter	X						

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Table 24.5: Hitchcock

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
H (Past Action) 1: Purchase fire water truck (2500 gallon)					X	2015	
H (Past Action) 2: Address poor drainage on Lexington Drive			X				Delayed due to lack of funding
H (Past Action) 3: Address poor drainage on Concord Drive			X				Delayed due to lack of funding
H (Past Action) 4: Address poor drainage on Lincoln Drive			X				Delayed due to lack of funding
H (Past Action) 5: Address poor drainage on Willow Drive			X				Delayed due to lack of funding
H (Past Action) 6: Address poor drainage on Meadowplace Drive			X				Delayed due to lack of funding
H (Past Action) 7: Address poor drainage on Tacguard Drive			X				Delayed due to lack of funding
H (Past Action) 8: Address poor drainage on Barry Street			X				Delayed due to lack of funding
H (Past Action) 9: Address poor drainage on Woodacres Drive			X				Delayed due to lack of funding
H (Past Action) 10: Address poor drainage on Buins St		X					
H (Past Action) 11: Address poor drainage on Jay Road		X					
H (Past Action) 12: Address poor drainage on Hacker Rd			X				Delayed due to lack of funding
H (Past Action) 13: Address poor drainage on Gulf Street					X	2015	
H (Past Action) 14: Address poor drainage on Florida St					X	2015	
H (Past Action) 15: Address poor drainage on Washington Street					X	2015	
H (Past Action) 16: Address poor drainage on Stewart Road			X				Delayed due to lack of funding
H (Past Action) 17: Address poor drainage on Mills Street					X	2015	
H (Past Action) 18: Address poor drainage on Hawthorne Street			X				Delayed due to lack of funding
H (Past Action) 19: Address poor drainage on Smith Drive					X	2015	

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
H (Past Action) 20: Address poor drainage on Belring Rd			X				Delayed due to lack of funding
H 1: Implement public awareness program to residents regarding mitigating flooding and drainage issues with various methods such as curbside planting, elevating structures, and disseminate NFIP information regarding purchase of flood insurance.	X						Program not implemented due to lack of understanding what is required. This action will be modified to address all hazards under action H-2011-1.
H 2: Develop and implement a program to routinely check and maintain fire hydrants	X						
H 3: Extend water and sewer lines to septic and well water customers not currently on City system, thus reducing high use of septic systems in use.	X						
H 4: Install gate valves and boxes on the water mains. Lines are susceptible to various hazards and extreme temperatures					X	UNK	Uncertain when the city completed the installation of gate values and boxes.
H 5: Provide and distribute safety procedures to builders and developers to require adequate building setbacks from natural gas pipelines				X			City does not have the expertise to provide information regarding this action. Appropriate education and outreach efforts for this action will be included under action H-2011-1.
H 6: Educate the public about hazardous materials and waste, pipeline dangers				X			City does not have the expertise to provide information regarding this action. Appropriate education and outreach efforts for this action will be included under action H-2011-1.
H 7: Remove downed trees and brush that pose increase fire risk throughout city.				X			Combine with Hitchcock 8 under action H-2011-8
H 8: Implement a tree trimming program that clears tree limbs from public right of ways.	X						
H 9: Purchase NOAA “all hazard” Radios for early warning and post-event weather information for residents				X			The city does not have the financial resources to purchase radios for their residents
H 10: Purchase and install emergency power generators and connections equipment at critical sanitary sewer lift station sites			X				Delayed due to lack of funding.
H 11: Implement storm sewer system improvement projects to mitigate flooding	X						

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
H 12: Educate residents regarding benefits of xerogardening and xeriscaping				X			City does not have the expertise to provide information regarding this action. Appropriate education and outreach efforts for this action will be included under action H-2011-1.
H 13: Upgrade water and sanitary sewer distribution and collection system infrastructure where needed, include backflow prevention valves where feasible	X						
H 14: Develop and implement a program to routinely check and maintain fire hydrants				X			Duplicate action – addressed under H-2011-2
H 15: Implement a tree trimming program that clears tree limbs from public right of ways				X			Duplicate action – addressed under H-2011-8
H 16: Purchase NOAA "all hazard" Radios for early warning and post-event weather information for residents				X			The city does not have the financial resources to purchase radios for their residents
H 17: Educate residents and businesses about benefits of xeriscaping through a public awareness campaign				X			City does not have the expertise to provide information regarding this action. Appropriate education and outreach efforts for this action will be included under action H-2011-1.
H 18: Increase native canopy by tree planting in public right of way to reduce urban heat levels				X			This action is not realistic for the community to complete
H 19: Evaluate, design, and implement hardening designs to protect critical facilities and critical infrastructure during disasters	X						
H 20: Conduct a fire safety and prevention program				X			City does not have the expertise to provide information regarding this action. Appropriate education and outreach efforts for this action will be included under action H-2011-1.
H 21: Implement a public outreach program designed to educate the public about availability and benefits of NFIP flood insurance				X			City does not have the expertise to provide information regarding this action. Appropriate education and outreach efforts for this action will be included under action H-2011-1.

32 UNK = Unknown

Table 24.6: Jamaica Beach

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
JB (Past Action) 1: Implement beach and dune restoration program		X					
JB (Past Action) 3: Join the Community Rating System		X					
JB (Past Action) 4: Conduct annual hurricane town hall meeting	X						
JB 1: Conduct routine hydrant maintenance	X						
JB 2: Develop system to maintain records of Elevation Certificates		X					
JB 3: Become a National Weather Service (NWS) "Storm Ready" Community					X	2013	
JB 4: Establish pre-disaster debris management contracts					X	2015	
JB 5: Prepare a Drought and Extreme Heat Contingency Plan		X					
JB 6: Form Mutual Aid Agreement with the City of Texas City in the event of Pipeline Failure or Hazardous Material Release					X	2013	A Mutual Aid Agreement was executed with Galveston County rather than Texas City
JB 7: Construct a retaining wall around the sewer plant to protect the facility from surge during coastal flood events					X	2014	
JB 8: Provide NOAA Weather Radios for Police and Fire Departments					X	2013	
JB 9: Provide larger size generator for City Hall Building					X	2013	

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Table 24.7: Kemah

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
K (Past Action) 1: Initiate outreach campaign promoting the purchase of flood insurance and lightning arrestors		X					
K (Past Action) 2: Develop severe weather audio alert system.			X				Pending funding and support
K (Past Action) 3: Implement storm sewer system re-engineering and follow-up construction project to mitigate flood-related impacts.		X			X		
K (Past Action) 4: Develop city ordinance requiring the incorporation of wind resistant construction provisions and enforcement measures in the city building code.			X				Pending support to develop ordinance
K (Past Action) 5: Develop city ordinance establishing water use regulations during drought.					X		
K 1: Participate in National Weather Service tornado drills along with elementary school in jurisdiction		X			X		
K 2: Develop procedures for mass notification of citizens and merchants to development of winter storms possibilities					X	2013	
K 3: Develop procedures for making mass notifications to citizens and merchants in the event of a fuel pipeline breach or hazardous material spill or release from a transporter or fixed site						2013	
K 4: Participate in Pipeline Group training and annual community meetings						2015	
K 5: Review and revise existing building codes to include more stringent measures such as roof shingles that reduce the effect of hail greater than 1" in diameter; maintain and adopt updates from International Code Congress		X			X	2014	
K 6: Seek grant funding adding a full-time building inspector position to support stronger ordinances and building codes that are proposed				X			Unable to support

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
K 7: Develop procedures for making mass notifications to citizens and merchants during times of drought, conditions of extreme temperatures and urban and wildland fire. Post same information on City website at www.kemah-tx.gov					X	2013	
K 8: Review, participate and implement any updates for drought contingency plans as developed by the WCID# 12							
K 9: Develop awareness of potential impact to community as result of failure of function of flood gates at Second Cut - 1900 Shipyard Drive (intersection of Highway 146 and Shipyard Drive)						2013	
K 10: Develop program to integrate with the Harris County Flood Control District for the purpose of optimizing the operation of the flood gates at second cut outlet - 1900 Shipyard Drive (intersection of Highway 146 and Shipyard Drive)			X		X		Pending support
K 11a: Review and update if necessary flood plain ordinance to ensure compliance with minimum standards of NFIP		X			X		
K 11b: Alert community about dangers of flooding, NFIP compliance, and importance of purchasing flood insurance to protect property						2013	
K 12: Seek Community Development Block Grant funding for repairs to, modification of, or relocation of flood water lift station destroyed by Hurricane Ike on September 13,2008 100 Second Street						2014	
K 13: Develop maintenance and flow testing program for fire hydrants in jurisdiction		X					
K 14: Develop and implement program for hardening existing public buildings from winter storm – 1401 State Hwy 146 (city hall), 800 Harris (community center) 602 Bradford (visitor center)		X			X		
K 15: Educate residents regarding benefits of xerogardening and xeriscaping		X					
K 16: Become a National Weather Service (NWS) “Storm Ready” Community						2014	

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Table 24.8: La Marque

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
LM (Past Action) 2: Implement drainage projects that support low maintenance and cleaning of drainage ditches.			X				Deferred pending funding
LM (Past Action) 4: Install new 12" – 10" and 8" water line and ten (10) additional fire hydrants					X	2013	
LM (Past Action) 6: Purchase a rescue pumper truck for Main Station					X	2011	
LM (Past Action) 7: Build new west side fire station				X			Duplicate action
LM 1: Purchase and install a freshwater supply backflow preventer for ground water system - The City of La Marque's main connection to the Gulf Coast Water Authority located at Orchid Drive and 5th Ave, Texas City					X	2012	
LM 2: Purchase and Install Storm Shutters for Fire Station Entry Way - 1109-A Bayou Road			X				Deferred pending funding
LM 3: Purchase new Fire Station Doors for Apparatus Bays - 1109-A Bayou Road			X				Deferred pending funding
LM 4: Purchase and install two 350 KV generators at the Sewer Treatment Plant. 2701B Woodland Drive					X	2012	
LM 5: Purchase new generator for Fire Station and City Hall					X	2012	
LM 6: Purchase New Rescue Pumper for Fire Station			X				Deferred due to lack of funding
LM 7: Build a Westside Public Safety Complex			X				Deferred pending funding
LM 8: Replace two generators at the fresh water well in order to support our emergency operations. 4319 Kirby, and 2102 Magnolia					X	2015	
LM 9: Purchase Generator for the Public Works Facility.			X				Deferred pending grant funding
LM 10: Update the City of La Marque's Emergency Communications System: Federal Mandated (700MHZ) System by 2020					X	2015	

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
LM 11: Construct safe room shelter at emergency operations command center to house local residents; shelter could be used for multiple purposes during non-emergency events			X				Deferred pending grant funding
LM 12: Build new roads to accommodate evacuations and reduce congestion at the intersections cited - Off IH-45 Feeder Road on La Marque/Texas City line. Start road on city line and continue past Gulf Greyhound Park and tie into FM 2004			X				Deferred pending grant funding
LM 13: Install generators for Wastewater Lift stations located around the city		X					
LM 14: Construct a storm water retention area on the east side of the City - The location of this detention area is located in close proximity to FM 1765 and SH 146			X				Deferred pending funding
LM 15: Increase the height of the existing Levee wall system to withstand a Category 5 storm surge. The South side of La Marque and through Texas City			X				Deferred pending funding
LM 16: Purchase 100' Aluminum Aerial platform fire apparatus for residential and commercial structure fire rescues. Central fire station			X				Deferred pending grant or bond funding
LM 17: Build public service facility			X				Deferred pending grant or bond funding
LM 18: Remove downed trees and brush that pose increase fire risk throughout the City.	X						
LM 19: Disseminate Texas Forest Service and other information to the public on minimizing damage from drought by xeriscape landscaping plants, and fire buffers surrounding structures.	X						

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Table 24.9: League City

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
LC (Past Action)-1: Storm drainage improvement			X				Pending funding
LC (Past Action)- 2: Coryell Street drainage					X	2011	
LC (Past Action)-3:Highland Terrace drainage			X				Pending funding
LC (Past Action)-4: Kansas Street drainage			X				Pending funding
LC (Past Action)-5: Robinson Bayou Bank stabilization					X	2013	
LC (Past Action)-6: Shellside detention		X					
LC (Past Action)-7: Develop a stormwater and master drainage plan update					X	2011	
LC (Past Action)-8: Clear Creek Heights Drainage					X	2014	
LC (Past Action)-9: Develop and manage a repetitive flood loss database		X					
LC (Past Action)-10:Weather station with the capability to monitor creek levels					X	2013	
LC (Past Action)-11: Develop a floodplain management plan					X	2012	
LC (Past Action)-12: Critical facilities protection emergency backup power					X	2012	
LC (Past Action)-13: Emergency power Clear Creek Independent School District's kitchen facilities				X			League City no longer uses these schools as a shelter location
LC (Past Action)-14: Critical facilities protection window protection					X	2011	Protective film installed on 12 city buildings
LC (Past Action)-15: Public education campaign - tornado			X				Pending funding to develop program
LC (Past Action)-16: Public education campaign – lightning safety					X	2013	
LC (Past Action)-17: Critical Infrastructure Protection Install Lightning/Surge Protection Equipment at City Buildings		X					New public safety building is equipped with physical and electrical lightning and surge protection
LC (Past Action)-18: Public safety campaign – extreme heat					X	2013	

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
LC (Past Action)-19: Develop a cooling station location and implementation plan – extreme heat				X			Unnecessary as public buildings such as civic center are available during normal business hours
LC (Past Action)-20: Public education campaign water conservation					X	2012	
LC (Past Action)-21: Firefighting equipment – assist the fire department with pursing grants				X			This action is no longer a priority.
LC (Past Action)-22: Homeowner mitigation incentive campaign			X				Pending funding
LC (Past Action)-23: Update mitigation plan to include pipeline and hazardous material incidents		X					

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Table 24.10: Tiki Island

Action	Ongoing	In Progress	Delayed	No Longer Required	Completed	Completion Date	Comment
TK 1: Plan and construct emergency water well for backup water supply. Construct necessary reverse osmosis equipment, delivery system, backup generator, switchgear, fuel supply, and security fencing. Well location: 400 Jones Lake Rd						2014	
TK 2: Implement water conservation awareness campaign (at Citywide Fourth of July picnic and other local activities.)	X						
TK 3: Expand and harden Public Safety building to: • Withstand 150 MPH hurricane winds • Provide public shelter for citizens in aftermath of disaster • Elevate storage above flood elevation • Store emergency supplies • Provide base of operations for recovery effort					X	2009	
TK 4: Purchase generator for backup power to Public Safety building					X	2012	
TK 5: Elevate 11 wastewater lift stations and provide backup power							
TK 6: Elevate Water Plant lab building and storage					X	2011	
TK 7: Elevate Water Plant lab building and storage					X	2010	
TK 8: Purchase new Emergency Notification System			X				Funding Needed
TK 9: Replace the Tiki Drive bridge with an improved, hardened bridge to withstand storm surge and debris. 300 to 400 Tiki Drive			X				CDBG funding needed
TK 10: Become a NOAA "Storm Ready" community			X				Funding needed
TK 11: Improve NFIP CRS rating above current class 8	X						
TK 12: Increase native canopy by tree planting in public right of way to reduce urban heat levels					X	2014	
TK 13: Implement a tree trimming program that clears tree limbs from public right of ways.			X				Funding needed
TK 14: Conduct a fire safety and prevention program			X				Funding needed

24.2 Mitigation Goals and Objectives

Goals and objectives from the previous FEMA-approved plans (Galveston County 2011-2016, Friendswood 2015, and League City 2009) were reviewed by each jurisdiction during planning sessions held the week of January 5-7, 2016 (see section 2 for details). In an effort to streamline the goals and objectives between the three planning initiatives, the planning consultants looked for common themes to develop proposed goals and objectives to meet the participating jurisdictions going forward. A detailed crosswalk of the previous goals and objectives and how they aligned to the approved multi-jurisdictional goals and objectives is provided in Appendix G. Each of the 2016-2020 mitigation actions references which of the mitigation goals and objectives they address. The following goals and objectives were adopted:

Goal 1: Minimize loss of life, injury, damage to property, the economy, and natural systems

- Objective 1.1: Protect the life, health and safety of residents
- Objective 1.2: Protect existing/new critical facilities and infrastructure
- Objective 1.3: Provide protection for future/existing developments
- Objective 1.4: Provide backup power to critical facilities/infrastructure
- Objective 1.5: Minimize impacts from all hazards

Goal 2: Maintain and enhance emergency management/mitigation capabilities

- Objective 2.1: Update/develop plans, studies, and mapping for all hazards
- Objective 2.2: Incorporate/improve hazard mitigation strategies into ordinances, plans and polices
- Objective 2.3: Conduct/develop drills/training for all hazards
- Objective 2.4: Implement and maintain the Galveston County Multi-Jurisdictional Hazard Mitigation Plan
- Objective 2.5: Participate in programs that promote hazard mitigation strategies
- Objective 2.6: Build, obtain, and maintain critical facilities and equipment

Goal 3: Maintain public education and awareness activities

- Objective 3.1: Expand Public Outreach Campaigns for all hazards
- Objective 3.2: Promote disaster preparedness planning for families

24.3 Mitigation Action Plans 2016 to 2020

Once the completed or no longer relevant actions were removed from each jurisdictions mitigation action plan, the planning team began working with the Steering Committee to document those actions moving forward with an analysis of the progress made over the past five years. Each jurisdiction also identified new actions based on their current capabilities and needs.

Establishing Priorities

As discussed in Section 2 (Planning Process), a mitigation strategy workshop was held with each jurisdiction the week of January 5-7, 2016 to finalize the 2016-2020 mitigation action plans. At these workshops, jurisdictions and stakeholders completed a final review of the actions and conducted a prioritization process based on FEMA's Mitigation Action Evaluation Worksheet 6.1 provided in the Local Mitigation Planning Handbook (March 2013). This evaluation system utilized the following ranking scale for each of the criteria defined by FEMA.

Ranking Scale:

1 = Highly effective or feasible	0 = Neutral	-1 = Ineffective or not feasible

Evaluation Criteria:

Life Safety – How effective will the action be at protecting lives and preventing injuries?

Property Protection – How significant will the action be at eliminating or reducing damage to structures and infrastructure?

Technical – Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.

Political – Is there overall public support for the mitigation action? Is there the political will to support it?

Legal – Does the community have the authority to implement the action?

Environmental – What are the potential environmental impacts of the action? Will it comply with environmental regulations?

Social – Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?

Administrative – Does the community have the personnel and administrative capabilities to implement the action and maintain it or will outside help be necessary?

Local Champion – Is there a strong advocate for the action or project among local departments and agencies that will support the actions' implementation?

Other Community Objectives – Does the action advance other community objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of the comprehensive plan?

Scoring:

The total points scored on each mitigation action per the evaluation criteria listed above was then placed into a high, moderate, and low priority as defined below:

High Priority = 10 to 4	Moderate Priority = 3 to -3	Low Priority = -4 to -10

Defining Hazard Type and Mitigation Strategy Group

Each mitigation action was identified for the natural hazard it addresses, using multi-hazard approaches where practical, and determining which mitigation strategy group as defined below.

Prevention: Government, administrative, and regulatory actions or processes influencing the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and storm water management regulations.

Property Protection: Actions involving the modification of existing buildings or infrastructure to protect them from a hazard or remove them from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter-resistant glass.

Public Education and Awareness: Actions that inform and educate citizens, elected officials, and property owners about potential risks from hazards and potential ways to mitigate these risks. Actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.

Natural Resource Protection: Actions that not only minimize hazard losses but also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.

Emergency Services: Actions protecting people before, during, and after a hazard event. Administrative and emergency operations offices that provide critical and vital services, coordinate warnings, responses, and recovery from a disaster are identified. Actions include

protection of warning system capabilities, protection or hardening of critical facilities, protection of infrastructure needed for emergency response and training.

Structural Projects: Actions involving the construction of structures to reduce the impact of a hazard include storm water controls (e.g. culverts, floodwalls, seawalls, retaining walls, and safe rooms).

Technical Assistant Projects: Actions that involve required support/education from federal, state and local agencies, data collection for GIS mapping, utilization of technology, and upgrades as products are developed.

Mitigation Action Plans - 2016 to 2020

As previously stated, the mitigation actions not completed from the previous plan were assessed against the current needs to reduce and/or eliminate risk, improve outreach efforts, and participation in various programs that promote mitigation strategies.

Through the development of this plan update, the planning team and officials in each participating jurisdiction assembled to discuss their known risks to determine which mitigation actions should be considered for the next five year cycle.

A revised numbering system, which includes the plan year an action was identified, was also developed to improve tracking of the progress made on actions for years to come. In addition, the details for each mitigation action were reviewed and modified to reflect pertinent information that will assist the jurisdictions in tracking the progress of actions going forward. A multi-hazard approach was utilized to streamline public education/outreach and property protection strategies where appropriate.

Tables 24.11 to 24.21 are provided by jurisdiction for the mitigation actions they desire to implement as funding and opportunities arise.

2016 – 2020 Mitigation Action Table Reference

Jurisdiction	*Table Number*	*Page Number*
Galveston County	*24.11*	*24-32*
Bayou Vista	*24.12*	*24-43*
Clear Lake Shores	*24.13*	*24-58*
Friendswood	*24.14*	*24-66*
Hitchcock	*24.15*	*24-87*
Jamaica Beach	*24.16*	*24-101*

Jurisdiction	*Table Number*	*Page Number*
Kemah	*24.17*	*24-108*
La Marque	*24.18*	*24-118*
League City	*24.19*	*24-133*
Santa Fe	*24.20*	*24-145*
Tiki Village	*24.21*	*24-153*

154 *Table 24.11: Galveston County*

GC 2006-12: Incorporate GIS System into emergency planning and operations	
Mitigation Goal/Objective:	2/2.1
Site and Location:	Countywide
Background/Next Steps:	Build a GIS System to store County data/records that will enhance preparedness, response and recovery activities
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Technical Assistance
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Local General Funds, Hazard Mitigation Grant Program. Pre-disaster Mitigation Program
Lead Agency/Department Responsible:	Office of Emergency Management
Implementation Schedule:	2016-2020
Analysis	
2010 - This project will be deferred. The County recently hired GIS personnel and will continue to move forward with this initiative. County will continue to seek grant funding for this initiative.	
2016 - Renumbered action from Galv. Co (Past Action)-12 and updated implementation schedule The County received GIS capabilities in 2014 and is in the process of incorporating GIS into applicable emergency management planning and operations.	

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GC 2011-3: Implement/maintain tree and vegetation trimming/removal program	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Unincorporated areas of County
Background/Next Steps:	Trees and other vegetation can encroach overhead power lines, drainage systems, and road ways. Keep areas of concern free of unnecessary debris.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Wildfire (Urban and Rural), Severe Winter Storm, Earthquake
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Staff time
Potential Funding Sources:	General fund
Lead Agency/Department Responsible:	Road and Bridge

Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from Galv. Co -3 and updated implementation schedule Action description was modified to reflect an all hazards approach and includes previous actions Galv. Co-15, 16, and 18. The County coordinates the implementation of tree/debris removal as needed.	

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GC 2011-6: Continue efforts on public information and awareness for all hazards	
Mitigation Goal/Objective:	3/3.1
Site and Location:	Unincorporated areas of the County
Background/Next Steps:	The planning area has several outreach initiatives to communicate hazard preparedness information to the general public and visitors to the area. Providing timely information and educational information related to preparedness, mitigation, response, and recovery to the public fosters their ability to become self-sufficient. Continue to provide information on all hazards that may include but not be limited to educational information, evacuation routes/procedures, workshop/training programs, alert systems, and the like. Technological, man-made and health-related hazard information will be provided to the public as it is received from the proper authorities.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$110,000 annually
Potential Funding Sources:	Grants/General Fund
Lead Agency/Department Responsible:	GCOEM and applicable county departments, and state and federal agencies
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from Galv. Co -6 and updated implantation schedule. This action also includes previous actions 12, 13 and 19. The action description was modified to reflect an all hazard approach to public awareness and education. The County continues to provide information as needed/required to prepare for various events/seasons. In addition, new communication techniques will continue to be explored.	

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GC 2011-9: Design and construct a multi-purpose EMS facility for Crystal Beach and High Island area residents	
Mitigation Goal/Objective:	1/1.2
Site and Location:	Unincorporated communities of Crystal Beach and High Island

Background/Next Steps:	High Island and Crystal Beach do not have an EMS Facility. The goal is to develop a multi-purpose structure for each community, which would function as a base of operations during a disaster event and times of extreme temperature; a location for the volunteer fire department, a storage area for equipment; and a response staging area.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Extreme Heat, Severe Winter Storm, Earthquake
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$3 million per structure
Potential Funding Sources:	Grants (CDBG, FEMA PA, HMGP)
Lead Agency/Department Responsible:	GCOEM
Implementation Schedule:	2017
Analysis	
2016 - Renumbered action from Galv. Co -9 and updated implementation schedule Crystal Beach EMS facility was completed in 2013. High Island shelter is scheduled to be completed in 2017	

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GC 2011-10: Harden critical facilities by purchasing equipment and installing emergency backup power at Bayview Municipal Utility District lift stations, operations center, and wastewater treatment facility	
Mitigation Goal/Objective:	1/1.4
Site and Location	1. Public Works Operations Center, 309 Miles Rd. 2. Bay View MUD Water Plant, 3206 Hwy 146 3. Bay View MUD Waste Water Treatment , 3208 Hwy 146
Background/Next Steps:	Backup power allows the District to operate as normal and provide continuous utility service to all structures. The estimated cost of the project does not include the engineering fees for set up and installation of the equipment. The following units are needed: 1. 25 KW 1 phase unit 2. Two 150 KW 3 phase units
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$1,140,000
Potential Funding Sources:	Grants/Emergency State funds
Lead Agency/Department Responsible:	Bayview MUD Board of Directors
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from Galv. Co -10 and updated implementation schedule from As soon as funded Generators were installed on lift stations 1 and 3 in 2013. Lift station 2 has been changed to a gravity feed and no longer requires a generator. Generators are still needed for Public Works, MUD Water Plant and MUD Wastewater Treatment	

Plan.

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GC 2011-21: Implement the Corp of Engineers study of the Texas City Hurricane Flood Protection Project to improve the current levee system to provide protection from a Category 5 storm.	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Galveston County, Texas City and La Marque area levee
Background/Next Steps:	Reduce potential flooding of existing structures. Subsidence over the years, combined with current levee design to protect residents and industrial structures only to Category 3 or 4 hurricanes does not provide the best possible protection from storm surge. Inspections have been completed (2012) but specific projects will need to be prioritized, scoped, and funded before implementation can begin.
Hazard(s) Addressed:	Flooding, Tsunami, Dam and Levee Failure, Coastal Erosion and Retreat
Mitigation Strategy:	Structural
Priority:	Moderate
Estimated Cost:	Millions of dollars
Potential Funding Sources:	Funding source dependent on project scope
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	2016 to 2026
Analysis	
2016 - Renumbered action from Galv. Co -21 and updated implementation schedule from upon funding Inspection of the levee system was completed in 2012. Projects will be scoped and implemented as funding becomes available.	

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GC 2016-1: Install / maintain severe weather warning systems	
Mitigation Goal/Objective:	1/1.1
Site and Location:	Countywide
Background/Next Steps:	Weather warning systems complement the methods of warning already used by the County Emergency Operation Center and the National Weather Service. Identify site locations and develop cost estimates as needed. For installed sirens, provide routine testing and inspection.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Dam and Levee Failure
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$35,000 each
Potential Funding Sources:	HMGP, general fund
Lead Agency/Department Responsible:	GCOEM and applicable jurisdictions
Implementation Schedule:	2016-2026

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GC 2016-2: Stormproof/retrofit critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.2
Site and Location:	County-owned properties and unincorporated areas
Background/Next Steps:	New construction of public buildings/infrastructure should include advanced mitigation techniques when practical. Measures may include, but are not limited to, roof and foundation supports, shutters, shatter-proof and high wind doors and windows, etc. During the planning process, no new facilities or infrastructure were identified. However, the County's needs may require new construction over the next five years. The County will develop plans and specifications to include mitigation measures where practical on future initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm, Earthquake
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Unknown, dependent upon facility type
Potential Funding Sources:	HMGP, CDBG, General Funds
Lead Agency/Department Responsible:	County Administration
Implementation Schedule:	To be determined

GC 2016-3: Promote/build storm water detention ponds when appropriate	
Mitigation Goal/Objective	1/1.5
Site and Location:	Unincorporated areas of the County
Background/Next Steps:	Detention ponds could be a solution for addressing flood impacts. Develop/implement action when feasible and applicable
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	General funds, private funds
Lead Agency/Department Responsible:	Engineering coordinate with developers
Implementation Schedule:	Continuous action

GC 2016-4: Secure generators for existing and new critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.4
Site and Location:	Countywide
Background/Next Steps:	Generators are essential for providing continual operations in the event of a disaster. As funding becomes available, the county will apply for grants to install/upgrade generators to support existing or new facilities/infrastructure.

Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Extreme Heat, Severe Winter Storm, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, General Funds
Lead Agency/Department Responsible:	GCOEM
Implementation Schedule:	Continuous action

164

GC 2016-5: Continue efforts on mitigation Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Unincorporated areas of the county
Background/Next Steps:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Section 20 provides a summary of the RFC/SRL properties that have not been mitigated, Mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be explored with property owners as funding and opportunities arise.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	GEOEM
Implementation Schedule:	Continuous Action

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GC 2016-6: Update/develop applicable plans and studies as needed	
Mitigation Goal/Objective	2/2.1
Site and Location:	Countywide
Background/Next Steps:	Preparing for all hazards requires planning and coordinating for preparedness, response, and recovery procedures. Review planning needs annually to include, but not be limited to, CEMP, debris management, stormwater management, master plan, drainage, drought, GIS mapping, etc.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High

Estimated Cost:	To be determined
Potential Funding Sources:	General funds, Homeland Security, HMGP
Lead Agency/Department Responsible:	GCOEM
Implementation Schedule:	Continuous action

166

GC 2016-7: Upgrade drainage systems and culverts	
Mitigation Goal/Objective	1/1.5
Site and Location:	Unincorporated areas of the county
Background/Next Steps:	The drainage systems and culverts throughout the county are frequently impacted by flood and severe weather events. Coordinate efforts with water district to improve systems that will be required.
Hazard(s) Addressed:	Flooding, Severe Winter Weather, Hurricane/Tropical Storm, Tsunami, Tornado, Windstorm, Flooding, Coastal Erosion and Retreat, Land Subsidence, Earthquake
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	CDBG, HMGP, Developers
Lead Agency/Department Responsible:	Engineering and applicable jurisdictions and water district
Implementation Schedule:	Continuous action

167

GC 2016-8: Install lightning grounding systems and protection devices on critical facilities/infrastructure	
Mitigation Goal/Objective	1/1.2
Site and Location:	County-owned facilities and infrastructure
Background/Next Steps:	Lightning strikes can create outages to essential water and sewer services as well as invite unnecessary damage to critical facilities. Consider a program to establish lightning grounding systems on critical water and sewer system elements and other facilities prone to strikes.
Hazard(s) Addressed:	Lightning
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	General funds
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	2016-2026

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GC 2016-9: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County	
Mitigation Goal/Objective	2/2.1
Site and Location:	Unincorporated areas of the county
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	GCOEM and applicable departments
Implementation Schedule:	Continuous Action

GC 2016-10: Continue to enforce / improve regulations and permit requirements to promote hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Site and Location:	Unincorporated areas of the county
Background/Next Steps:	Regulations and permit requirements are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop as required to address all hazards prone to the area and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	GCOEM and applicable departments
Implementation Schedule:	Continuous action

GC 2016-11: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective	2/2.2
Site and Location:	Unincorporated areas of the county
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	GCOEM and applicable departments
Implementation Schedule:	Continuous action

173

GC 2016-12: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Site and Location:	Unincorporated areas of the county and participating jurisdictions
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	GCOEM and participating jurisdictions
Implementation Schedule:	Continuous action

GC 2016-13: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective	2/2.4
Site and Location:	Countywide
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	GCOEM and participating jurisdictions
Implementation Schedule:	Continuous action

GC 2016-14: Improve / maintain participation in the National Flood Insurance Program (NFIP)	
Mitigation Goal/Objective	2/2.5
Site and Location:	Unincorporated areas of the county
Background/Next Steps:	Continue participation in the NFIP program which offers incentives to reduce insurance premiums
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	GCOEM
Implementation Schedule:	Continuous action

GC 2016-15: Promote emergency preparedness/continuity of operation plans	
Mitigation Goal/Objective	3/3.2
Site and Location:	Countywide
Background/Next Steps:	Family emergency preparedness plans establish how families will get to a safe place; how to contact one another; how to get back together; and what families will do in different situations. Continuity of operation plans establishes a clear chain of command, line of succession, and procedures for backup or alternate emergency facilities in case of extreme emergency or disaster.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	GCOEM
Implementation Schedule:	Continuous action

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179 *24.12: Bayou Vista*

BV 2006-1: Continue efforts on public information and awareness for all hazards	
Mitigation Goal/Objective:	3/3.1
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$5,000, Staff time and resources
Potential Funding Sources:	General funds, HMGP, Homeland Security
Lead Agency/Department Responsible:	City of Bayou Vista Administration
Implementation Schedule:	Continuous Action
Analysis	
2010-This project is currently underway and will be deferred	
2016-Renumbered action from BV (Past Action)-1 and included BV (Past Action) 2 and 3. Proposed action was modified to address all public outreach efforts for all hazards. The city continues to provide information on all hazard preparedness, mitigation, recovery, and response efforts on their website, at town meetings/events.	

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BV-2011-4: Implement drainage improvement program to reduce standing water and runoff, and reduce minor flooding for residents located in District No.12	
Mitigation Goal/Objective:	1/1.5
Site and Location:	1. Bayou Vista 2. Omega Bay 3. Original Bayou Vista
Background/Next Steps:	Standing water in existing buildings could be reduced or eliminated if adequate drainage provisions are implemented Provide routine maintenance to drainage systems.
Hazard(s) Addressed:	Flooding, Severe Winter Weather, Hurricane/Tropical Storm, Tsunami, Tornado, Windstorm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Office of Rural Community Affairs, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program,406 Public Assistance Program(following federal disaster declaration), Us Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-

	Watershed Protection and Flood Prevention Program, EPA-Nonpoint Source Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	2016 to 2020
Analysis	
2016 - Renumbered action from BV-4 and updated implementation schedule Project is deferred until adequate funding can be obtained. Will apply for a grant when funding and opportunity become available	

181

BV-2011-6: Implement Stormwater management plan to improve drainage during flood and other weather events; clean and repair storm sewer system	
Mitigation Goal/Objective:	1/1.5
Site and Location	Bayou Vista, Omega Bay, Original Bayou Vista
Background/Next Steps:	Routinely cleaning and repairing stormwater drains can help avoid unnoticed clogs that may hamper the efficiency of the stormwater system. Insuring that flow paths will have the capacity to convey storm- event flood water volumes will reduce damages.
Hazard(s) Addressed:	Flooding, Severe Winter Weather, Hurricane/Tropical Storm, Tsunami, Tornado, Windstorm, Coastal Erosion and Retreat, Land Subsidence
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$25,000
Potential Funding Sources:	Office of Rural Community Affairs, HMGP, PDM Grant Program,406 Public Assistance Program(following federal disaster declaration), USACE-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Nonpoint Source Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-6 and updated implementation schedule MUD #12 continues to implement their maintenance program for stormwater management when appropriate.	

182

BV-2011-7: Develop Master Drainage Plan to assist in reducing flooding through increased lowest finish floor requirements	
Mitigation Goal/Objective:	2/2.1
Site and Location	Citywide including Bayou Vista, Omega Bay, and Original Bayou Vista
Background/Next Steps:	A master drainage plan will be a comprehensive document that correlates future and existing land use and flood/storm water drainage needs into one

	plan. This plan will also help identify projects needed to reduce flooding impacts. Develop plan when funding and opportunity presents itself.
Hazard(s) Addressed:	Flooding, Dam and Levee Failure, Coastal Erosion and Retreat, Tornado, Windstorm, Hurricane/Tropical Storm, Tsunami
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$100,000
Potential Funding Sources:	General Funds, Office of Rural Community Affairs, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, Us Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Nonpoint Source Grant Program, Texas Water Development Board- Research and Planning Fund Grants, Pre Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from BV-7 and updated implementation schedule. Project is deferred until adequate funding can be obtained. Will apply for a grant when funding and opportunity become available	

183

BV-2011-8: Reconstruct/upgrade storm sewer systems	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide including Bayou Vista, Omega Bay and Original Bayou Vista
Background/Next Steps:	Inadequate and damaged storm sewers are problematic during natural disasters and severe weather events and need to be upgraded. Repairing/upgrading storm sewers will reduce the risk of flooding to new and existing buildings.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Windstorm, Tsunami
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$4,000,000
Potential Funding Sources:	Office of Rural Community Affairs, Local Funds, US Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service- Emergency Watershed Protection Agency, Texas Water Development Board-Clean Water State Revolving Fund, Texas Water Development Board (Development Fund II)-Texas Eater Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Non-point Source Grant Program, 406 Public Assistance Program (following federal disaster declaration), HMGP, PDM Grant Program (FEMA)

Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from BV-8 and included BV-10 in this action. Project is deferred until adequate funding can be obtained. Will apply for a grant when funding and opportunity become available	

184

BV-2011-9: Implement water conservation measures	
Mitigation Goal/Objective:	1/1.1
Site and Location	Bayou Vista, Omega Bay and Original Bayou Vista
Background/Next Steps:	Although the county receives 47 inches of rain annually, long periods between rains can occur. Drought is not a great threat to the area; however, implementing water conservation measures will increase reserves. Extreme temperatures can occur in conjunction with drought thereby increasing the necessity of having an available reserve.
Hazard(s) Addressed:	Drought, Extreme Heat, Wildfire (Urban and Rural), Expansive Soils, Land Subsidence
Mitigation Strategy:	Prevention
Priority:	Moderate
Estimated Cost:	$5,000
Potential Funding Sources:	Local funds, Water Resources, Texas Commission on Environmental Quality-Texas Clean Rivers Program, Texas Water Development Board Research and Planning Fund-Research and Planning Fund Grants, USDA National Resource Conservation Service- Watershed Surveys and Planning, USDA National Resources Conservation Service-Watershed Protection and Flood Prevention Program, Army Corps of Engineers-Planning Assistance to States
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-9 and updated implementation schedule. The city continues to implement their water conservation measures when appropriate	

185

BV-2011-11: Implement best management practices for securing windblown debris in canals as part of an ongoing Canal Debris Management Plan.	
Mitigation Goal/Objective:	1/1.5
Site and Location	Bayou Vista, Omega Bay and Original Bayou Vista
Background/Next Steps:	Debris is generated by many hazards if the level of intensity allows. Bayou Vista is a residential canal community. Debris in water breaks down physically and chemically and becomes pollution. Water is fluid and waterborne pollution will travel. Furthermore, oxygen is removed from

	water in the breakdown process thereby opening up the potential for mass fish kills in poorly circulated canal system. Human health is then put at risk.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Coastal Erosion and Retreat Dam and Levee Failure, Hazardous Materials, Earthquake
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$5,000 Administration Costs
Potential Funding Sources:	General funds, HMGP, PDM
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-11 and updated implementation schedule. The city continues to implement their BMP measures to remove debris from their canal system	

186

BV-2011-12: Develop and implement a plan for canal dredging to reduce sediment deposited during storm events, reducing access in canals	
Mitigation Goal/Objective:	2/2.1
Site and Location	Bayou Vista, Omega Bay and Original Bayou Vista
Background/Next Steps:	Sedimentation of manmade canals occurs with water low; water moving at higher velocities will have more sediment entrained than a slower mass of water. Sediment is deposited when and where the water slows. Flow is slowed in dead-end canals and sedimentation occurs. Sedimentation reduces the capacity for flood water and leaves an area more vulnerable to damage of high wind and rain during storm events.
Hazard(s) Addressed:	Flooding, Coastal Erosion and Retreat, Hurricane/Tropical Storm, Windstorm, Tornado, Tsunami
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$200,000
Potential Funding Sources:	Office of Rural Community Affairs, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program,406 Public Assistance Program(following federal disaster declaration), Us Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Non-point Source Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	2016-2020

Analysis
2016 - Renumbered action from BV-12 and updated implementation schedule. Project is deferred until adequate funding can be obtained to develop a canal dredging plan. Will apply for a grant when funding and opportunity become available

187

BV-2011-13: Repair, upgrade or replace Water and Sewer infrastructure for 175 connections as needed	
Mitigation Goal/Objective:	1/1.5
Site and Location	Original Bayou Vista
Background/Next Steps:	In past disaster events, emergency repair of connections post- disaster was costly and delayed water and sewer repairs and service. Many connectors were in need of replacement, repair, or upgrade. Ensuring that all connections are in working order by repairing, upgrading, or replacing connection as needed prior to events will reduce damages such as sewage backflow and be cost effective by reducing manpower and emergency repairs post disaster.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Drought, Wildfire (Urban and Rural), Severe Winter Storm, Coastal Erosion and Retreat
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$750,000
Potential Funding Sources:	Office of Rural Community Affairs, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program,406 Public Assistance Program(following federal disaster declaration), Us Army Corps of Engineers-Small Flood Control Projects, USDA Natural Resources Conservation Service-Emergency Watershed Protection Agency, Texas Water Development Board(Development Fund II)-Texas Water Development Fund, USDA Natural Resources Conservation Service-Watershed Protection and Flood Prevention Program, EPA-Non-point Source Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from BV-13 and updated implementation schedule. Project is deferred until adequate funding can be obtained. Will apply for a grant when funding and opportunity become available	

188

BV-2011-15: Implement water conservation awareness campaign for residents	
Mitigation Goal/Objective:	1/1.5
Site and Location	Bayou Vista, Omega Bay and Original Bayou Vista
Background/Next Steps:	Bayou Vista can experience drought albeit infrequent. Temperatures can exceed 100° F for consecutive days in the summer months. Reminding resident of these dangers and how to be aware of and prepared for them

	will mitigate for such damages that can be fatal.
Hazard(s) Addressed:	Drought, Extreme Heat, Wildfire (Urban and Rural), Land Subsidence, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$2,000 + Staff time
Potential Funding Sources:	General fund, Water Resources, Texas Water Development Board, Texas Commission on Environmental Quality
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-15 and updated implementation schedule. The city continues to provide information on water conservation when appropriate	

189

BV-2011-16: Install a deflective shield over two (2) clarifiers	
Mitigation Goal/Objective:	1/1.2
Site and Location	Wastewater Treatment Plant, 3031 Highway 6
Background/Next Steps:	Severe storms cause damages to components of wastewater treatment plant. Clarifier will protect mechanisms in treatment facilities, thus allowing continuation of operation and ongoing availability of utilities for customers.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Lightning, Tsunami, Coastal Erosion and Retreat, Earthquake
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$40,000
Potential Funding Sources:	Pre-Disaster Mitigation Grant Program, Hazard Mitigation Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from BV-16 and updated implementation schedule. Project is deferred until adequate funding can be obtained. Will apply for a grant when funding and opportunity become available	

190

BV-2011-17: Implement a plan for shutting down water and sewer systems	
Mitigation Goal/Objective:	1/1.5
Site and Location	Wastewater Treatment Plant, 3031 Highway 6
Background/Next Steps:	Back flows and bacterial contamination occur due to system not being shut down during fire or other weather events. Continuous flushing is unnecessary and wasteful. Multiple hazards can make shutting the water and sewer system down necessary in order to avoid contamination of the

	system or a loss of pressure system wide from breakage at a distribution point.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Wildfire (Urban and Rural), Earthquake, Tsunami, Windstorm, Severe Winter Weather
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$1,000 + Operator Time
Potential Funding Sources:	General Funds, Hazard Mitigation Grant Program, Pre- Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-17 and updated implementation schedule. This action is continuous in nature.	

191

BV-2011-19: Implement a plan for the hardening the water system during freeze events	
Mitigation Goal/Objective:	1/1.5
Site and Location	Wastewater Treatment Plant, 3031 Highway 6
Background/Next Steps:	Freeze events are problematic to the water treatment plan when extreme temperature and freezing occurs. Winterizing the water system will insure the city residents, schools, and businesses do not have to close due to frozen water systems.
Hazard(s) Addressed:	Severe Winter Storm
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$5,000
Potential Funding Sources:	General funds, Pre-Disaster Mitigation Grant Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-19 and updated implementation schedule. The city will continue to implement protection measures to the wastewater treatment plan when warranted by excessively cold temperatures.	

192

BV-2011-20: Implement a plan for minimizing damage due to pipeline breach or failure	
Mitigation Goal/Objective:	1/1.5
Site and Location	Bayou Vista, Omega Bay and Original Bayou Vista
Background/Next Steps:	Galveston county is one of the top areas in the nation for oil and gas refining. Multiple miles of fuel pipelines traverse residential neighborhoods underground in Galveston county. A community that has a response plan in place will suffer less damage and fewer or no lies will be lost to

	damages from a fuel pipeline breach.
Hazard(s) Addressed:	Pipeline Failure, Hazardous Materials, Land Subsidence
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$4,000
Potential Funding Sources:	General funds, FEMA- Emergency Management Performance Grants, FEMA-All Hazards Operational Planning, FEMA-Hazardous Materials Assistance Program, USDA-Environmental Quality Incentives Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-20 and updated implementation schedule. There has not been a need to implement this action to date.	

193

BV-2011-21: Identify and implement all public buildings and critical facilities for flood proofing and hardening needs	
Mitigation Goal/Objective:	1/1.2
Site and Location	Bayou Vista, Omega Bay, Original Bayou Vista
Background/Next Steps:	Critical facilities must function throughout a disaster or in a worst case as Hurricane Ike provided; the critical facility must be quickly shut down and patients/tenants safely transported to a supporting facility. The city will explore opportunities to install mitigation measures such as shutters, flood proofing, roofing, etc. as funding and opportunities allow.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Coastal Erosion and Retreat, Earthquake, Expansive Soils
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	General funds, FEMA- Emergency Management Performance Grants, FEMA-All Hazards Operational Planning, FEMA-Hazardous Materials Assistance Program
Lead Agency/Department Responsible:	Galveston County MUD #12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from BV-21 and updated implementation schedule. Project is deferred until adequate funding can be obtained. Will apply for a grant when funding and opportunity become available	

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BV 2016-1: Install / maintain severe weather warning systems	
Mitigation Goal/Objective:	1/1.1
Site and Location:	To be determined
Background/Next Steps:	Weather warning systems complement the methods of warning already used by the County Emergency Operation Center and the National Weather Service. Identify a site location and develop cost estimate as needed. For installed sirens, provide routine testing and inspection. Apply for funding when available.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$35,000
Potential Funding Sources:	HMGP, general fund
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2026

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BV 2016-2: Stormproof/retrofit critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.2
Site and Location:	Municipal Building (includes city hall, police, fire, and administrative services)
Background/Next Steps:	New construction of public buildings/infrastructure should include advanced mitigation techniques when practical. Measures may include, but are not limited to, roof and foundation supports, shutters, shatter-proof and high wind doors and windows, etc. During the planning process, The city expressed a potential need for a new municipal building; however, needs may require other new construction over the next five years. Bayou Vista will develop plans and specifications to include mitigation measures where practical on future initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, CDBG, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2026

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BV 2016-3: Secure generators for existing and new critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.4
Site and Location:	2929 Highway 6 (City Hall, Police, and Fire) and potential new Municipal building, and Community Center (783c Marlin)
Background/Next Steps:	Generators are essential for providing continual operations in the event of a disaster. As funding becomes available, the city will apply for grants to install/upgrade generators to support existing or new facilities/infrastructure.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$400,000
Potential Funding Sources:	HMGP, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

BV 2016-4: Continue efforts on mitigation Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Bayou Vista, Omega Bay, Original Bayou Vista
Background/Next Steps:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Section 20 provides a summary of the RFC/SRL properties that have not been mitigated, Mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be explored with property owners as funding and opportunities arise.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	City Administration and applicable state and county agencies
Implementation Schedule:	Continuous Action

BV 2016-5: Install lightning grounding systems and protection devices on critical facilities/infrastructure	
Mitigation Goal/Objective	1/1.2
Site and Location:	City-owned facilities and infrastructure
Background/Next Steps:	Lightning strikes can create outages to essential water and sewer services as well as invite unnecessary damage to critical facilities. Consider a program to establish lightning grounding systems on critical water and sewer system elements and other facilities prone to strikes.
Hazard(s) Addressed:	Lightning
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	General funds
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	2016-2026

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BC 2016-6: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

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BC 2016-7: Continue to enforce / improve regulations and permit requirements to promote hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Regulations and permit requirements are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop as required to address all hazards prone to the area and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

BV 2016-8: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

BC 2016-9: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

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BC 2016-10: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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BV 2016-11: Improve / maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS) programs	
Mitigation Goal/Objective	2/2.5
Site and Location:	Bayou Vista, Omega Bay, Original Bayou Vista
Background/Next Steps:	Continue participation in the NFIP program which offers incentives to reduce insurance premiums
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City administration and applicable departments
Implementation Schedule:	Continuous action

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BV 2016-12: Promote emergency preparedness/continuity of operation plans	
Mitigation Goal/Objective:	3/3.2
Site and Location:	Bayou Vista, Omega Bay, Original Bayou Vista
Background/Next Steps:	Family emergency preparedness plans establish how families will get to a safe place; how to contact one another; how to get back together; and what families will do in different situations. Continuity of operation plans establishes a clear chain of command, line of succession, and procedures for backup or alternate emergency facilities in case of extreme emergency or disaster.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City administration and applicable departments
Implementation Schedule:	Continuous action

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Table 24.13 - Clear Lake Shores

CLS-2006-2: Implement stormwater management practices	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Citywide
Background/Next Steps:	The Stormwater management plan is focused on six minimum measures regarding what is being done to prevent stormwater pollution. Annual reporting and renewals are required to ensure compliance is met.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storms, Windstorm, Hailstorm, Tornado, Tsunami, Dam/Levee Failure
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$5,000
Potential Funding Sources:	Local funds
Lead Agency/Department Responsible:	City of Clear Lake Shores
Implementation Schedule:	Continuous action
Analysis	
2010 - This action will be deferred as an ongoing activity	
2016 - Renumbered action from CLS (Past Action)-2 and updated implementation schedule. Renewal of MS4 Permit has been completed.	

CLS 2011-2: Review drought plan with WCID 12 and implement when necessary	
Mitigation Goal/Objective:	1/1.1
Site and Location:	Citywide
Background/Next Steps:	The drought plan identifies measures to prevent damage to existing structures through water conservation measures, including foundation damage from cracking soil in high heat. While maintaining the plan is the responsibility of the WCID, Clear Lake Shores will contribute perspective and help to create awareness of water conservation measures
Hazard(s) Addressed:	Drought, Extreme Heat, Wildfire (Urban and Rural), Expansive Soils
Mitigation Strategy:	Prevention
Priority:	Moderate
Estimated Cost:	No additional cost
Potential Funding Sources:	No Funding Required
Lead Agency/Department Responsible:	WCID 12
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from CLS-2 and updated implementation schedule. Clear Lake Shores continues to cooperate with WCID when they implement their drought contingency plan.	

CLS 2011-4: Educate and alert citizens on the dangers of flooding. Inform residents of the benefits of the National Flood Insurance Program and purchase of flood insurance.	
Mitigation Goal/Objective:	3/3.1
Site and Location	Citywide
Background/Next Steps:	Frequent flooding due to hurricane and storm tidal surge is impetus for residents to purchase flood insurance to protect building and contents from flooding. This action would provide awareness for potential builders of hazards in the development of new structures
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$1,000
Potential Funding Sources:	General fund
Lead Agency/Department Responsible:	Emergency management
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from CLS-4 and updated implementation schedule. The city continues to enforce their flood damage control ordinance.	

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CLS 2011-8: Conduct mass notification for pipeline breach or release of hazardous materials emergencies related to in□place protection and/or evacuation	
Mitigation Goal/Objective:	3/3.1
Site and Location:	Citywide
Background/Next Steps:	A mass notification system could prevent damage to existing structures if people have proper warning time to strengthen buildings. Project could prevent future accidents and injuries
Hazard(s) Addressed:	Pipeline Failure, Hazardous Materials
Mitigation Strategy:	Public Education and Awareness
Priority:	Moderate
Estimated Cost:	No cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Emergency management and applicable agencies
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from CLS-8 and updated implementation schedule. Mass notification system in place and operating and there have been no known occurrences to date.	

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CLS 2011-9: Participate in pipeline group training pertaining to responding to pipeline emergencies, evacuation, in□place protection of residents	
Mitigation Goal/Objective:	2/2.3
Site and Location	Citywide
Background/Next Steps:	Early warning of dangerous conditions allows time for individuals to take appropriate action to save lives and property. With appropriate training and awareness, city staff will be better prepared to keep citizens safe from all hazards by learning how to integrate a mass notification system.
Hazard(s) Addressed:	Pipeline Failure, Hazardous Materials
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	First responders
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from CLS-9 and updated implementation schedule. The city participates in annual training and continually communicates with the area pipeline groups.	

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CLS 2011-16: Review current building codes and periodically review code and update accordingly.	
Mitigation Goal/Objective:	2/2.2
Site and Location	Citywide
Background/Next Steps:	Not all possible natural hazards are addressed in the existing building codes or inspection codes. Reviewing existing codes will determine how they can be improved to better protect life and property. Buildings built or retrofitted to higher standard will better withstand hazardous weather events.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, , Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Building Department
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from CLS-16. The city adopted the 2015 IBC in January 2016.	

CLS 2016-1: Implement public awareness campaigns for all hazards	
Mitigation Goal/Objective:	3/3.1
Site and Location	Citywide
Background/Next Steps:	Public awareness campaigns are launched in preparation of the seasons in which the storms tend to take place. This action captures the overall efforts of the city to coordinate and launch outreach initiatives with applicable agencies when appropriate.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	No cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Emergency Management and applicable departments/agencies
Implementation Schedule:	Continuous Action
Analysis	
2016 – This action combined previous mitigation actions CLS-1, 12, 18. The city continues to provide information through town meetings, social media, etc. according to their public participation planning procedures and as specific events warrant action.	

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CLS 2016-2: Continue efforts on mitigation Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Section 20 provides a summary of the RFC/SRL properties that have not been mitigated, Mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be explored with property owners as funding and opportunities arise.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	City Administration and applicable state and county agencies
Implementation Schedule:	Continuous Action
Analysis	

2016 – The city continues to promote efforts to implement mitigation measures with property owners when opportunities and funding become available.

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CLS 2016-3: Upgrade drainage systems and culverts	
Mitigation Goal/Objective	1/1.5
Site and Location:	Citywide
Background/Next Steps:	The drainage systems and culverts throughout the area are frequently impacted by flash flood and severe weather events. The city adopted their master drainage plan in 2016. The next step is to prioritize drainage systems for upgrades and implement when funding and opportunity presents itself.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Windstorm, Hailstorm, Severe Winter Weather
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	CDBG, HMGP, General Funds,
Lead Agency/Department Responsible:	City Administration and applicable department and water district staff
Implementation Schedule:	Continuous Action

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CLS 2016-4: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

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CLS 2016-5: Continue to enforce / improve regulations and permit requirements to promote hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Regulations and permit requirements are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop as required to address all hazards prone to the area and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

CLS 2016-6: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

CLS 2016--7: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

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CLS 2016-8: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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CLS 2016-9: Improve / maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS) programs	
Mitigation Goal/Objective	2/2.5
Background/Next Steps:	Continue participation in the NFIP program which offers incentives to reduce insurance premiums
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City administration and applicable departments
Implementation Schedule:	Continuous action

235 *Table 24.14: Friendswood*

F-2009-1: P Action: Improve / maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS) programs	
Mitigation Goal/Objective:	2/2.2
Site and Location:	Citywide
Background/Next Steps:	Detailed records are to be compiled for use with CRS rating review with ISO. Steps to achieve this action include, but may not be limited to the following: • Continue to improve CRS rating • Review/update floodplain regulations/ordinances as appropriate • Review/update city's regional drainage plan • Coordinate/cooperate with Harris County Flood Control District and USACE with regard to Clear Creek Federal Flood Protection Project • Require elevation certificates on all construction plans submitted for development • Maintain annual progress records of RL/SRL properties • Continue adherence to the open space requirements • Continue annual outreach for structures located in the SFHA • Continue to implement the drainage system maintenance program • Continue homeowner participation in the NFIP
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	Staff time
Potential Funding Sources:	General budget
Lead Agency/Department Responsible:	Community Development, Floodplain Manager, Office of Emergency Management
Implementation Schedule:	Continuous action
Analysis	
2016- This action item was carried over from 2003 and 2009 mitigation plans titled Flood-Events Floodplain Management and CRS Recertification. • CRS rating was downgraded in 2015 to 7. New requirements were initiated by ISO & NFIP regarding activities which must be completed and/or maintained to achieve each rating level. • Letters are sent annually to all property owners in the SFHA to ensure they are aware of any changes in the CRS rating; FEMA updated information, the NFIP program, etc. • Promote flood insurance through "Focus on Friendswood" spring newsletter • RL/SRL properties are maintained in database and verified against NFIP/FEMA records on a routine basis.	

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F 2009-2: Continue efforts on mitigation Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	The Community Development Department maintains the RL/SRL property database for all flood events in the city, and is updated and reviewed as necessary. Staff seeks funding sources to assist property owners with elevation, relocation and/or buyout of RL/SRL properties.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Staff time
Potential Funding Sources:	General budget
Lead Agency/Department Responsible:	Community Development, Floodplain Manager, Office of Emergency Management and applicable state and county agencies
Implementation Schedule:	Continuous Action
Analysis	
2016- This action item was carried over from 2003 and 2009 mitigation plans titled NFIP Elevation, Relocation & Acquisition. • 112 properties were mitigated following TS Allison (buyout) • 14 properties were mitigated through an elevation program administered through Galveston County in 2013-2014	

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F 2009-3: Maintain public notification and warning programs/systems	
Mitigation Goal/Objective	1/1.1
Site and Location:	Citywide
Background/Next Steps:	The city provides notifications to the public through the following programs/systems: • Friendswood Information Radio 1650 AM • KTRH 740 AM • TV-City of Friendswood PEG Channel 17 • E-mail alerts • Outdoor warning systems • Storm spotters • Code Red • Social media
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Land Subsidence , Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High

Estimated Cost:	Staff time
Potential Funding Sources:	General budget
Lead Agency/Department Responsible:	Community Development, Floodplain Manager, Office of Emergency Management and applicable state and county agencies
Implementation Schedule:	Continuous Action
Analysis	
2016- This action item was carried over from 2003 and 2009 mitigation plans titled Public Warning System. • The city disseminates alert warnings as needed through the various media outlets listed	

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F-2009-4: Construct and expand evacuation routes	
Mitigation Goal/Objective:	1/1.1
Site and Location:	Brittany Bay Blvd to Pearland Pkwy Blackhawk Blvd to FM 2351 and Beamer Road
Background/Next Steps:	Within Friendswood, there are limited east/west corridors to efficiently move traffic through northern Galveston County. Sunset Drive and Blackhawk Blvd both terminate at Farm-to-Market roadways (528 & 2351) which requires motorists to travel to FM 518 or I-45; both of which are heavily congested. The construction of Friendswood Parkway would greatly improve mobility and become a vital evacuation route in northern Galveston County. • Construct Friendswood Parkway in the northeaster portion of the city to connect with League City Pkwy (Brittany Bay Blvd) to provide additional evacuation route • Construct Blackhawk Blvd to connect FM 2351 with Beamer Road. • Within Friendswood, there are limited east/west corridors to efficiently move traffic. • Blackhawk Blvd currently terminates at Farm-to-Market roadways (528 & 2351), which requires motorist to travel to FM 518 or I-45; both of which are heavily congested.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tsunami, Dam and Levee Failure, Pipeline Failure, Hazardous Materials
Mitigation Strategy:	Structural, Emergency Services
Priority:	High
Estimated Cost:	$30,000,000
Potential Funding Sources:	Capital improvement funding, bond, grant acquisition
Lead Agency/Department Responsible:	• Public Works Department • Fire Marshal's Office
Implementation Schedule:	Design, bid, and build bridge structure within the next 5 to 10 years

Analysis	
2016-This is an amended/updated mitigation item carried over from the 2003 and 2009 mitigation plans titled Major Thoroughfare Planning. This is a continuous action to be completed as CIP funding and/or grant funds are made available.	

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F-2009-5: Monitor water supply and establish conservation regulations	
Mitigation Goal/Objective:	2/2.5
Background/Next Steps:	• Develop a regular schedule to monitor drought conditions; i.e., monthly or quarterly, through the U.S. Drought Monitor website. • Report drought conditions to Public Works Department. • Report drought conditions to Department Heads. • If necessary, implement the city's Drought Contingency Plan in coordination with the Decision Makers and Department Heads. • Notify public of status of the Drought Contingency Plan through PSAs.
Hazard(s) Addressed:	Drought, Extreme Heat, Wildfire (Urban and Rural), Land Subsidence
Mitigation Strategy:	Prevention, Property Protection, Natural Resource Protection, Emergency Services
Priority:	Moderate
Estimated Cost:	Minimal; can be absorbed by staff
Potential Funding Sources:	Annual budget
Lead Agency/Department Responsible:	Office of Emergency Management, Public Works Department, City Manager, Public Information Officer
Implementation Schedule:	Continuous action
Analysis	
2016-This action was carried over from the 2009 mitigation plan. In 2014, the city purchased 12 million gallons/day surface water from the City of Houston. At this capacity, the supply will serve up to 57,000 people and will sustain the city to total build-out status. The City will continue to monitor water supply and update regulations as required.	

241

F-2016-1: Purchase and install warning equipment within the nine city parks to provide early warning of approaching storms	
Mitigation Goal/Objective:	1/1.1
Site and Location:	Locations: • Baker Road (17.60 acres) • Centennial Park (58.40 acres) • Friendswood Sports Park (19.85 acres) • Lake Friendswood (42.00 acres) • Leavesley Park (2.90 acres) • Old City Park (14.70 acres) • Renwick Sports Complex (16.48 acres) • 1776 Memorial Park (2.90 acres) • Stevenson Park (includes city swimming pool 27.00 acres)
Background/Next Steps:	Baker Road Park, 1776 Park & portions of Stevenson Park are located within a floodplain or the floodway. Renwick Park, Friendswood

	Sportspark, Centennial Park, Lake Friendswood, Old City Park & Leavesley Park are not located within a floodplain or floodway. Total Park (241.02 in acres)
Hazard(s) Addressed:	Tornado, Windstorm, Hailstorm, Lightning
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$86,900
Potential Funding Sources:	HMGP $65,175 City budget $21,725
Lead Agency/Department Responsible:	Office of Emergency Management/Fire Marshal's Office, Parks and Recreation Department
Implementation Schedule:	2016-2020

242

F-2016-2: Purchase Tiger Dam Systems	
Mitigation Goal/Objective:	1/1.2 and 1.3
Site and Location:	Public Works Complex
Background/Next Steps:	The public works complex of approximately 3 acres floods on average once every 5-6 years. Access to the public works complex is inhibited during flood events. Elevation of current office, lunchroom, equipment, fueling station and other outbuildings is not feasible as access to entire complex is blocked during flood events. Because the entire facility is located in the floodway, the possibility of installation of a permanent backup generator is not feasible. Office portion of current facility is insured by TML and NFIP is mandatory. **Tiger Dam System Information** • The system consists of elongated flexible tubes which can be staked, joined end to end & filled with water (flood water, 2" pump, fire hydrant or garden hose. • Tubes can be stacked up to 32" high, and linked together seamlessly (triangular in shape) • They are flexible and can form any shape. • Water can be drained back into Clear Creek once the flood waters have subsided. • Reusable • Can possibly divert up to 70-100% of floodwaters. **Tiger Dam vs. Facility Relocation** • Estimated cost of relocating the Public Works Building, Parks & Recreation storage unit, and securing enough property to house all equipment is estimated to cost $5-6 million dollars (including property purchase). • Projected property size would be 3-5 acres.

	Location of property large enough to house such a facility is going to be an issue: • If located within the COD (Community Overlay District) where any portion of the property lies within 300' of the major thoroughfares; i.e., FM 518, FM 528, FM 2351, Bay Area Blvd, and Friendswood Lakes, the structures would have to include fenestrations which will increase cost of construction, etc. for the structures.
Hazard(s) Addressed:	Flooding, Tsunami, Hurricane/Tropical Storm
Mitigation Strategy:	Property Protection
Effect on new/existing buildings:	Location of property large enough to house such a facility is going to be an issue: • If located within the COD (Community Overlay District) where any portion of the property lies within 300' of the major thoroughfares; i.e., FM 518, FM 528, FM 2351, Bay Area Blvd, and Friendswood Lakes, the structures would have to include fenestrations which will increase cost of construction, etc. for the structures. Estimated cost for property purchase and relocation for all facilities is estimated at $4-6 million.
Priority:	High
Estimated Cost:	Estimated cost $450,000 to Utilize Tiger Dams to protect the following buildings at their current location between 3 and 4 feet high (3 – 42" high tubes) • Public Works Facility (600'), Parks Facility (350'), & Public Works & Parks Department Fuel Station (200')
Potential Funding Sources:	Grant
Lead Agency/Department Responsible:	Public Works Department, Parks & Recreation Department, Office of Emergency Management
Implementation Schedule:	2016-2020

243

F-2016-3: Upgrade and renovate Public Works Building and Community Services/Parks Facility	
Mitigation Goal/Objective:	1/1.2
Site and Location:	1306 and 1324 Dogwood
Background/Next Steps:	• The current facilities are located in Hurricane Category 4 Storm Surge Zone. • Current facility was built in 1978. • Current facility has approximately 2400 square feet, and is not sufficient to accommodate current office staff members (public works, engineering, projects and design). • Current facility needs to be improved to adhere to current codes, i.e., IBC, IFR, ADA, etc.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning
Mitigation Strategy:	Property Protection

Priority:	High
Estimated Cost:	Projected cost is $1.4 million
Potential Funding Sources:	CIP or bond initiative
Lead Agency/Department Responsible:	Community Development, Public Works Department, Engineering Department, Capital Projects Department
Implementation Schedule:	2016-2026

244

F-2016-4: Purchase and installation of a back-up natural gas generator at the Activity Center	
Mitigation Goal/Objective:	1/1.4
Site and Location:	416 Morning Side
Background/Next Steps:	• The current facility is being utilized as the city's activity center and offers numerous and various activities to the senior population. • The current facility has a diesel generator and would like to switch to natural gas due to current fuel issues. • During periods of extreme heat and/or power outages, with the addition of back-up power, the library could be utilized as a cooling station for residents lacing the ability to cool their homes. • The Activity Center has also been identified as a feeding station for the city staff members who are assigned as essential emergency staff prior to, during, and following a severe emergency event. • The Activity Center would also be capable of providing a source for shelter arrangements for the essential emergency staff members.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Lightning, Severe Winter Storm, Tsunami, Extreme Heat
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$50,000-$80,000 for natural gas generator and installation.
Potential Funding Sources:	HMGP
Lead Agency/Department Responsible:	• Community Development Department o Capital Improvements • Fire Marshal's Office
Implementation Schedule:	2016-2020

245

F-2016-5: : Purchase and installation of Back-Up Generator for Friendswood Animal Control Facility and Friendswood Public Library Expansion	
Mitigation Goal/Objective:	1/1.4
Site and Location:	3000 W. Parkwood (Animal Control) 416 S. Friendswood (Library)
Comments:	**Purchase and installation of a back-up natural gas generator at the Friendswood Animal Control Facility** • Wind events will likely cause damage to residential fences which will impede the ability to maintain and/or provide a safe environment for pets.

	• Flood events will displace wildlife and potentially force them into neighborhoods. • Hazardous material releases and/or spills have the potential to displace or contaminate wildlife and pets. **Purchase and installation of a back-up natural gas generator at the New Expansion to Friendswood Public Library** • November 2013 Tax Bond Proposition approved the 21,000 square foot expansion to the existing footprint of the Public Library. • Current facility has a natural gas back-up generator. • Projected 211 KW expected total load (current load is 138 KW)
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	Animal Control Facility • $50,000-$80,000 for generator and installation. Public Library • $80,000-$100,000 for generator and installation
Potential Funding Sources:	HMGP
Lead Agency/Department Responsible:	• Community Development Department o Capital Improvements • Fire Marshal's Office
Implementation Schedule:	2016-2020, or when library expansion is completed

246

F-2016-6: Installation of a Fuel Station for City Vehicles	
Mitigation Goal/Objective:	2/2.6
Site and Location:	Feasible location would be at Public Safety Building -1400 Whitaker Drive
Background/Next Steps:	• Design and Install a compartmentalized fuel tank • Design a 12,000 gallon combination diesel and no-lead fuel tank. • This would be compartmentalized tank with the capacity to provide 8,000 gallons no-lead fuel and 4,000 gallons diesel fuel. • AST – Above ground storage tank • The design will include the storage tanks, dispensing pumps, card management system, and covered awning over tank and fueling area
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Lightning, Tsunami, Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Earthquake
Mitigation Strategy;	Emergency Services
Priority:	Moderate
Estimated Cost:	$500,000 (generator, gas pumps, storage tanks, installation, and concrete pad)
Potential Funding Sources:	Grants and/or city operating funds

Lead Agency/Department Responsible:	Public Works, Community Development, Office of Emergency Management
Implementation Schedule:	To be accomplished as soon as possible after funding is obtained; or within the next five years.

247

F-2016-7: Obtain a portable reader board	
Mitigation Goal/Objective:	2/2.6
Background/Next Steps:	• Purchase and maintain a portable reader board mounted on a trailer that could be deployed during emergencies and other events within the City. • The reader board would be accessible to all of Friendswood emergency services as well as Public Works and Parks and Recreation. • This project would convey public information to the public during evacuations and other emergencies.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Pipeline Failure, Hazardous Materials, Earthquake
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$40,000 (reader board and trailer)
Potential Funding Sources:	Grants and/or city operating funds
Lead Agency/Department Responsible:	• Police Department • Fire Marshal's Office
Implementation Schedule:	Upon funding and approval, the equipment could be purchased and implemented within one year.

248

F-2016-8: Acquire portable lighting devices to be used at major intersections during power outages	
Mitigation Goal/Objective:	2/2.6
Background/Next Steps:	Purchase 4 portable light towers on trailers to be utilized at four (4) major intersections during extended power outages to protect residents while driving into and/or outside the city. • Intersection of FM 528 and FM 518 • Intersection of FM 518 & FM 2351 • Intersection of FM 528 and Moore Road • Intersection of FM 528 and Bay Area Boulevard
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Severe Winter Storm, Earthquake, Tsunami
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	Per unit cost of $10,000 to $40,000 Minimum costs: $40,000 Maximum costs: $160,000

Potential Funding Sources:	Grant funding, annual city budgeting process
Lead Agency/Department Responsible:	Public Works, Office of Emergency Management
Implementation Schedule:	2016-2020

249

F-2016-9: Upgrade drainage systems and culverts	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Several locations within the city
Background/Next Steps:	These projects are in areas that have already been built out and have experienced flooding in the past. These projects are designed to protect existing structures from future flooding losses. **FM518 DRAINAGE IMPROVEMENTS – PHASE 2** o FM 2351 to Willowick o Convey the 100 year flows into Clear Creek o Component of the 2007 Master Drainage Plan Phase 2 Estimated cost $2.7 million **ANNALEA/WHITEHALL/KINGS PARK DRAINAGE – DRAINAGE IMPROVEMENTS PHASE 2** o Initial phase of project completed in 2005 o Upsizing storm sewer system to reduce potential flooding Estimated cost $862,000 **Shadowbend Drainage Improvements Phase 2** o Component of 1993 master Drainage Plan Phase 1 o Upsizing storm sewer system to reduce potential flooding Estimated cost $416,000 **Sunmeadow Drainage Improvements Phase 2** o Component of 1993 Master Drainage Plan Phase 1 o Initial phase of project completed in 2005 o Upsizing storm sewer system to reduce potential flooding Estimated cost $3.1 million **Tributary 2 Drainage/Outfall Improvements** o Component of 2004 TxDOT study o First 3 segments of project have been completed o From FM2351 to Cowards Creek o Placement of 3,300 linear feet of box culverts o Possible partnership with Galveston County Consolidated Conservation District Estimated cost $3.6 million
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Windstorm, Tornado, Severe Winter Weather, Earthquake, Land Subsidence, Expansive Soils
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$10.678 million
Potential Funding Sources:	Capital Improvements Budget & grant funding
Lead Agency/Department Responsible:	Community Development, Public Works-Engineering & Capital Projects

Implementation Schedule:	• Capital improvements are an ongoing program within the city. • Projects are proposed and prioritized though City Council. • Project completion is dependent upon the securing of funding either through the general operating budget or other avenues; i.e., bonds, grants, loans, etc.

250

F-2016-10: Maintain drainage systems and culverts	
Mitigation Goal/Objective:	1/1.2, 1.3, 1.5
Site and Location:	Citywide
Comments:	Mitigate the Impact of Flooding to Safeguard against the Loss of Life and/or Damage to Structures • Funding available through Public Works operating budget to clean & recut drainage ditches, complete work orders related to conveyance systems, remedy localized ponding issues. • Pursue sub-regional drainage improvements in the built environment to reduce the impact of flooding in areas outside the designation of official capital projects
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Windstorm, Tornado, Severe Winter Weather, Earthquake, Land Subsidence, Expansive Soils
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$1.4 million
Potential Funding Sources:	To be addressed in the annual budget process and capital improvements program
Lead Agency/Department Responsible:	• Public Works Department - Streets & Drainage and Engineering • Community Development - Floodplain Manager
Implementation Schedule:	Continuous action

251

F-2016-11: Mary's Creek Bridge Elevation ("Devils Dip")	
Mitigation Goal/Objective:	1/1.5
Site and Location:	▪ Mary's Creek Bridge ▪ Alleviate and/or eliminate potential flooding of residential properties in Imperial Estates Section 2.
Background/Next Steps:	• Following TS Allison in 2001, 38 residential properties were mitigated (buyout) following the severe flooding. The city-owned properties have been included to the original footprint of 1776 Memorial Park expanding the park. The city has installed an outdoor Frisbee field for use by all city residents. • Replace the current pedestrian bridge across Mary's Creek connecting 1776 Park to Imperial Estates Section 2. The current bridge, which has been in place since 1962, was closed to vehicular traffic in the early 2000s. Its low profile acts as blockade to flow within Mary's Creek during heavy rain events.

	• Moreover, shortly following those extreme events, substantial effort is expended on the part of the Galveston County Consolidated Drainage District to remove natural debris that collects within the bridge's substructure further impacting the flow within the Creek and causing flooding of the surrounding properties. • This project has been included in the city's Master Park Plan.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami
Mitigation Strategy:	Property Protection, Structural
Priority:	High
Estimated Cost:	$100,000 for the reconstruction of an elevated bridge which will not impede the flow of water and act as a "dam" when debris flows down Mary's Creek
Potential Funding Sources:	To be addressed in the annual budget process, capital improvement program, and cooperation with Galveston County Consolidated Drainage District
Lead Agency/Department Responsible:	• Public Works Department • Office of Emergency Management • Galveston County Consolidated Drainage District
Implementation Schedule:	Design, bid, and build bridge structure within the next 5 years

252

F-2016-12: Develop a RLAA (Repetitive Loss Area Analysis) to satisfy CRS rating through the ISO	
Mitigation Goal/Objective:	2/2.1
Site and Location:	Citywide
Background/Next Steps:	• Research and develop a RLAA addressing all RL/SRL properties within the city. • Decrease flood losses in designated flood hazard areas • Potentially decrease losses and damages to those properties classified as RL and SRL • Ensure all new construction adheres to BFE certification criteria • Plan and provide open space area for water detention/retention areas to alleviate and/or prevent flooding of homes and commercial facilities
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Staff time for research and compilation of the RLAA
Potential Funding Sources:	General fund through annual budget process/apply for planning grant funding
Lead Agency/Department Responsible:	Community Development – Floodplain Manager Office of Emergency Management/Fire Marshal's Office Assistance from Hazard Mitigation Committee
Implementation Schedule:	2016-2020

253

F-2016-13: Bury Power Lines	
Mitigation Goal/Objective:	1/1.3 and 1.5
Site and Location:	Citywide
Background/Next Steps:	• The Community Development Department requires all potential developers to submit their potential plans and participate in a review process which includes Community Development, Fire Marshal's Office, Public Works and Engineering. • All future developments are required to bury power lines to prevent disruption by protecting said lines from wind and flying debris. • By requiring future developments to bury power lines, interruption of power can be minimized in more portions of the community.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Wildfire (Urban and Rural), Severe Winter Storm, Tsunami
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	Developers, utility companies
Lead Agency/Department Responsible:	Community Development, Engineering, Fire Marshal's Office
Implementation Schedule:	Begin and continue this program through the next five years.

254

F-2016-14: Continue to enforce/improve ordinances and regulations to promote hazard mitigation strategies	
Mitigation Goal/Objective:	2/2.2
Background/Next Steps:	• Adopt the 2012 International Building Code to include3 ASCE-24-10 and the 2012 International Fire Code (IFC). The city currently operates under the 2009 IBC which includes the ASCE-24-05 Flood Resistant Design and Construction and the 2009 IFC. • Establish design standards for buildings located in areas susceptible to storm surge. • Adoption of these codes will require higher elevations in structures in inundation zones. • Require deep foundations in order to avoid erosion and scour. Plans for future storm surge heights due to potential rise in sea levels.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention, Property Protection
Priority:	High
Estimated Cost:	• Cost to implement the adoption of these codes is limited to staff review time of the 2012 IBC and IFC, and submitting suggested amendments to City Council for approval. • Additional staff time would be required if it was recommended that the

	city adopt the 2015 IBC and IFC.
Potential Funding Sources:	Annual budget
Lead Agency/Department Responsible:	Community Development - Design Review Committee (DRC)
Implementation Schedule:	This process could begin in Fiscal Year (FY) 2015 and be completed within a year.

255

F-2016-15: Database Development & Maintenance for RL/SRL Properties - Elevation, Relocation & Acquisition-	
Mitigation Goal/Objective:	2/2.5

Background/Next Steps:	▪ Develop a user friendly database for entry of all designed RL and SRL properties as well as those properties located in SFHA areas.
	▪ Maintain accurate information regarding BFE.
	▪ Designate a coordinator to maintain integrity of the system.
	  ▪ Database development will ensure that documentation of flood losses is consistent and up-to-date.
	  ▪ The database will assist to ensure map coordinates and property identification is consistent.
	  ▪ Enhance inventory control of all structures in or out of SFHA designated areas (number of structures/parcels, improvement values; total land area) to assess loss liability following a disaster.

Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection and Prevention
Priority:	High
Estimated Cost:	• The development of the RL/SRL database could be accomplished with the current staffing patterns. • Current database of mitigated buyout lots is currently being handled with current staffing pattern.
Potential Funding Sources:	City budget
Lead Agency/Department Responsible:	Floodplain Manager, Community Development, Parks & Recreation Department, Office of Emergency Management
Implementation Schedule:	2016-2020

256

F-2016-16: Update City Storm Surge Maps to Reflect the NWS Predictions	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	The updated maps will display potential storm surge by water depth based upon the NWS predicted storm surge and projected track for landfall. The new maps may more accurately display water depth in areas within the city. • The storm surge maps currently utilized to depict storm surge are based upon hurricane category wind speeds. • As indicated during Hurricane Ike (2008), the storm surge recorded at Bolivar Peninsula was 20', however, surge at Kemah (entrance of Clear

	Lake) was recorded at 10-12 feet, which did not affect any structures within the city. • Storm surge water depth is in direct relation to the path or track of the hurricane. • A hurricane making landfall nearer the west portion of Galveston Bay or west portion of Galveston County will affect the city more than a hurricane tracking over the east portion of Galveston Bay (as occurred during Hurricane Ike). • The updated maps will display potential storm surge by water depth based upon the NWS predicted storm surge and projected track for landfall. The new maps may more accurately display water depth in areas within the city.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami
Mitigation Strategy:	Property Protection, Prevention
Priority:	High
Estimated Cost:	Projected cost is $5,000-10,000 (updated mapping provided by the current contracted engineering firm). .
Potential Funding Sources:	Projected costs could potentially be covered by annual budget funding through the city's annual budgeting process
Lead Agency/Department Responsible:	Community Development, Office of Emergency Management
Implementation Schedule:	2016-2020

257

F-2016-17: Continue to participate in maintaining the Pipeline Integrity Management Resource Reporting in High Consequence Areas (HCA) through the National Pipeline Mapping System (NPMS)	
Mitigation Goal/Objective:	2/2.5
Background/Next Steps:	• The Pipeline and Hazardous Materials Safety Administration (PHMSA) of the US Department of Transportation (DOT) has a rule requiring pipeline operators to develop an integrity management program for gas transmission lines where a leak or rupture could impact a HCA. • Pipeline operators are also required to identify the location of any "Identified Sites" located near their pipelines. • "Identified Site" o Outside area or open structure that is occupied by 20 or more persons on at least 50 days in any 12 month period (i.e., playgrounds, recreational facilities, camp grounds, outdoor theaters, stadiums, etc.) o A building that is occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12 month period (i.e., religious facilities, office buildings, community centers, general stores, etc.) o A facility occupied by persons who are confined, are of impaired mobility, or would be difficult to evacuate (i.e., hospitals, schools, day-care facilities, nursing homes, retirement facilities or assisted living facilities) • Every six months access the PHMSA site and verify the location of all "Identified Sites", and include any new facilities which meet the defined criteria.

Hazard(s) Addressed:	Pipeline Failure, Hazardous Materials
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	Staff time utilized to annually verify and update the HCAs for the NPMAS
Potential Funding Sources:	Annual budget
Lead Agency/Department Responsible:	Office of Emergency Management
Implementation Schedule:	Continuous action

258

F-2016-18: Develop, initiate, and enhance public information campaigns and awareness programs for all hazards	
Mitigation Goal/Objective:	3/3.1
Background/Next Steps:	Develop outreach initiatives to communicate hazard preparedness information to the general public; provide timely information and educational materials related to preparedness, mitigation, response & recovery to enhance the public's ability to become self-sufficient. **SEVERE THUNDERSTORM/HAIL/LIGHTNING** • Develop public information materials and conduct outreach programs which include information regarding thunderstorms/hail/lightning to include how they develop, precautionary measures to take to protect property and lives, and developing a disaster plan. o Protective measures which can be utilized to protect against thunderstorms, lightning and hail events ✓ Remove dead or rotting trees & branches which could fall and cause damage or injury; ideal planting conditions for fruit trees is 16', ash 32' and oak 59' from a building structure to prevent damage to foundations and/or structural damage from the canopy; go indoors after seeing lightning and remain inside for at least 30 minutes after hearing last clap of thunder; postpone outdoor activities; secure outdoor objects which may be blow around or cause further damage; avoid corded telephones – cordless & cellular phones are safe to use; unplug electrical appliances and other electrical items such as computers, TVs, radio, etc.; use NOAA Weather Radio for updates from local officials o Encourage the public to make a family disaster plan to include contacts and locations to reunite in the event they become separated o Assemble a 3 day disaster supply kit with food, water, medical supplies, battery powered NOAA radio, flashlights, batteries, extra clothing. • Gather important documents and store them in a fire and/or water-proof container. **SEVERE WEATHER EVENTS, HURRICANES, TORNADOES & WIND** • Minimize and/or eliminate tree vegetation within local utility ROWs o Remove dead or rotting trees & branches which could fall and cause damage or injury; ideal planting conditions for fruit trees is 16', ash 32' and oak 59' from a building structure to prevent damage to

	foundations and/or structural damage from the canopy o Work with Texas New Mexico Power Company to develop public information materials or a cooperative plan to encourage residents and/or business to trim and/or remove trees and other vegetation located within the utility easement and intermingling through the power lines which could potentially tear down power lines during severe thunderstorms with high winds. o Effect on existing buildings would be to minimize damage to power lines by the removal of trees or trimming of canopies away from the power lines. o Effect on future buildings would be to ensure that electrical utility lines are buried and not affected by tree canopies and/or vegetation. • Develop tornado awareness materials to educate the public as to how to protect themselves and property in the event a tornado would occur in the area. o Items to cover: if no concrete safe room is located in the residence, use an internal room with no windows; secure all items located outside the residence (patio furniture, flower pots, grilling accessories, etc.) so they do not become flying projectiles; encourage installation of impact-resistant windows; reinforce garage doors **DROUGHT - WATER CONSERVATION** • Develop public informational materials to educate the public regarding water conservation measures during periods of drought conditions. o Encourage recapturing of water with buckets when showering or bathing to be used on outside vegetation areas; educate public on restricted watering criteria; i.e., by house number/days of week; limiting watering of lawns to certain hours; establish only flower beds and gardens can be watered using only the end hose – no sprinklers; encourage xeriscaping property and lawns; encourage installation of permeable driveways and sidewalks in new subdivision developments to reduce runoff and promote groundwater recharge **WINTER STORMS/SEVERE HEAT** • Establish a warming center and/or cooling center at the Public Library and Activity Center for the general public and senior citizens o Develop public information materials for the general public regarding the location of a warming station at the Public Library. **SUBSIDENCE** • In coordination with the Houston-Galveston Subsidence District, develop materials regarding the status of subsidence within the planning area, along with developing educational pamphlets for residents to alleviate the effects of subsidence on their properties. • Examples of mitigation projects would be foundation stabilization to alleviate structural damage to residences and pipes.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Goal/Objective:	3/3.1

Priority:	High
Estimated Cost:	• Minimal; can be created and obtained by staff; annual budget • Obtain pre-printed materials through FEMA • Information can be disseminated through public service announcements (PSAs) via the city PEG channel, Twitter feed, Facebook, Focus on Friendswood newsletter, email messages, newspaper articles, and public presentations at civic organizations.
Potential Funding Sources:	Annual budget process
Lead Agency/Department Responsible:	Office of Emergency Management - Public Information Officer
Implementation Schedule:	Continuous action

259

F-2016-19: Public information and warning mobile application for Android and Apple applications	
Mitigation Goal/Objective:	1/1.1 and 1.5
Background/Next Steps:	• Research and develop a mobile application to be available for citizens to download for IOS and Android operating systems • If cost is too prohibitive, research and promote applications already developed to encourage emergency preparedness • Promote the use of emergency preparedness apps currently available at the Apple Store.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	Moderate
Estimated Cost:	• Research has shown that costs associated with the development of an emergency management application – simple, table based app – for IOS systems range $500 to $4,000. All content & clear direction is provided by the organization. If GSP locators, social media integration, and additional add-ins are included, costs will rise accordingly. • If costs are maintained in the range of $5,000 to $10,000, proposals could be made during the budget development process to include this project in the annual operating budget.
Potential Funding Sources:	If this project is rejected by the governing body, research and application for grants could provide an alternative funding source
Lead Agency/Department Responsible:	Office of Emergency Management, IT Department
Implementation Schedule:	If a funding source is secured, ideally development could be accomplished within 2-3 years.

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261

F-2016-20: Develop a Comprehensive Flood Mitigation Plan	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	To attain a lower CRS rating and improve the city's approach for addressing RL/SRL properties, the city should consider developing a flood mitigation plan to meet the current NFIP standards. • Develop a Flood Mitigation Plan for the city and submit the plan to the Texas Water Development Board for guidance and review. • Strive to meet criteria necessary to achieve a lower CRS rating through this initiative. • Initiate and implement additional floodplain requirements that are above the minimum floodplain compliance. • Update the city's current floodplain map to coordinate with the currently proposed FEMA Flood Insurance Rate Map relative to all floodplains as proposed.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$100,000
Potential Funding Sources:	General fund through annual budget process/apply for planning grant funding
Lead Agency/Department Responsible:	Community Development, Floodplain Manager, Office of Emergency Management
Implementation Schedule:	2016-2020

262

F 2016-21: Participate in local and statewide studies, workshops, and committees that address all hazards prone within Galveston County	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Office of Emergency Management, Community Development
Implementation Schedule:	Continuous Action

F 2016-22: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective:	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Office of Emergency Management and applicable departments
Implementation Schedule:	Continuous action

F 2016-23: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	Office of Emergency Management
Implementation Schedule:	Continuous action

F 2016-24: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Office of Emergency Management
Implementation Schedule:	Continuous action

Table 24.15: Hitchcock

H-2006-2: Address poor drainage on Lexington Dr.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action) 2 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

H-2006-3: Address poor drainage on Concord Dr.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-3 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

H-2006-4: Address poor drainage on Lincoln Dr.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado

Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-4 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

272

H-2006-5: Address poor drainage on Willow Dr.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-5 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

273

H-2006-6: Address poor drainage on Meadowplace Dr.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020

Analysis
2010 – Action deferred due to lack of grant funding
2016 - Renumbered action from Hitchcock (Past Action)-6 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.

274

H-2006-7: Address poor drainage on Tacguard Dr.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-7 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

275

H-2006-8: Address poor drainage on Barry St.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-8 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

276

H-2006-9: Address poor drainage on Woodacres Dr.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-9 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

277

H-2006-10: Address poor drainage on Buins St.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-10 As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able. The city has attempted to improve some of the drainage in this area by installing new culvert, clearing ditches and tree trimming.	

278

H-2006-11: Address poor drainage on Jay Rd.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural

Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-11 As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able. The city has attempted to improve some of the drainage in this area by installing new culvert, clearing ditches and tree trimming.	

279

H-2006-12: Address poor drainage on Hacker Rd.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

280

H-2006-16: Address poor drainage on Steward Rd.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020

Analysis
2010 – Action deferred due to lack of grant funding
2016 - Renumbered action from Hitchcock (Past Action)-16 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.

281

H-2006-18: Address poor drainage on Hawthorne St.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-18 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

282

H-2006-20: Address poor drainage on Belring Rd.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	Unknown
Lead Agency/Department Responsible:	City of Hitchcock
Implementation Schedule:	2016-2020
Analysis	
2010 – Action deferred due to lack of grant funding	
2016 - Renumbered action from Hitchcock (Past Action)-20 Action deferred due to lack of grant funding. As it is unclear if funding will become available to permanently address the drainage issue, the city will continue to monitor the area and provide routine maintenance when able.	

283

H 2011-1: Provide public awareness materials and information at community events (food bank) and city website regarding all hazards	
Mitigation Goal/Objective:	3/3.1
Site and Location	Citywide
History of Damages	Hitchcock is prone to natural and technological hazards
Comments	The city will strive to provide appropriate information regarding all hazards including the NFIP program to enable residents to prepare, mitigate, respond, and recover from future events. The Food bank provides the best opportunity to reach those residents who typically do not have the resources to understand the importance of personal and property protection measures. Information will also be developed for the city's website as opportunities for updating their site become available. Galveston County EMC will be encouraged to participate in this outreach activity as well as applicable pipeline and hazardous material industry representatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	Staff salary
Potential Funding Sources:	Budget
Lead Agency/Department Responsible:	Police and Fire Departments, Galveston County EMC
Implementation Schedule:	Continuous action
Analysis	
2016 – Renumbered action from Hitchcock 1 and included Hitchcock 5, 6, 12, 17, 20, and 21. Revised the action to address all hazard education and outreach initiatives. This action has been delayed due to the lack of knowledge by the city officials as to what their role is in providing education and outreach programs.	

284

H 2011-2: Routinely check and maintain fire hydrants	
Mitigation Goal/Objective:	2/2.6
Site and Location	Citywide
Background/Next Steps:	Working fire hydrants ensure adequate water for putting out fires/protecting structures and lives. Improperly working fire hydrants pose higher risk to people and residents. Fire hydrants require annual inspections at minimum.
Hazard(s) Addressed:	Wildfire (Urban and Rural)
Mitigation Strategy:	Emergency Services
Priority:	High

Estimated Cost:	$40,000 annually
Potential Funding Sources:	Grants, general funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action
Analysis	
2016 – Renumbered from Hitchcock-2 and includes Hitchcock-14. Modified action name to reflect nature of this deliverable. The city has a contractor in place to provided annual inspections of the hydrants.	

285

H 2011-3: Extend water and sewer lines to septic and well water customers not currently on City system	
Mitigation Goal/Objective:	1/1.1
Site and Location	Citywide
Background/Next Steps:	Reducing the number of septic systems in use in the higher hazard areas will reduce contamination. Decreasing groundwater withdrawal will allow for maximum recharge and user participation in a managed system.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Drought, Extreme Heat, Severe Winter Storm
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$100,000
Potential Funding Sources:	Office of Rural community affairs
Lead Agency/Department Responsible:	City departments
Implementation Schedule:	Continuous Action
Analysis	
2016 – Renumbered from Hitchcock-3. The city continues to provide water and sewer services to residents as opportunities arise.	

286

H 2011-8: Implement a tree trimming/vegetation removal program from public right of ways	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Tree limbs and vegetation generated by storms or natural decay process can block access of streets from first responders, clog storm sewers, down power lines and damage buildings.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Wildfire (Urban and Rural), Severe Winter Storm
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$50,000/year
Potential Funding Sources:	Budget
Lead Agency/Department Responsible:	City Administration

Implementation Schedule:	Continuous action
Analysis	
2016 – Combined actions Hitchcock 7, 8, and 15 together in this action. The city continues to provide tree trimming and vegetation removal as needed	

287

H 2011-10: Purchase and install emergency power generators and connections equipment to support critical facilities and infrastructure	
Mitigation Goal/Objective:	1/1.4
Site and Location	Citywide
Background/Next Steps:	Lift stations, water/wastewater and sewer facilities should be equipped for generator connections. City-owned facilities should also have fixed-unit generators in place.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Extreme Heat, Severe Winter Storm, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$4,500,000
Potential Funding Sources:	Office of Rural Community Affairs, Grants
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020
Analysis	
2016 – Renumbered from Hitchcock-10 and updated implementation schedule. Delayed due to lack of funding	

288

H 2011-11: Implement storm sewer system improvement projects to mitigate flooding	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Outdated storm sewers require updating and reconstruction. Reduce/prevent minor flooding from substandard storm sewer and clogged roadside ditches
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$1,000,000
Potential Funding Sources:	Office of Rural Community Affairs, Grants
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020
Analysis	

2016 – Renumbered from Hitchcock-11 and updated implementation schedule. Delayed due to lack of funding

289

H 2011-13: Upgrade water and sanitary sewer distribution and collection system infrastructure where needed, include backflow prevention valves where feasible	
Mitigation Goal/Objective:	1/1.1
Site and Location	Citywide
Background/Next Steps:	Water and sewer lines were severely damaged or destroyed during flooding due to Hurricane Ike and other storm events. Many lines are old and in need of replacing or improving.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Drought
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$10,000,000
Potential Funding Sources:	Office of Rural Community Affairs, Grants
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020
Analysis	
2016 – Renumbered from Hitchcock-13 and updated implementation schedule. Delayed due to lack of funding	

290

H 2011-19: Evaluate, design, and implement hardening measures to protect existing critical facilities and critical infrastructure during disasters	
Mitigation Goal/Objective:	1/1.2
Site and Location	Citywide
History of Damages	Area prone to high wind and flooding events
Background/Next Steps:	Reduction of risk to buildings and properties, including lost services. Hardening measures may include, but not be limited to: hurricane shutters, high-wind resistant doors/windows and roofing systems, elevation, Nema enclosures, etc.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm, Land Subsidence, Expansive Soils, Earthquake, Coastal Erosion and Retreat
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA: HMGP, PDM, FMA, RFC, SRL; General Fund
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020

Analysis
2016 – Renumbered from Hitchcock-19 and updated implementation schedule. Delayed due to lack of funding

291

H 2016-1: Stormproof/retrofit critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.2
Site and Location:	Citywide
Background/Next Steps:	New construction of public buildings/infrastructure should include advanced mitigation techniques when practical. Measures may include, but are not limited to, roof and foundation supports, shutters, shatter-proof and high wind doors and windows, etc. During the planning process, There are no plans for new construction at this time however, needs may require other new construction over the next five years. Hitchcock will develop plans and specifications to include mitigation measures where practical on future initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm, Land Subsidence, Expansive Soils, Earthquake, Coastal Erosion and Retreat
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, CDBG, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2026

292

H 2016-2: Continue efforts on mitigation Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Section 20 provides a summary of the RFC/SRL properties that have not been mitigated, Mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be explored with property owners as funding and opportunities arise.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	City Administration and applicable state and county agencies
Implementation Schedule:	Continuous Action

H 2016-3: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

293

H 2016-4: Continue to enforce / improve regulations and permit requirements to promote hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Regulations and permit requirements are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop as required to address all hazards prone to the area and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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295

H 2016-5: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective:	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

296

H 2016-6: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

297
298

H 2016-7: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

Table 24.16: Jamaica Beach

JB 2006-1: Implement beach and dune restoration program	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Coastal Erosion and Retreat, Land Subsidence
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$2,100,000
Potential Funding Sources:	Texas Coastal coordination Council-Texas Coastal Management Program, Texas General Land Office, USACE, General Fund, 406 Public Assistance
Lead Agency/Department Responsible:	City staff and council
Implementation Schedule:	2016-2020
Analysis	
2010 - This action was completed in 2006. However it is deferred due to the devastation of the beach during Hurricane Ike. This action will now be implemented after receipt of funds. The cost for the project has increased to $2,100,000 from $1,500,000.	
2016 - Renumbered action from JB (Past Action)-1 and updated implementation schedule. Currently seeking easement forms from beach front property owners. Construction is tentatively scheduled for early 2016.	

JB 2006-3: Improve / maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS) programs	
Mitigation Goal/Objective:	2/2.2
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	Staff time and resources
Potential Funding Sources:	Local commitment
Lead Agency/Department Responsible:	City staff
Implementation Schedule:	Continuous action
Analysis	
2010 - This action will be deferred as Jamaica Beach still intends to join the CRS	
2016 - Renumbered action from JB (Past Action)-3 and modified the action name to include NFIP. Project is in progress waiting for Community Assessment Visit (CAV)	

JB 2006-4: Conduct annual hurricane town hall meetings	
Mitigation Goal/Objective:	3/3.1
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding

Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$750
Potential Funding Sources:	Donations and the general fund
Lead Agency/Department Responsible:	City staff
Implementation Schedule:	Continuous Action
Analysis	
2010 - This action should be deferred as an ongoing activity for the community.	
2016 - Renumbered action from JB (Past Action)-4 and update implementation schedule. The city continues to schedule meetings as needed	

304

JB 2011-1: Conduct routine hydrant maintenance	
Mitigation Goal/Objective:	1/1.2
Site and Location	Citywide
History of Damages	Possible malfunction of hydrant in the event of a fire and during periods of drought and extreme temperature
Comments	Twice a year, hydrants should be inspected to ensure they are operational
Hazard(s) Addressed:	Wildfire (Urban and Rural)
Mitigation Strategy:	This would better prepare the city in case of a fire and ensure water is available/hydrants working to protect existing and new structures.
Priority:	High
Estimated Cost:	$2,500
Potential Funding Sources:	Municipal Services Fund
Lead Agency/Department Responsible:	City Administrator
Implementation Schedule:	Continuous action – implemented twice a year
Analysis	
2016 - Renumbered action from JB-1. The city continuous to monitor and maintain fire hydrants	

305

JB 2011-2: Develop system to maintain records of elevation certificates	
Mitigation Goal/Objective:	2/2.2
Background/Next Steps:	After the devastation of Hurricane Ike, the city was unable to find adequate records of elevation certificates.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$500
Potential Funding Sources:	General fund

Lead Agency/Department Responsible:	City Administrator
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from JB-2 and updated implementation schedule. The city intends to implement this action beginning in January 2016	

306

JB 2011-5: Prepare a Drought and Extreme Heat Contingency Plan	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	Jamaica Beach experiences drought and periods of extreme heat during the summer months. A contingency plan allows for water storage to keep building cook and also can describe measures to prevent foundations from cracking.
Hazard(s) Addressed:	Drought, Extreme Heat, Expansive Soils, Wildfire (Urban and Rural)
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$45,000
Potential Funding Sources:	Grants, general funds
Lead Agency/Department Responsible:	City Administrator
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from JB-5 and updated implementation schedule. The city intends to update the 2001 Drought Contingency Plan in 2016	

307

JB 2016-1: Jamaica Cove Rd. Survey	
Mitigation Goal/Objective:	2/2.1
Site and Location	Jamaica Cove Rd.
Background/Next Steps:	Jamaica Cover Road is prone to flooding. Conduct a survey to determine if elevating the road would reduce future flooding impacts.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$3,500
Potential Funding Sources:	General funds
Lead Agency/Department Responsible:	City Administrator
Implementation Schedule:	2016

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JB 2016-2: Secure generators for existing and new critical facilities and infrastructure	
Mitigation Goal/Objective:	1/1.4
Site and Location:	Fire Station and others as identified
Background/Next Steps:	Generators are essential for providing continual operations in the event of a disaster. The fire station may be in need of a generator but other facilities may be needed over the next five years. As funding becomes available, the city will apply for grants to install/upgrade generators to support existing or new facilities/infrastructure.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Extreme Heat, Severe Winter Storm, Lightning, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$50,000
Potential Funding Sources:	HMGP, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

JB 2016-3: Continue efforts on mitigation Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Section 20 provides a summary of the RFC/SRL properties that have not been mitigated, Mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be explored with property owners as funding and opportunities arise.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	City Administration and applicable state and county agencies
Implementation Schedule:	Continuous Action

JB 2016-4: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

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JB 2016-5: Continue to enforce / improve regulations and permit requirements to promote hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Regulations and permit requirements are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop as required to address all hazards prone to the area and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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JB 2016-6: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective:	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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JB 2016--7: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

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JB 2016-8: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

JB 2016-9: Continue efforts on public information and awareness for all hazards	
Mitigation Goal/Objective:	3/3.1
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$1,000
Potential Funding Sources:	Local funds
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

321 *Table 24.17: Kemah*

K 2006-1: Continue efforts on public information and awareness for all hazards	
Mitigation Goal/Objective:	3/3.1
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$1,000
Potential Funding Sources:	Local funds, National Weather Service, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, FEMA – Emergency Operations Center Funding, FEMA – Emergency Management Performance Grant, USDA – Environmental Quality Incentives Program
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action
Analysis	
2010 - This is an ongoing educational activity and will therefore be deferred. An outreach campaign is needed to educate residents and merchants concerning the effects of flooding and the need to participate in the NFIP.	
2016 - Renumbered action from Kemah (Past Action)-1 and included Kemah-15 and modified action description to address all hazards. The city continues to provide information to the public regarding all hazards	

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K 2006-2: Develop severe weather audio alert system.	
Mitigation Goal/Objective:	1/1.1
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$2,000
Potential Funding Sources:	General Fund, FEMA – Emergency Performance Grants, FEMA – All Hazards Operational Planning, FEMA – Hazardous Materials Assistance Program. FEMA – Fire Management Assistance Grants, USDA – Environmental Quality Incentives Program
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020
Analysis	
2010 - Action deferred due to lack of additional funding to support implementation	
2016 - Renumbered action from Kemah (Past Action)-2 and updated implementation scheduled. Delayed due to support	

and funding

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K 2006-3: Implement storm sewer system re-engineering and follow-up construction project to mitigate flood related impacts.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam and Levee Failure
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$4,000,000
Potential Funding Sources:	US Army Corps of Engineers – Small Flood Control Projects, Hazard Mitigation Grant Program, Pre- Disaster Mitigation Grant Program, Texas Water Development Board – Clean Water State Revolving Fund, Texas Water Development Board (Development Fund II) – Texas Water Development Fund, USDA Natural Resources Conservation Service – Watershed Protection and Flood Prevention Program, EPA – Nonpoint Source Grant Program
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020
Analysis	
2010 - This action is deferred and the priority has been increased from low to high as the entire pump station was destroyed during Hurricane Ike; See also Kemah 12	
2016 - Renumbered action from Kemah (Past Action)-3 and updated implementation scheduled. At this time, the city is continuing to monitor the storm sewer system and provide maintenance as needed.	

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K 2006-4: Develop city ordinance requiring the incorporation of wind resistant construction provisions and enforcement measures in the city building code.	
Mitigation Goal/Objective:	2/2.2
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Tornado, Windstorm
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	Staff time and resources
Potential Funding Sources:	Local commitment
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020
Analysis	
2010 - Action deferred as staff time/position has not been available to develop requisite ordinance. The city is working on hiring a full time building inspector.	
2016 - Renumbered action from Kemah (Past Action)-4 and updated implementation scheduled. Delayed due to support and funding to develop ordinance	

K 2011-1: Participate in National Weather Service tornado drills along with elementary school in jurisdiction	
Mitigation Goal/Objective:	2/2.3
Site and Location	Citywide
Hazard(s) Addressed:	Flooding, Tornado, Windstorm, Hailstorm, Lightning
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Emergency management
Implementation Schedule:	Continuous Action
Analysis	
2016 - Renumbered action from Kemah-1 and updated the implementation schedule. The city is working with CCISD to participate in this program on an annual basis	

K 2011-8: Review, participate and implement any updates for drought contingency plans as developed by the WCID# 12	
Mitigation Goal/Objective:	2/2.1
Site and Location	Citywide
Background/Next Steps:	Jurisdiction experiences occasional drought conditions and days of extreme heat during the summer months which may also cause wildfires (Urban and Rural). City of Kemah does not provide water or waste water for its citizens. This service is provided by Water Control Improvement District #12 (WCID#12). Implementation ensures adequate water supply by lessening water usage
Hazard(s) Addressed:	Extreme Heat, Drought, Wildfire (Urban and Rural), Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	Staff time
Potential Funding Sources:	General Fund Municipal
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from Kemah-8 and updated the implementation schedule. The city communicates frequently with WCID during drought conditions	

K 2011-10: Develop program to integrate with the Harris County Flood Control District for the purpose of optimizing the operation of the flood gates at second cut outlet	
Mitigation Goal/Objective:	2/2.1
Site and Location	1900 Shipyard Drive (intersection of Highway 146 and Shipyard Drive)
Background/Next Steps:	This structure is located outside the city of Kemah. However, the failure of this gate to function impacts structures within the jurisdiction of Kemah
Hazard(s) Addressed:	Dam and Levee Failure
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Staff Time
Potential Funding Sources:	General Fund
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from Kemah-10 and updated the implementation schedule. Coordination is needed between the city and Harris County Flood Control District to develop a program.	

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K 2011-11a: Review and update if necessary flood plain ordinance to ensure compliance with minimum standards of NFIP	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	A review of the city's floodplain ordinance will reveal where improvement and updating can allow the city to move beyond the minimum standards for development in the regulatory floodway.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$1,000
Potential Funding Sources:	General Fund Municipal
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered action from Kemah-11a and updated the implementation schedule. Veritas is assisting the city to implement this action	

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K 2011-13: Develop maintenance and flow testing program for fire hydrants in jurisdiction	
Mitigation Goal/Objective:	2/2.1
Hazard(s) Addressed:	Wildfire (Urban and Rural)
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$20,000
Potential Funding Sources:	Grants
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered action from Kemah-13 and updated the implementation schedule. WCID #12 provides maintenance on an annual basis	

332

K 2011-14: Harden existing critical facilities and infrastructure to be more resistant to all hazards	
Mitigation Goal/Objective:	1/1.2
Site and Location	1401 State Hwy 146—City Hall 800 Harris Community Center 602 Bradford-Visitor Center
Background/Next Steps:	Continuity of emergency services and general government operations is necessary to protect staff and city property. Existing facilities may be lacking protective measures and adequate building standards. Mitigation options may include the provisions for shatterproof glass for windows and doors, frame enhancements, strengthening roofs to withstand high winds, and elevating or flood proofing, etc. Potential hardening projects may include any municipal building and public infrastructure.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$100,000
Potential Funding Sources:	HMGP and Other Post Ike Funding
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	2016-2026
Analysis	
2016 - Renumbered action from Kemah-14 and updated the implementation schedule. Action description changed from winter weather to all hazards and includes infrastructure. The city continues to seek opportunity and funding to harden their existing structures.	

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K-2016-1: Stormproof/retrofit critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.2
Site and Location:	Fire Station
Background/Next Steps:	New construction of public buildings/infrastructure should include advanced mitigation techniques when practical. Measures may include, but are not limited to, roof and foundation supports, shutters, shatter-proof and high wind doors and windows, etc. During the planning process, The city expressed a potential need for a new fire station; however, needs may require other new construction over the next five years. Kemah will develop plans and specifications to include mitigation measures where practical on future initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, CDBG, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2026

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K2016-2: Secure generators for existing and new critical facilities and infrastructure	
Mitigation Goal/Objective	1/1.4
Site and Location:	Fire Station and others as needed
Background/Next Steps:	Generators are essential for providing continual operations in the event of a disaster. As funding becomes available, the city will apply for grants to install/upgrade generators to support existing or new facilities/infrastructure.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Lightning, Tsunami, Severe Winter Storm, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$100,000
Potential Funding Sources:	HMGP, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

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K 2016-3: Continue efforts on mitigation Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Section 20 provides a summary of the RFC/SRL properties that have not been mitigated, Mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be explored with property owners as funding and opportunities arise.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	City Administration and applicable state and county agencies
Implementation Schedule:	Continuous Action

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K-2016-4: Upgrade drainage systems and culverts	
Mitigation Goal/Objective	1/1.5
Site and Location:	Citywide
Background/Next Steps:	The drainage systems and culverts throughout the area are frequently impacted by flash flood and severe weather events. Prioritize drainage systems for upgrades and implement when funding and opportunity presents itself.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	CDBG, HMGP, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous Action

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K-2016-5: Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural),

	Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

339

K-2016-6: Continue to enforce / improve regulations and permit requirements to promote hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Regulations and permit requirements are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop as required to address all hazards prone to the area and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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K-2016-7: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake,

	Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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K-2016-8: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

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K-2016-9: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective:	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services

Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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K-2016-10: Improve / maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS) programs	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	Continue participation in the NFIP program which offers incentives to reduce insurance premiums
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City administration and applicable departments
Implementation Schedule:	Continuous action

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345 *Table 24.18: La Marque*

LM 2006-2: Implement drainage projects that support low maintenance and cleaning of drainage ditches.	
Mitigation Goal/Objective:	1/1.5
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Dam and Levee Failure, Severe Winter Storm,
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	General funds and FEMA grants
Lead Agency/Department Responsible:	Public Services
Implementation Schedule:	2016-2020
Analysis	
2010 - Action deferred to solicit funds	
2016 - Renumbered action from LM (Past Action)-2 and updated the implementation schedule from 2010 To date, 14,000 linear feet of ditches have been cleaned. Residents have also become proactive in keeping their property ditches cleaned – this is being monitored by Code Compliance Staff. The remaining drainage systems will be addressed as funding becomes available. Coordinating efforts with local Drainage District to accommodate outfall.	

346

LM 2011-2: Purchase and Install Storm Shutters for Fire Station Entryway	
Mitigation Goal/Objective:	1/1.2
Site and Location	La Marque Fire Rescue 1109-A Bayou Road La Marque, Texas 77568
Background/Next Steps:	This project addresses several hazards that could impact the City of La Marque. Protective shutters would reduce damage from flying debris and hail. The shutters could also be sandbagged when closed in order to keep flood water from entering the building. Entryway door was damaged during Hurricane Ike due to excessive winds. The Main door was bowed in the center and broke the system that closes it. By installing this storm shutter, we could minimize building damage in future events.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Tornado, Windstorm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$3,750
Potential Funding Sources:	Grant / General Budget
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	2016-2020
Analysis	
2016 – Renumbered action from LM -2. Delayed pending budgetary funding. Implementation schedule modified to allow for submission of FEMA Grant Application in 2016 and/or seek General Fund appropriation during Fiscal Year - 2017.	

347

LM 2011-3: Purchase new Fire Station Doors for Apparatus Bays	
Mitigation Goal/Objective:	1/1.2
Site and Location	La Marque Fire Rescue 1109-A Bayou Road La Marque, Texas 77568
Background/Next Steps:	The existing bay doors do not meet local windstorm ratings. The doors had to be left open in past storms in order to keep them from being damaged. This allowed excessive up-loading to our building's roof system, winds damaged the interior resulting in repairs costing the citizens almost $300,000. The new doors will be rated for 165 mph wind and would most likely be able to provide protection from hail storms. Door rated for maximum wind resistance will keep Emergency Operation staff safe from storm debris.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Tornado, Windstorm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$125,000
Potential Funding Sources:	Grant / General Budget
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	2017-2018
Analysis	
2016 - Renumbered action from LM -3 and updated the implementation schedule Delayed pending grant or budgetary funding. Implementation schedule modified to allow for submission of FEMA Grant Application in 2016 and/or seek General Fund appropriation during Fiscal Year - 2017.	

348

LM 2011-6: Purchase New Rescue Pumper for Fire Station	
Mitigation Goal/Objective:	2/2.6
Site and Location:	1109-A Bayou Road La Marque, Texas 77568 Lot 29.369629 Land -94.9717
Background/Next Steps:	A realistic 10 - 15 year fire apparatus replacement program must be instituted. Reserve Fire Apparatus currently in service are 20 and 23 years old. A Rescue Pumper is a support truck that can carry all equipment and compensate for a down sized staff. Continued growth and service calls has placed higher demand on the Fire Station personnel and trucks. Adding a new rescue pumper to the fleet will allow personnel to respond to more calls at the same time. Reliable Reserve Apparatus are essential to augment the fleet during disasters and multiple / major emergencies.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Lightning, Wildfire (Urban and Rural), Pipeline Failure, Hazardous Materials
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$800,000

Potential Funding Sources:	Grant / Bond
Lead Agency/Department Responsible:	Fire Department
Implementation Schedule:	2017-2019
Analysis	
2016 - Renumbered action from LM -6 and updated the implementation schedule Delayed pending grant or budgetary funding. This initiative can no longer be deferred without jeopardizing public safety.	

349

LM 2011-7: Build Westside Public Safety Complex	
Mitigation Goal/Objective:	1/1.2
Site and location:	Westside of La Marque
Background/Next Steps:	This annex would consist of a 4-bay fire / emergency medical service station, police station complete with holding cells, EOC, Municipal Court, and multipurpose training facility. Currently departments are fragmented throughout the city. Departments that need to be involved in emergency response are housed in old buildings that were modified to serve the purpose and have since suffered damage in recent storms. The city is constantly spending money repairing buildings that do not provide sufficient space and safety. Make shift offices and rented buildings are being used until needed repairs are complete on some buildings.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Earthquake, Land Subsidence, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$35,000,000
Potential Funding Sources:	Grants / Bonds / or EDC Funds
Lead Agency/Department Responsible:	City of La Marque Fire/Police Departments
Implementation Schedule:	2017-2018
Analysis	
2010 - This project will be deferred with a current maximum estimated cost of $5,000,000	
2016 - Renumbered action from LM-7. The project scope has been modified to reflect a Westside Public Safety Complex inclusive of Westside Fire Station and Administrative Headquarters, new Police Station and Detention Facilities, Municipal Court Facilities, Multipurpose Training Facilities, and Emergency Operations Center. Estimated costs associated with this project include the acquisition of property in the vicinity of IH 45 and FM 1764 and/or FM 2004 in addition to site development, construction, furnishings, necessary equipment, and Fire / Emergency Medical Services apparatus based on the Houston / Galveston regional area development / construction costs, and market apparatus acquisition costs. The proposal provides for the inclusion of a modern Emergency Operations Center necessary to sustain effective city operations / services; improve emergency preparedness and provide technological support and telecommunication capabilities required for survivability and	

interoperability with surrounding jurisdictions during emergencies.

350

LM 2011-9: Secure Generators for existing and new critical facilities and infrastructure	
Mitigation Goal/Objective:	1/1.4
Site and Location	Public Services 1500 Municipal Drive, and Police Department, 431 Bayou Road, La Marque, Texas 77568 and other facilities as they are identified.
Background/Next Steps:	The Public Services main field office was totally inoperable during Hurricanes Ike and Rita due to no alternative generator equipment. It resulted in being unable to fuel our equipment or maintain water system operations. This project mitigates for damages from severe weather power outages. This facility powers fuel distribution and water system operation which is vital to any emergency response situation. Currently, there is no alternate power source. The Police Department's generator is more than 20 years old and in dire need of replacement. It not only powers the police department building, but also most of the City's internet connectivity and phone systems. Additional generators may be required in the future to support critical facilities and infrastructure throughout the city
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Extreme Heat, Severe Winter Storm
Mitigation Strategy:	Emergency Services
Priority:	Moderate
Estimated Cost:	$260,000
Potential Funding Sources:	Grant / General Budget
Lead Agency/Department Responsible:	Public Services / Police Department
Implementation Schedule:	2016-2020
Analysis	
2016- Renumbered action from LM -9 and modified action to cover existing and new facilities and infrastructure. Delayed pending grant or budgetary funding. Every essential city facility requires a back-up power source and this is the last remaining city building without a generators. As funding becomes available, the city will apply for grants to install generators to support Public Services, Police Department, and other facilities as they are identified.	

351

LM 2011-11: Construct safe room shelter at emergency operations command center to house local residents; shelter could be used for multiple purposes during non-emergency events	
Mitigation Goal/Objective:	1/1.1
Site and Location	1100 Block of Bayou Road La Marque, Texas 77568
Background/Next Steps:	No such multi-functional facility currently exists that can accommodate large numbers of people. Citizens have needed to be rescued in the past during small scale incidents. There was no shelter other than the fire station.

	La Marque is growing and emergency operation capabilities must grow with it. A community safe room shelter would provide a place for an emergency operations command center, emergency medical care area, and evacuation staging area, and/or a safe shelter for affected residents. No such facility currently exists. Shelter could be used for other public functions during non-emergency events.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Lightning, Pipeline Failure, Hazardous Materials, Earthquake, Severe Winter Storm
Mitigation Strategy:	Structural
Priority:	Moderate
Estimated Cost:	$5,000,000
Potential Funding Sources:	Grant
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	2016-2022
Analysis	
2016 – Renumbered action from LM-11 and updated the implementation schedule. Delayed pending grant or budgetary funding. No structure exists that could serve as an emergency shelter for affected residents. Although ranked low in priority, this safe room would be a vital asset to our community, especially for those residents who choose not to evacuate or when critical event timing does not allow for time to evacuate. Alternate funding sources will be considered.	

352

LM 2011-12: Build new roads to accommodate evacuations and reduce congestion at the intersections cited	
Mitigation Goal/Objective:	1/1.1
Site and Location	Off IH-45 Feeder Road on La Marque/Texas City line. Start road on city line and continue past Gulf Greyhound Park and tie into FM 2004.
Background/Next Steps:	Three roads meet at the IH□45 / Exit 15 intersection. During evacuations, this area becomes severely congested. Delays of up to several hours have occurred. Traffic flow, emergency services, and recovery operations are severely impeded. Building a new road to the new standards should help alleviate some of the traffic and flooding problems. An alternate evacuation route is crucial considering the hazardous materials that are transported through this intersection, the poor drainage of floodwater, and hurricane evacuations. The nearby Gulf Greyhound Park was used during Hurricane Ike recovery efforts to house the power utility (electric) companies that responded to assist with the recovery effort. An estimated 2,000 contractors with trucks and equipment moved in and out, 24 hours a day. Interstate 45 was congested to a standstill and several major accidents occurred. Had an additional roadway been built, traffic flow could have moved more safely and many accidents may have been avoided.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tsunami, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Earthquake

Mitigation Strategy:	Structural
Priority:	Moderate
Estimated Cost:	$20,000,000
Potential Funding Sources:	Bond, or Grant
Lead Agency/Department Responsible:	TXDOT, Public Services to coordinate
Implementation Schedule:	2018-2020
Analysis	
2016 – Renumbered action from LM-12 and updated the implementation schedule. Delayed pending grant or budgetary funding. This project would need to be funded by an outside agency(ies), through a Texas Department of Transportation project as it pertains to state-owned roadways. The City of La Marque would participate as an interested party.	

353

LM 2011-13: Install generators for wastewater lift stations located throughout the city.	
Mitigation Goal/Objective:	1/1.4
Site and Location	Wastewater lift stations require redundant power sources; this includes but may not be limited to the following locations: 2500 6th Ave 1810 Bayou 200 Main St 724 Shady Lane 901 First St 201 Bayou 301 Vauthier 4818 Delany 2502 Duroux 2995 FM 1764 2420 Jackson 1019 Walnut St 1024 Hathaway 604 Ross 728 Hwy 3 2813 Cedar 3905 McKinney 1111 Volney 6090 FM 1764
Background/Next Steps:	Hurricanes Ike, Rita, and others of the past have caused power outages lasting as long as 20 days. Some residents received a back flow of raw sewage into their homes. Back flow of raw sewage into a home is a direct threat to human health that could have been completely avoided if generators were available to support the continual operation of the city's lift stations.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Extreme Heat, Severe Winter Storm, Dam and Levee Failure, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$357,445
Potential Funding Sources:	Grant / General Budget
Lead Agency/Department Responsible:	Public Services
Implementation Schedule:	2017-2018
Analysis	

2016 – Renumbered action from LM-13 and updated the implementation schedule. In progress - Two generators have been purchased and installed to date, with the above locations still pending funding. All locations are critical to the city's wastewater operations and require reliable, redundant power sources in order to ensure continual wastewater operations, preserving human health.

354

LM 2011-14: Construct a storm water detention area on the east side of the City	
Mitigation Goal/Objective:	1/1.5
Site and Location	The location of this detention area is located near FM 1765 and SH 146 Lat. 29.378173732237762 Long. -94.9524736404419
Background/Next Steps:	Areas east of town are prone to flooding during heavy rain events. Dow Chemical purchased several acres of land east of town for use as a greenbelt. The city of La Marque would like to build a detention pond in this area that will help alleviate flooding on the east side. Phase I will include a feasibility study and a drainage analysis of the new pond row acquisition and associated conveyance improvements on a part of 10 acres of land. Engineering of the pond will be based on results of the study and analysis. Construction of the pond will be the second phase.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami
Mitigation Strategy:	Property Protection
Priority:	Moderate
Estimated Cost:	$3,868,150
Potential Funding Sources:	Grant / Bond / Corporate Sponsor
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	2017-2020
Analysis	
2016 – Renumbered action from LM-14 and updated the implementation schedule. Delayed pending grant or budgetary funding. It is possible that this project could be funded through corporate sponsorship.	

355

LM 2011-15: Increase the height of the existing Levee wall system to withstand a Category 5 storm surge	
Mitigation Goal/Objective:	1/1.5
Site and Location	The South side of La Marque and through Texas City
Background/Next Steps:	Recent storms have brought the storm surge to within 1 foot of breaching the levy. This project addresses several issues that may impact the city of La Marque. The existing levee was built to protect our community from a category 3 hurricane tidal surge. Should we receive a storm surge greater than that of a category 3 storm, chances are this levee system will fail and cause catastrophic flooding throughout our community.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam and Levee Failure
Mitigation Strategy:	Structural

Priority:	Moderate
Estimated Cost:	$23,000,000
Potential Funding Sources:	Grant or Federal Funding
Lead Agency/Department Responsible:	US Army Corps of Engineers, Galveston County Drainage District
Implementation Schedule:	2018-2020
Analysis	
2016 – Renumbered action from LM-15 and updated the implementation schedule. Delayed pending grant or budgetary funding. The levy, although within the city limits of La Marque, is owned/managed by the Corps of Engineers and the pumps are maintained by the Galveston County. The City of La Marque would participate in this project as an involved party, overseeing the city's interests.	

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LM 2011-16: Purchase 100' Aluminum Aerial platform fire apparatus for residential and commercial structure fire rescues.	
Mitigation Goal/Objective:	2/2.6
Site and Location	Central Fire Station 1109-A Bayou Road, La Marque, Texas 77568
Background/Next Steps:	An aerial ladder can be used in many rescue situations. The City responds to and has assisted in responding to refinery fires/explosions, major pipeline breaches, flood water rescues, and residential fires. The city has summoned aerial ladder support from outside jurisdictions six times in the past five years. Wait times for the ladder to arrive have exceeded 20 minutes and resulted in fatalities. One fire incident in an apartment complex within the city limits resulted in the deaths of two young children who were unable to escape a multi-story apartment complex while the city had to wait for a neighboring fire department to bring their aerial ladder to the scene to make the rescue. The city currently serves a population of 14,600 persons which includes a bay front community consisting of 275 two-story homes. The projected growth in La Marque is estimated to exceed 20,000 citizens by 2020. The aerial apparatus would also aid in swift water and coastal flooding emergencies. Additionally, the city has assisted with plant explosion rescues and major pipeline breach incidents. On several of these occasions a ladder was required to respond.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Lightning, Wildfire (Urban and Rural), Earthquake, Pipeline Failure, Hazardous Materials
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$1,250,000
Potential Funding Sources:	Grant / General Budget
Lead Agency/Department Responsible:	Fire Department

Implementation Schedule:	2017-2018
Analysis	
2016 – Renumbered action from LM-16. Delayed pending grant or budgetary funding. Revised cost estimate from $1,000,000 to 1,250,000 due to continued inflation. Implementation schedule revised to address increasing risk factors. This acquisition is rapidly becoming increasingly critical to address increased commercial growth and construction of multi-story structures.	

357

LM 2011-17: Build Public Services Facility	
Mitigation Goal/Objective:	1/1.2
Site and Location	Western area of La Marque
Background/Next Steps:	Public Services building would house public works, development services, and code enforcement and should be located in the western area of the city.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$15,000,000
Potential Funding Sources:	Grant / General Budget / Bonds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2017-2025
Analysis	
2016 – Renumbered action from LM-17 and updated the implementation schedule. Delayed pending grant or budgetary funding. Updated location from area of 431 Bayou Road to western area of the city. The City is in the infant stages of planning and has begun searching for suitable location options for this project. Phase 1 would include identifying a prospective location and working with an architect to determine the project specifications and cost. Phase II would identify funding for this project; Phase III would be implementation/completion.	

358

LM 2011-18: Remove downed trees and brush that pose increased fire risk throughout the City.	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Brush and debris create fuel for obstruction to drainage, and impedes vehicle movement. This action is provided through maintenance program.
Hazard(s) Addressed:	Wildfire (Urban and Rural), Severe Winter Weather, Hurricane/Tropical Storm, Tsunami, Earthquake, Tornado, Windstorm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$100,000
Potential Funding Sources:	Grants, City funds
Lead Agency/Department Responsible:	Fire Department/Public Services

Implementation Schedule:	Continuous Action
Analysis	
2016 – Renumbered action from LM-18 and updated the implementation schedule. The city provides brush and debris removal as needs arise through their maintenance process.	

359

LM 2011-19: Continue efforts on public information and awareness for all hazards	
Mitigation Goal/Objective:	3/3.1
Background/Next Steps:	Information is provided to the public as part of the city's communication procedures
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Outreach and Awareness
Priority:	High
Estimated Cost:	$5,000 annually
Potential Funding Sources:	Grants/General fund
Lead Agency/Department Responsible:	GCOEM, Emergency Management, and applicable state/federal agencies
Implementation Schedule:	Continuous action
Analysis	
2016 – Renumbered action from LM-19 and updated description to address all hazards. Town hall meetings are held and information is made available to the public and local businesses annually and as expected events occur. The city presents programs at various civic groups to further promote awareness.	

360

LM 2016-1: Continue efforts on mitigating Repetitive Flood Claim / Severe Repetitive Loss (RFC/SRL) properties when feasible and practical	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	Grant funding through the HMGP (Flood Mitigation Assistance) may be used to mitigate RFC and SRL properties. Section 20 provides a summary of the RFC/SRL properties that have not been mitigated, mitigation options (elevate, reconstruct, acquisition, demolition, etc.) will be explored with property owners as funding and opportunities arise.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP/FMA
Lead Agency/Department Responsible:	City Administration and applicable state and county agencies

Implementation Schedule:	Continuous Action

361

LM 2016-2: Install lightning grounding systems and protection devices on infrastructure and municipal buildings	
Mitigation Goal/Objective	1/1.2
Site and Location:	Citywide
Background/Next Steps:	Lightning strikes can create outages to essential water and sewer services as well as invite unnecessary damage to critical facilities. Consider a program to establish lightning grounding systems on critical water and sewer system elements and other facilities to ensure essential services continue.
Hazard(s) Addressed:	Lightning
Mitigation Strategy:	Property Protection
Priority:	Moderate
Estimated Cost:	To be determined
Potential Funding Sources:	General funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2026

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LM 2016:3 Participate in local and statewide studies, workshops, and committees that address all hazards prone within Galveston County	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

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LM 2016:4 Develop Critical Infrastructure and Key Resources database (CIKR)	
Mitigation Goal/Objective	2/2.1
Background/Next Steps:	A comprehensive database of critical facilities and infrastructure to build out a mapping system will further the planning area's preparedness and response abilities for all hazards. Develop a listing of properties to include, facility name, latitude/longitude, physical address, number of people based in facility, building and content value, etc.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

LM 2016-5: Continue to enforce / improve regulations and permit requirements to promote hazard mitigation strategies	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Regulations and permit requirements are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop as required to address all hazards prone to the area and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

LM 2016-6: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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LM 2016-7: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

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LM 2016-8: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective:	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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LM 2016-9: Improve / maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS) programs	
Mitigation Goal/Objective	2/2.5
Site and Location:	Citywide
Background/Next Steps:	Continue participation in the NFIP program which offers incentives to reduce insurance premiums
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City administration and applicable departments
Implementation Schedule:	Continuous action

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LM 2016-10: Become a Certified NWS StormReady Community	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	StormReady helps arm America's communities with the communication and safety skills needed to save lives and property-before and during an event. StormReady helps leaders and emergency managers strengthen local safety programs. StormReady communities are better prepared to save lives from the onslaught of severe weather through advanced planning, education, and awareness. Contact NWS before applying, complete application, schedule verification meeting and receive approval.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Drought, Extreme Heat, Severe Winter Storm
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	Undetermined
Potential Funding Sources:	General Funds
Lead Agency/Department Responsible:	Emergency Manager
Implementation Schedule:	2016-2020

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376 *Table 24.19: League City*

LC 2005-1: Stormwater Drainage Improvement	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	The project consists of proposed slope paving (concrete lining) improvements to the following drainage rights-of-way throughout the city: • Interurban Ditch, north from FM 518 (900 Feet, $312,000) – Designed but on hold due to costs associated with stream bank mitigation. Newport Ditch, north from FM 518, (900 Feet, $360,000) – pending funding, will be performed after Interurban Ditch • Bradshaw Road, southwest from SH 3 to the north line of CCISD's Elem. School # 25 (1,200 Feet, $390,000) – pending funding • Nottingham Ditch from Calder Road to the Old Interurban Right-of-Way (3,200 Feet, $1,335,000) – still in planning, consultant hired. Design complete and pending construction funding
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$2,397,000
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Public Works and Engineering
Implementation Schedule:	Dependent upon funding
Analysis	
2010 – Pending funding	
2016– Nottingham and Interurban are pending construction funding	

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LC 2005-2: Highland Terrace Drainage	
Mitigation Goal/Objective:	1/1.5
Site and Location	FM 518, Highland Terrace Drive
Background/Next Steps:	The proposed project includes: • Slope paving a portion of the drainage ditch north of FM 518, with probable wetland mitigation. • Lowering the pavement section of Highland Terrace Drive, with attendant utility adjustments. This project will reduce the number of repetitive flood losses in the sub-watershed area. There are six repetitive loss structures on Highland Terrace Drive that would benefit from this project.

Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$4,000,000
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Public Works and Engineering
Implementation Schedule:	Dependent upon funding
Analysis	
2010- Drainage study done, but no further action taken. Not in CIP due to drainage improvement in the Conoco-Phillip corridor (FY 2012). Studies have indicated that resolution should be within the FM518 and Wesley intersection at a higher cost. Project unfunded	
2016–No funding approval to date, continue to seek funding.	

378

LC 2005-3: Kansas Street Drainage	
Mitigation Goal/Objective:	1/1.5
Site and Location	Kansas Street
Background/Next Steps:	The purpose of this project is change the existing roadway section from a flexible based, open ditch rural pavement section to a 28-feet wide, concrete curb and gutter urban pavement section with enclosed conduit storm sewer system. It is proposed that the pavement section be lowered 12 to 18 inches, thereby providing a route for overland sheet flow in extreme rainfall events. In addition, staff proposes to provide irrigation along the street using treated grey-water from the Dallas Salmon Wastewater Treatment Plant and an 8-foot wide concrete trail along one side of the new roadway section. This project will reduce the number of repetitive flood losses in the neighborhood. There are approximately 10 undeveloped lots in this area whose future residents will benefit from this project.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$3,610,000
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Public Works and Engineering
Implementation Schedule:	2019-2020

Analysis
2010 - This project will provide extreme event overflow (such as the flooding that occurred on April 18, 2009) to a natural stream. Project unfunded.
2016 – Project remains unfunded, protected to be completed in FY 2019

379

LC 2005-4: Shellside Detention	
Mitigation Goal/Objective:	1/1.5
Site and Location	SH 96 to Shellside area and Tuscan Lakes Development Area
Background/Next Steps:	The proposed Robinson Gully – Profile 6E Drainage Extension is to extend approximately 1,500 linear feet of an earthen channel south from SH 96 to the Shellside area. The channel will have a 10-feet wide bottom and be approximately 9 feet deep, thereby providing a deep outfall for the area. This project will reduce repetitive flood losses (there is one SRL property in the area) and protect many lower-income residents, most of whom cannot afford flood insurance, from flooding. This project will provide drainage for the many new homes and businesses that are projected to be built in the Tuscan Lakes development area.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$500,000
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Public Works and Engineering
Implementation Schedule:	2016-2020
Analysis	
2010 –Formally Robinson Gully Drainage	
2016 – Funding has been received and improvements are underway. Expected to be completed in 2016	

380

LC 2005-5: Develop and Manage a Repetitive Flood Loss Database (NFIP Action)	
Mitigation Goal/Objective:	2/2.1
Site and Location	Citywide
Background/Next Steps:	Build a database containing RL properties using information provided by the Texas Water Development Board. Manage and update this data by entering information obtained by city employees regarding mitigation of the property (drainage or structural), grant participation, etc.

	Property status will be reflected as "mitigated" on the RL list if mitigation actions and dates of flood losses are documented and provided to the TWDB and FEMA.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Technical Assistance
Priority:	High
Estimated Cost:	Existing salaries
Potential Funding Sources:	City Funds
Lead Agency/Department Responsible:	Building Department
Implementation Schedule:	2016-2020
Analysis	
2016 – The city has allocated funding from their budget and is currently developing the database	

381

LC 2005-6: Tornado Public Education Campaign	
Mitigation Goal/Objective:	3/3.1
Background/Next Steps:	Develop a tornado public education campaign to provide tornado hazard information to the residents.
Hazard(s) Addressed:	Tornado, Windstorm
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	City Funds
Lead Agency/Department Responsible:	Office of Emergency Management in coordination with CCISD and local private schools
Implementation Schedule:	2016-2020
Analysis	
2010- Not Started	
2016 - This project was identified by previous staff but never started. The city is currently designing the campaign and expects to have completed within the next 3 to 5 years.	

382

LC 2005-7: Install Lightning/Surge Protection Equipment at City Buildings	
Mitigation Goal/Objective:	1/1.2
Background/Next Steps:	Provide external and/or internal lightening and surge protection equipment to city buildings and other critical infrastructure. Provides protection to electrical equipment housed within existing and future public buildings.

Hazard(s) Addressed:	Lightning
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	City Funds
Lead Agency/Department Responsible:	Office of Emergency Management, Facilities Maintenance
Implementation Schedule:	Continuous action
Analysis	
2010- Since the creation of this mitigation action the City has constructed a new public safety building. This building is equipped with physical and electrical lightning and surge protection.	
2016 - As future buildings are designed and constructed the city will continue to implement these protections.	

383

LC 2005-8: Homeowner Mitigation Incentive Campaign	
Mitigation Goal/Objective:	1/1.1
Background/Next Steps:	League City is prone to many natural hazards. Provide partial compensation to homeowners that mitigate their primary residence against hazards in an effort to reduce damage from future impacts. Potential projects could include: • installation of rainwater capture systems • installation of storm shutters or protective window film • upgrading roofs and garage doors to meet current wind codes • other projects as identified
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA Mitigation Grant Funds, Other Grant Funds
Lead Agency/Department Responsible:	Office of Emergency Management, Buildings
Implementation Schedule:	Continuous action
Analysis	
2010 – pending funding	
2016 – pending funding	

LC 2005-9: Update Local Mitigation Plan to include Pipeline and Hazardous Materials Incidents	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	Pipelines and hazardous material industries are located within the planning area. Research and include the following information in the LMP: • Locate all pipelines • Create/update map • ID owner/lessee • ID product • ID evacuation zones for release and fire/explosion • Develop training programs
Hazard(s) Addressed:	Pipeline Failure, Hazardous Materials
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$10,000
Potential Funding Sources:	City Funds, FEMA Mitigation Grant Funds
Lead Agency/Department Responsible:	Office of Emergency Management
Implementation Schedule:	2016-2020
Analysis	
2010 – This has been identified this as an important addition to the Hazard Mitigation plan but have not yet committed the resources to complete this project	
2016 – Pipeline and hazardous material incidents are being developed into this plan update	

384

LC 2016-1: Clear Creek Federal Project - South Belt Detention aka MUD Gully Detention	
Mitigation Goal/Objective:	1/1.5
Site and Location	South Belt Detention aka Mud Gully Detention:
Background/Next Steps:	This project was identified in the Clear Creek Federal Project study as being effective for flood management but did not yield a high enough cost benefit ratio for Federal funding. Therefore, Harris and Galveston County have decided to fund this effort. Information for the Public will be available at http://www.hcfcd.org as the project progresses toward. This project is managed by Harris County Flood Control and monitored by the Clear Creek Watershed Steering Committee. Designed in 2012 and 2013. Phase1 Construction started in 2014. Reduces or maintains BFE upstream and downstream thereby reducing the 1% flood zone
Hazard(s) Addressed:	Flooding

Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$10,000,000
Potential Funding Sources:	Harris and Galveston County
Lead Agency/Department Responsible:	Engineering
Implementation Schedule:	2016-2020

385

LC 2016-2: Elevate Homes in RL and SRL Properties	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Flooding is prone to the area and has caused damage to the properties involved in the program. Existing structures will be elevated above floodplain (BFE) on a voluntary basis. - Elevating homes from the floodplain will reduce long-term, repetitive loss. - Elevating homes from in the floodplain will contribute towards Activity 530 (Flood Protection) in the CRS program.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$4,600,000
Potential Funding Sources:	HMGP/FMA, federal and state grants
Lead Agency/Department Responsible:	Building Department
Implementation Schedule:	Continuous action

386

LC 2016-3: Increased Freeboard - Update City ordinance to require 24" of freeboard in the floodplain.	
Mitigation Goal/Objective:	2/2.2
Site and Location	Citywide
Background/Next Steps:	Increasing freeboard will reduce an individual structure's vulnerability to floodwaters. Increasing freeboard will contribute towards Activity 430 (Higher regulatory standards) in the CRS program and will generate points toward improving the City's CRS rating. Homeowners in the floodplain will see a reduction in their flood insurance premiums if the City's CRS rating improves. Homeowners with 24" of freeboard will enjoy reduced flood insurance premiums relative to homeowners whose houses are elevated to the current standard of 18" of freeboard. Substantially improved/damaged existing structures that need to be

	brought into compliance with code will have to elevate to a higher design flood elevation.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Building Department
Implementation Schedule:	Continuous action

387

LC 2016-4: Acquisition and Relocation	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Buying and removing property from the floodplain will reduce long-term, repetitive flood loss. The open space created by the removal of insured property will facilitate drainage and allow for the creation of recreation areas. Buying and removing property from the floodplain will contribute towards Activity 520 (Acquisition and relocation of buildings) in the CRS program.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$300,000,000
Potential Funding Sources:	City Funds, Federal and State Grants
Lead Agency/Department Responsible:	Building Department
Implementation Schedule:	Continuous action

388

LC 2016-5: Lightning Monitoring	
Mitigation Goal/Objective:	1/1.2
Site and Location	Citywide
Background/Next Steps:	The mobile units will provide early detection capabilities at city events and park facilities. Install a permanent lightning detection system at the fire department drill field. Also purchase 3 portable detectors to be placed in fire department response vehicles.
Hazard(s) Addressed:	Lightning
Mitigation Strategy:	Property Protection

Priority:	High
Estimated Cost:	$5,000
Potential Funding Sources:	City funds
Lead Agency/Department Responsible:	Fire Department, Emergency Management
Implementation Schedule:	2017-2020

389

LC 2016-6: Public Outreach and Education-All Hazards	
Mitigation Goal/Objective:	3/3.1
Site and Location	Citywide
Background/Next Steps:	Design a new outreach program that will take into account new storm surge graphics and warnings from the National Weather Service. Offer more accurate mapping of the hazard to citizens via the city's website, social media and physical maps to be distributed at outreach events.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Wildfire (Urban and Rural), Drought, Extreme Heat, Dam and Levee Failure, Expansive Soils, Land Subsidence, Earthquake, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$10,000
Potential Funding Sources:	City Funds and available grants
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	2016-2020

390

LC 2016-7: Rainwater Collection Incentive	
Mitigation Goal/Objective:	1/1.1
Site and Location	Citywide
Background/Next Steps:	The area is prone to excessive heat and drought conditions could be favorable. Provide monetary incentive for League City residents to purchase and install rainwater catchment barrels. Alleviates high demand on the existing water infrastructure. Reduces the need of future water infrastructure
Hazard(s) Addressed:	Drought, Extreme Heat, Wildfire (Urban and Rural)
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$15,000

Potential Funding Sources:	ERCOT Grant funding
Lead Agency/Department Responsible:	Public Works
Implementation Schedule:	Program begins April 2015 and includes 200 rain barrels. The program will continue in 200 barrel increments into the future

391

LC 2016-8: Safe Rooms	
Mitigation Goal/Objective:	1/1.1
Site and Location	Citywide
Comments	The area is prone to tornado and high wind events. Encourage construction and use of safe rooms in existing and new structures. Allow citizens to install safe rooms at a significant discount in preexisting homes. Provide homeowners and developers with funds to assist in installing a safe room in new homes.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	Unknown
Potential Funding Sources:	FEMA HMGP
Lead Agency/Department Responsible:	Emergency Management, Planning and Zoning and Building
Implementation Schedule:	Dependent on funding approval

392

LC 2016:9 Participate in local and statewide studies, workshops, and committees that address all hazards prone in Galveston County	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Wildfire (Urban and Rural), Drought, Extreme Heat, Dam and Levee Failure, Expansive Soils, Land Subsidence, Earthquake, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

393

LC 2016-10: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Wildfire (Urban and Rural), Drought, Extreme Heat, Dam and Levee Failure, Expansive Soils, Land Subsidence, Earthquake, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

394

LC 2016-11: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Wildfire (Urban and Rural), Drought, Extreme Heat, Dam and Levee Failure, Expansive Soils, Land Subsidence, Earthquake, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

395
396

LC 2016-12: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective:	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Wildfire (Urban and Rural), Drought, Extreme Heat, Dam and Levee Failure, Expansive Soils, Land Subsidence, Earthquake, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

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399 *Table 24.20: Santa Fe*

SF 2016-1: Stormproof / retrofit new critical facilities and infrastructure	
Mitigation Goal/Objective:	1/1.2
Site and Location	Citywide
Background/Next Steps:	New construction of public buildings/infrastructure should include advanced mitigation techniques when practical. Measures may include, but are not limited to roof and foundation supports, shutters, shatter-proof windows/doors, etc. During the planning process, no new facilities or infrastructure were identified. However the City's needs may require new construction over the next five years. The city will develop plans and specifications to include mitigation measures where practical on future new construction initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Expansive Soils, Land Subsidence, Earthquake, Coastal Erosion and Retreat
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	General fund, HMGP, PDM, CDBG
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

400

SF 2016-2: Harden existing critical facilities and infrastructure to be more resistant to all hazards	
Mitigation Goal/Objective:	1/1.2
Site and Location	City Hall, Maintenance Building, Library, and Community Center
Background/Next Steps:	Continuity of emergency services and general governmental operations is necessary to protect staff and county property. Existing facilities may be lacking protective measures and adequate building standards. Mitigation options may include the provision of shatterproof glass for windows and doors, frame enhancements, shutters, strengthening roofs to withstand high winds, and elevating or flood proofing, etc. Potential hardening projects may include any municipal building and public infrastructure. The following improvements have been noted: • City hall – windows and doors • Maintenance building, Library, and Community Center – roof, windows and doors
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Expansive Soils, Land Subsidence, Earthquake, Coastal Erosion and Retreat
Mitigation Strategy:	Property Protection

Priority:	Moderate
Estimated Cost:	$2,000,000
Potential Funding Sources:	HMGP, PDM, General Fund, CDBG
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

401

SF 2016-3: Promote / build storm water detention ponds when appropriate	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Detention ponds/basins could be a solution for addressing flood impacts. Implement when applicable
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	Developers, general fund
Lead Agency/Department Responsible:	City administration
Implementation Schedule:	Continuous action

402

SF 2016- 4: Secure generators for existing and new critical facilities and infrastructure	
Mitigation Goal/Objective:	
Site and Location	City Hall and Street Department
Background/Next Steps:	Generators are essential for providing continual operations in the event of a disaster. As funding becomes available, the city will apply for grants to install generators to support existing or new facilities/infrastructure. At this time, City Hall and the Street Department are in need of a generator
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Severe Winter Weather, Earthquake, Extreme Heat
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$500,000
Potential Funding Sources:	HMGP, PDM, General funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

403
404

SF 2016-5: Continue efforts on mitigating Repetitive Flood Claim / Severe Repetitive Loss (RFC / SRL) properties when feasible and practical	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Grant funding through the Hazard Mitigation Grant Program may be used to mitigate Repetitive Flood Claim (RFC) and Severe Repetitive Loss (SRL) properties that repeatedly flood. Section 20 provides a summary of the RFC/SRL properties that have not be mitigated. Mitigation options will be explored with the property owners as funding and opportunity presents itself.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, FMA, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action
Analysis	
2016 – As of the November 2014 report, Santa Fe has mitigated 8 properties out of 122. The city will continue to seek opportunities to promote elevation, acquisition, demolition, and reconstruction projects.	

405

SF 2016-6: Upgrade drainage systems and culverts	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	The drainage systems and culverts throughout the area are frequently impacted by flash flood and severe weather events. Prioritize drainage systems for upgrades and implement when funding and opportunity presents itself.
Hazard(s) Addressed:	Flooding, Hurricane/Tropical Storm, Tsunami, Dam/Levee Failure, Windstorm, Severe Winter Weather, Tornado
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	HMGP, PDM, CDBG, General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

406
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408

SF 2016-7: Install lightning grounding systems and protection devices on sewer and water systems and municipal buildings	
Mitigation Goal/Objective:	1/1.2
Site and Location	Citywide
Background/Next Steps:	Lightning strikes can create outages to essential water and sewer services as well as invite unnecessary damage to critical facilities. Consider a program to establish lightning grounding systems on critical water and sewer system elements and other facilities prone to strikes to ensure that essential services continue.
Hazard(s) Addressed:	Lightning
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$50,000
Potential Funding Sources:	General Funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020

409

SF 2016-8: Implement / maintain tree /vegetation trimming/removal near, infrastructure, drainage systems and roadside areas	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Trees and other vegetation can encroach overhead power line, drainage systems and road ways potentially causing loss of service and/or accidents during and after various weather events Keep areas of concern free of unnecessary debris as needed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Wildfire (Urban and Rural), Severe Winter Storm, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$5,000
Potential Funding Sources:	General funds
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

410
411

SF 2016-9: Participate in local and statewide studies, workshops and committees that address the all hazards prone within Galveston County	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	Identify opportunities to join committees and planning studies to learn about all hazards in an effort to integrate them into future planning and regulatory initiatives
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous Action

412

SF 2016-10: Develop Critical Infrastructure and Key Resources database (CIKR)	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	A comprehensive database of critical facilities and infrastructure to build out a mapping system will further the planning area's preparedness and response abilities for all hazards. Develop listing of properties to include, facility name, latitude/longitude, physical address, number of people based in facility, building and content value, etc.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	2016-2020

413
414

SF 2016-11: Continue to enforce / improve ordinances and regulations to promote hazard mitigation strategies	
Mitigation Goal/Objective:	2/2.2
Background/Next Steps:	Ordinances and regulations are in place to guide the development and enforcement of construction standards and land uses. Update and/or develop ordinances and regulations as required to address all hazards prone to the area and include any changes in future development areas
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous Action

SF 2016-12: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective:	2/2.2
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments/officials responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

SF 2016-13: Update the Galveston County Multi-Jurisdiction Hazard Mitigation Plan every five years	
Mitigation Goal/Objective:	2/2.4
Background/Next Steps:	Under CFR 44 §206 – communities are required to update their hazard mitigation plan every five years to remain eligible for disaster assistance. Coordinate plan update with TDEM Mitigation Planning Section and the participating jurisdictions in Galveston County to schedule plan updates as they become due.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
	High
Estimated Cost:	$60,000 (allocation to be determined)
Potential Funding Sources:	HMGP, general funds
Lead Agency/Department Responsible:	City Administration and applicable departments with GCOEM
Implementation Schedule:	Continuous action

418

SF 2016-14: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective:	2/2.4
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify needs. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration and applicable departments
Implementation Schedule:	Continuous action

419
420

421

SF 2016-15: Improve / maintain participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS) programs	
Mitigation Goal/Objective:	2/2.5
Site and Location	Citywide
Background/Next Steps:	Continue participation in the NFIP program which offers incentives to reduce insurance premiums.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	No Cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City administration and applicable departments
Implementation Schedule:	Continuous action

422

SF 2016-16: Continue efforts on public information and awareness for all hazards	
Mitigation Goal/Objective:	3/3.1
Background/Next Steps:	The planning area has several outreach initiatives to communicate hazard preparedness information to the general public and visitors to the area. Providing timely information and educational information related to preparedness, mitigation, response and recovery to the public fosters their ability to become self-sufficient. Continue to provide information on all hazards that may include but not be limited to educational information, evacuation routes/procedures, workshop/training programs, alert systems and the like.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Education and Awareness
Priority:	High
Estimated Cost:	No cost
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration in coordination with county and state officials
Implementation Schedule:	Continuous action

423

Table 24.21: Tiki Island

TI 2011-2: Implement water conservation awareness campaign (at Citywide Fourth of July picnic and other local activities.)	
Mitigation Goal/Objective:	3/3.1
Site and Location	Citywide
Background/Next Steps:	Past damages include post-Hurricane Ike water shortages, early 2009 Brazos watershed drought, numerous summer heat waves causing high water consumption and low water pressure. Publish information citywide; attend functions where citizens gather such as 4th of July at public park-man booth to promote program and answer questions
Hazard(s) Addressed:	Drought, Extreme Heat
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	$2,000
Potential Funding Sources:	General Fund, TCEQ, TWDB
Lead Agency/Department Responsible:	Water District
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered this action from TI-2. The city continues to provide information to the public regarding water conservation.	

TI 2011-5: Elevate 11 wastewater lift stations and provide backup power	
Mitigation Goal/Objective:	1/1.2
Site and Location	Numerous locations within city of Tiki Island
Background/Next Steps:	Electronic panels will be elevated above base flood elevations, requiring OSHA complaint work platforms. Quick connect backup power connections will be added, and two trailer based portable generators will be rotated among lift stations as needed.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Tsunami, Flooding, Tornado, Windstorm, Lightning, Severe Winter Storm, Earthquake
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$950,000
Potential Funding Sources:	CDBG, HMGP, General Fund
Lead Agency/Department Responsible:	Water District
Implementation Schedule:	2016-2020 (dependent on funding)
Analysis	
2016 - Renumbered this action from TI-5. Project delayed due to lack of funding	

TI 2011-8: Purchase new Emergency Notification System (ENS).	
Mitigation Goal/Objective:	1/1.1
Site and Location	802 Tiki Drive
Background/Next Steps:	In the aftermath of Hurricane Ike, City officials were unable to communicate with displaced citizens. The emergency notification system will be capable of easily registering citizens' cell phones, email, and VOIP lines. The system will be tested to insure completeness and accuracy of data. Prompt communication to inform residents when they can safely return to their homes and businesses will reduce looting and vandalism.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Earthquake
Mitigation Strategy:	Emergency Services
Priority:	High
Estimated Cost:	$5000
Potential Funding Sources:	General fund
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	2016-2020 (dependent on funding)
Analysis	
2016 - Renumbered this action from TI-8. Project delayed due to funding	

427

TI 2011-9: Replace the Tiki Drive bridge with an improved, hardened bridge to withstand storm surge and debris.	
Mitigation Goal/Objective:	1/1.2
Site and Location	300 to 400 Tiki Drive
Background/Next Steps:	This bridge is the only access to the City of Tiki Island. Hurricane Ike caused some damage to bridge and an unknown degree of scouring. Improving the bridge decking to withstand higher storm surge will insure that the ingress/egress is available for emergency evacuation and operations. Replace three section spans with single span, eliminating potential failure of current bridge supports in channel.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tsunami
Mitigation Strategy:	Structural
Priority:	High
Estimated Cost:	$4.8 million
Potential Funding Sources:	CDBG, County road & Bridge
Lead Agency/Department Responsible:	TXDOT, mayor
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered this action from TI-9. Project delayed pending funding	

TI 2011-10: Become a NOAA "Storm Ready" community	
Mitigation Goal/Objective:	1/1.1
History of Damages	Emergency Services
Background/Next Steps:	Recent storms have shown the vulnerabilities of this coastal community. To be officially StormReady, a community must: • Establish a 24-hour warning point and emergency operation center • Have more than one way to receive severe weather warnings and forecasts and to alert the public • Create a system that monitors weather conditions locally • Promote the importance of public readiness through community seminars • Develop a formal hazardous weather plan, which includes training severe weather spotters and holding emergency exercises
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Severe Winter Storm
Mitigation Strategy:	N/A
Priority:	High
Estimated Cost:	$150,000
Potential Funding Sources:	Unknown at this time
Lead Agency/Department Responsible:	Emergency Management
Implementation Schedule:	2016-2020
Analysis	
2016 - Renumbered this action from TI-10. This action has been delayed due to lack of funding. Next Steps: Pursue requirements to become a StormReady community. Download and complete application from http://www.stormready.noaa.gov/apply.htm.	

428

TI 2011-11: Improve NFIP CRS rating above current class 8	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	Hurricane Ike, Hurricane Alicia, other severe weather impacts residents and structures. CRS activities will further harden structures and promote purchase of flood insurance, while providing reduced premiums to residents. Improve city performance in the four categories: 1. Public information (6%) 2. Mapping and regulations (40%) 3. Flood damage reduction (45%) 4. Flood preparedness (9%) Rating improvement will improve insurance discounts
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Prevention
Priority:	High

Estimated Cost:	$75,000
Potential Funding Sources:	CDBG, grants
Lead Agency/Department Responsible:	Mayor, with Building Inspector
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered this action from TI-10 No progress made on lowering rating. City will explore areas where improvements can be made and continue to work towards lowering their rating.	

429

TI 2011-13: Implement a tree trimming program that clears tree limbs from public right of ways	
Mitigation Goal/Objective:	1/1.5
Site and Location	Citywide
Background/Next Steps:	Tree limbs and brush that falls during extreme temperature events block access of streets from first responders, clog storm sewers, down power lines and prevent road access. Minimizing falling tree limbs protects structures from damage during extreme temperature and weather events
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Tsunami, Wildfire (Urban and Rural), Severe Winter Storm
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	$50,000/year
Potential Funding Sources:	Grants, City Funds
Lead Agency/Department Responsible:	City Dept.
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered this action from TI-13. Project is an ongoing effort.	

430

TI 2011-14: Conduct a fire safety and prevention program	
Mitigation Goal/Objective:	3/3.1
Site and Location	Citywide
Background/Next Steps:	Due to extreme heat, drought, and lightning strikes during storms, the City is susceptible to fire hazard incidents. Through public education, the city of Tiki Island hopes to reduce fire hazards caused by citizens.
Hazard(s) Addressed:	Lightning, Wildfire (Urban and Rural)
Mitigation Strategy:	Public Education and Awareness
Priority:	High
Estimated Cost:	To be determined
Potential Funding Sources:	General Funds, Federal and State Grants

Lead Agency/Department Responsible:	Public Safety/Fire Marshal
Implementation Schedule:	Continuous action
Analysis	
2016 - Renumbered this action from TI-14. The city continues to provide information regarding fire safety	

431

TI 2016-1: Continue efforts on mitigating Repetitive Flood Claim / Severe Repetitive Loss (RFC / SRL) properties when feasible and practical	
Mitigation Goal/Objective:	1/1.5
Site and Location:	Citywide
Background/Next Steps:	Grant funding through the Hazard Mitigation Grant Program may be used to mitigate Repetitive Flood Claim (RFC) and Severe Repetitive Loss (SRL) properties that repeatedly flood. Section 20 provides a summary of the RFC/SRL properties that have not be mitigated. Mitigation options with the property owners will be explored as funding and opportunity presents itself.
Hazard(s) Addressed:	Flooding
Mitigation Strategy:	Property Protection
Priority:	High
Estimated Cost:	Undetermined
Potential Funding Sources:	Flood Mitigation Assistance
Lead Agency/Department Responsible:	City Administration, GCEOM
Implementation Schedule:	Continuous Action

432

TI 2016-2: Continue to enforce / improve ordinances and regulations to promote hazard mitigation strategies	
Mitigation Goal/Objective:	2/2.2
Site and Location	Citywide
Background/Next Steps:	Tiki Island has ordinances and regulations in place to guide the development and enforcement of construction standards and land uses. Update and/or develop ordinances and regulations as required to address all hazards prone to Tiki Island and include any changes in future development areas.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	N/A

Potential Funding Sources:	Budget
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

433

TI 2016-3: Conduct annual reviews of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	As defined in the plan maintenance section of this plan, the Galveston County EMC will schedule a meeting with the committee to review progress made on mitigation actions and identify changes/new vulnerabilities. A worksheet has been developed to facilitate this process and should be inserted into the appendix of this plan once completed. Review status of mitigation actions annually and participate in 2021-2025 plan update.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	N/A
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	Tiki Island HMP Representative, GCEOM
Implementation Schedule:	Continuous action

434

TI 2016-4: Continue efforts on public information and awareness for all hazards	
Mitigation Goal/Objective:	3/3.1
Background/Next Steps:	Tiki Island has several outreach initiatives to communicate hazard preparedness information to the general public and visitors to the area. Providing timely information and educational information related to preparedness, mitigation, response and recovery to the public fosters their ability to become self-sufficient. Continue to provide information on all hazards that may include but not be limited to educational information, evacuation routes/procedures, workshop/training programs, alert systems and the like.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Public Education and Awareness

Priority:	High
Estimated Cost:	N/A
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

435

TI 2016-5: Integrate hazard mitigation into local planning	
Mitigation Goal/Objective:	2/2.1
Background/Next Steps:	Hazard mitigation can be integrated into local planning efforts through incorporating risk assessment and hazard mitigation principles into the comprehensive plan, local development and subdivision review process, land suitability analyses, etc. Provide a copy of the Galveston County Multi-Jurisdiction Hazard Mitigation Plan to applicable departments responsible for the enforcement or development of policies and planning initiatives.
Hazard(s) Addressed:	Hurricane/Tropical Storm, Flooding, Tornado, Windstorm, Hailstorm, Lightning, Tsunami, Drought, Extreme Heat, Wildfire (Urban and Rural), Severe Winter Storm, Dam and Levee Failure, Pipeline Failure, Hazardous Materials, Coastal Erosion and Retreat, Land Subsidence, Earthquake, Expansive Soils
Mitigation Strategy:	Prevention
Priority:	High
Estimated Cost:	N/A
Potential Funding Sources:	N/A
Lead Agency/Department Responsible:	City Administration
Implementation Schedule:	Continuous action

436

25.0 Repetitive Flood Properties

25.1 National Flood Insurance Program (NFIP) Participation

Flood insurance offered through the National Flood Insurance Program (NFIP) is the best way for home and business owners to protect themselves financially against the ravages of flooding. All jurisdictions in this plan update participate in the NFIP.

Community Rating System (CRS) Participation

The NFIP's Community Rating System (CRS) is a voluntary incentive program that recognizes jurisdictions for implementing floodplain management practices that exceed the minimum federal requirements of the NFIP to provide protection from flooding.

In exchange for a community's proactive efforts to reduce flood risk, policyholders can receive reduced flood insurance premiums for buildings in the community. These reduced premiums reflect the reduced flood risk resulting from community efforts toward achieving the three CRS goals:

1. Reduce flood damage to insurable property
2. Strengthen and support the insurance aspects of the NFIP
3. Encourage a comprehensive approach to floodplain management

Participation in the CRS is voluntary. By participating, jurisdictions earn credit points that determine classifications. There are 10 CRS Classes: Class 1 requires the most credit points and provides the largest flood insurance premium reduction (45 percent) while Class 10 means the community does not participate in the CRS or has not earned the minimum required credit points, and residents receive no premium reduction. The CRS Classes are based on completion of 19 creditable activities organized into four categories:

CRS Class	Premium Discount	CRS Class	Premium Discount
1	45%	6	20%
2	40%	7	15%
3	35%	8	10%
4	30%	9	5%
5	25%	10	----

1. Public Information
2. Mapping and Regulations
3. Flood Damage Reduction
4. Warning and Response

Table 25.1 provides an overview of each community's participation in the NFIP and CRS as of September 2014.

Table 25-1: NFIP Participation as of September 2014

CID	Community	Initial FHBM Identified	Initial FIRM Identified	Current Effective Map Date	Regular / Emergency Date	CRS Rating
481589	Bayou Vista				04/09/71	
485461	Clear Lake Shores	10/23/70	10/23/70	04/04/83	10/23/70	
485468	Friendswood	06/05/70	03/03/72	09/22/99	03/03/72	7[1]
485470	Galveston County		04/09/71	12/06/02	04/09/71	
485479	Hitchcock	11/17/70	11/13/70	04/04/83	11/13/70	
481271	Jamaica Beach		04/08/71	12/06/02	04/08/71	
485481	Kemah	06/05/70	10/16/70	04/04/83	10/16/70	8[1]
485486	La Marque	05/26/70	10/16/70	02/16/83	10/16/70	
485488	League City	06/05/70	06/05/70	09/22/99	11/20/70	6
481562	Santa Fe	09/02/80	04/08/71	10/18/83	04/09/71	
481585	Tiki Island	04/09/71	04/09/71	11/01/85	04/15/83	8

Source: FEMA Community Status Book Report 01/19/16 http://www.fema.gov/cis/TX.html
Community Rating System Communities 06/01/14 www.fema.gov/media-library/assets/documents/15846

Note: [1]Reflects current CRS rating for Friendswood and Kemah.

25.2 Repetitive Loss and Severe Repetitive Loss Properties

A high priority in Texas and nationwide is the reduction of structures with repetitive losses. These structures strain NFIP. They increase the NFIP's annual losses and the need for borrowing and, more importantly, they drain resources needed to prepare for catastrophic events. The NFIP defines a repetitive loss property (RL) as "any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period since 1978. At least, two of the claims must be more than 10-days apart."

The Flood Insurance Reform Act of 2004 identified another category of repetitive loss. Severe repetitive loss (SRL) is defined as "a single family property (consisting of one-to-four residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage for which four or more separate claim payments (building and contents) have been paid under flood insurance coverage with the amount of each claim payment exceeding $5,000 and with cumulative amount of such claims payments exceeding $20,000; or for which at least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the reported value of the property."

The planning team reviewed the list of RL/SRL properties received from the Galveston County Housing and Economic Development (Report date September 2014) to determine how many properties that remain unmitigated are in the program compared to how many have been mitigated (Appendix H provides a property listing by jurisdiction, excluding addresses).

Table 25-2 provides a summary by occupancy type and reflects the total number of properties reported as mitigated to date. Additional details regarding insurance status and the number of flood claims and total amounts paid from 1978 to September 2014 are provided in Table 25-3.

Table 25-2: Summary of Repetitive Flood Properties by Occupancy Type and Number of Properties Mitigated

Community	2-4 Family	Assmd. Condo	Non-Resident	Other Resident	Single Family	Total RF Properties	No. of Mitigated Properties
Bayou Vista	0	0	0	0	45	45	9
Clear Lake Shores	1	2	13	1	86	103	53
Friendswood	1	4	5	2	295	307	129
Hitchcock	0	1	4	0	100	105	34
Jamaica Beach	0	1	0	0	44	45	4
Kemah	2	3	30	3	74	112	79
La Marque	0	1	5	0	69	75	6
League City	1	3	7	2	220	233	111
Santa Fe	0	0	7	1	114	122	11
Tiki Island	0	0	0	0	2	2	0
Galveston County-Unincorporated							
Alta Loma	0	0	1	0	4	5	3
Arcadia	0	0	0	0	1	1	0
Bacliff	1		6		60	67	4
Caplen	0	0	0	0	2	2	2
Crystal Beach	0	1	3	0	55	59	46
Gilchrist	1	1	4	0	68	74	72
High Island	0	0	0	0	2	2	1
Port Bolivar	0	0	4	0	63	67	46
San Leon	1	0	2	0	29	32	10
Seabrook	0	0	1	0	0	1	1
Total	8	17	92	9	1,333	1,459	621

Table 25-3: Summary of Repetitive Flood Properties Flood Claims and Total Payments Received 1978 to 2014

Community	No. of RF Properties	No. of Insured Properties			Flood Claims	Total Payments ($)
		No	Yes	SDF[1]		
Bayou Vista	45	29	5	11	196	4,901,778
Clear Lake Shores	103	61	36	6	408	9,838,341
Friendswood[2]	307	184	95	28	1177	48,719,984
Hitchcock	105	75	23	7	339	5,554,124
Jamaica Beach	45	31	12	2	133	3,173,088
Kemah	112	76	31	5	455	12,637,778
La Marque	75	66	7	2	274	1,887,720
League City[2]	233	130	88	15	728	17,383,753
Santa Fe	121	96	18	7	406	4,450,361
Tiki Island	2	1	1	0	6	33,624
Galveston County-Unincorporated:						
Alta Loma	5	5	0	0	16	156,890
Arcadia	1	1	0	0	2	48,108
Bacliff	67	42	22	3	228	3,259,796
Caplen	2	2	0	0	4	248,242
Crystal Beach	59	49	10	0	127	8,406,900
Gilchrist	74	70	4	0	191	9,491,736
High Island	2	2	0	0	4	84,493
Port Bolivar	67	58	7	2	189	6,250,562
San Leon	32	19	13	0	81	3,204,189
Seabrook	1	1	0	0	11	184,628
Total	1,458	998	372	88	4,975	$139,916,095

Source: Galveston County Housing and Economic Development, September 2014

Note: [1]Special Direct Facility–NFIP Insurance is obtained directly from FEMA/NFIP and not through local insurance brokers.
[2] Friendswood and League City have a few properties located in Harris County. Data for these properties is included in this table.

The NFIP also provides updates as to the total amounts paid on losses and policies in place. Table 25.4 provides a summary of these reports for the participating jurisdictions from 1978 to 2015.

Table 25-4: Summary of Loss and Policy Statistics 1978 to November 30, 2015

Community	Loss Statistics					Policy Statistics		
	No. Losses	Closed Losses	Open Losses	CWOP Losses	Total Payments	Policies In-Force	Insurance In-Force	Written Premium In-Force
Bayou Vista	27	27	0	0	$687,312	12	$2,326,700	$17,161
Clear Lake Shores	1,075	956	4	115	$24,307,538	534	$127,452,200	$367,874
Crystal Beach	660	484	0	176	$2,036,238	Included in Galveston County		
Friendswood	3,339	2,785	2	552	$86,475,320	6,845	$2,128,862,500	$2,884,981
Hitchcock	1,162	984	1	177	$17,226,974	812	$171,425,600	$512,197
Jamaica Beach	1,536	1,280	3	253	$22,293,349	915	$224,032,900	$1,211,719
Kemah	1,340	1,142	3	195	$40,886,780	532	$150,009,800	$443,487
La Marque	1,299	1,004	0	295	$11,992,475	1,551	$398,246,500	$788,355
League City	3,106	2,310	3	793	$42,388,008	14,568	$4,509,262,500	$5,934,617
Santa Fe	172	108	0	64	$1,322,706	1,080	$300,290,100	$431,887
Tiki Island	621	470	1	150	$6,299,524	568	$144,400,100	$2,089,404
Galveston County (Unincorporated)	16,448	14,125	37	2,286	$580,784,193	8,756	$2,258,675,700	$10,909,581

Source: Loss Statistics http://bsa.nfipstat.fema.gov/reports/1040.htm#48
Policy Statistics http://bsa.nfipstat.fema.gov/reports/1011.htm#TXT

Total losses - All losses submitted regardless of the status.
Closed losses - Losses that have been paid.
Open losses - Losses that have not been paid in full.
CWOP losses - Losses that have been closed without payment.
Total Payments - Total amount paid on losses.
Policies In Force - Policies in force on the "as of" date of the report.
Insurance In Force - The coverage amount for policies in force.
Written Premium In Force - The premium paid for policies in force

Progress Made on Repetitive Flood Properties

The largest SRL grant ever awarded in the nation went to Galveston County in 2011. More than $34 million was allocated to elevate 224 homes of which FEMA's SRL program covered 90 percent or $31 million. The properties were selected based on their SRL status and homeowner interest (source: fema.gov/news-release/2011/10/04).

Galveston County presented a voluntary buyout program through HMGP to property owners located on Bolivar Peninsula (Port Bolivar, Crystal Beach, Caplen, and Gilchrist), and Jamaica Beach, and Hitchcock (Freddiesville). As a result, Galveston County was able to purchase 550 properties (10 each in Jamaica Beach and Hitchcock, and 530 Bolivar Peninsula.

<u>Galveston County:</u>

- 2014 SRL program – 130 properties (101 completed or in progress and 29 pending)
- FMA Award – Texas City (4 reconstruction and 1 elevation)
- 2015 FMA Application Submitted – 40 elevation projects
- Housing Program – Round 1
    - 600 homes built
    - 8 demolition of slum/blighted properties
    - 59 single family rentals
- Housing Program – Round 2
    - 617 homes built
    - 31 veteran homes
    - 37 demolition of slum/blighted properties
    - 35 single family rentals
- Multi-family rental project
    - 2 projects with 51 single-family units
    - 1 rehabilitation project

Friendswood:

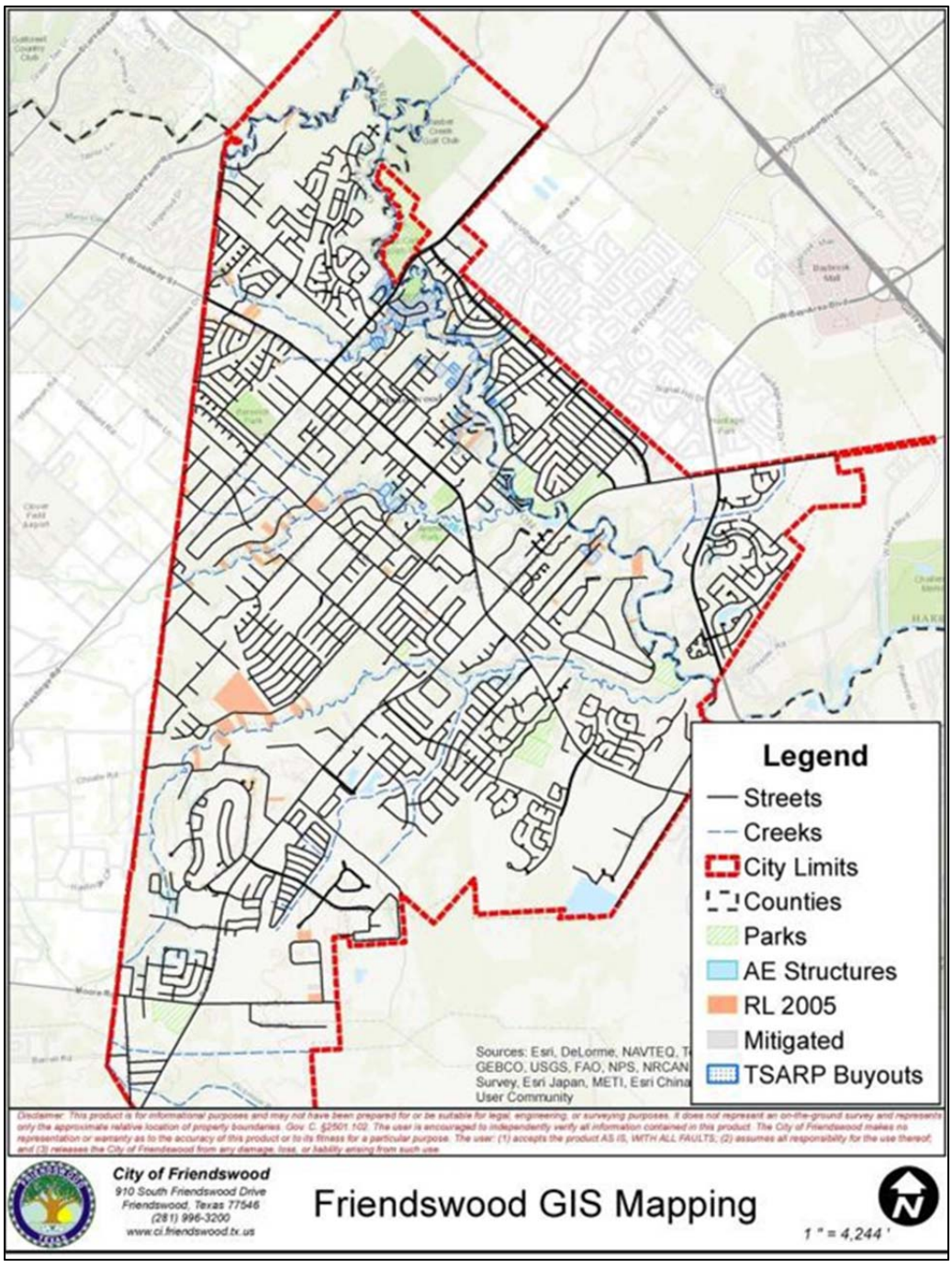
- 2013 HMA Grant Assistance program through the County (2011 SRL Award)
  - 14 contracts executed (90/10 funding)
    - four qualified for ICC (Increased Cost of Compliance) through private insurance carriers which went towards their 10 percent match
- 2001 Tropical Storm Allison Buyout Program
  - 112 properties removed

League City:

- 20 properties elevated at a cost of $4,064,272 (completed 2012-2014)
- 2 properties in progress at a cost of $508,962 (completion 2016)

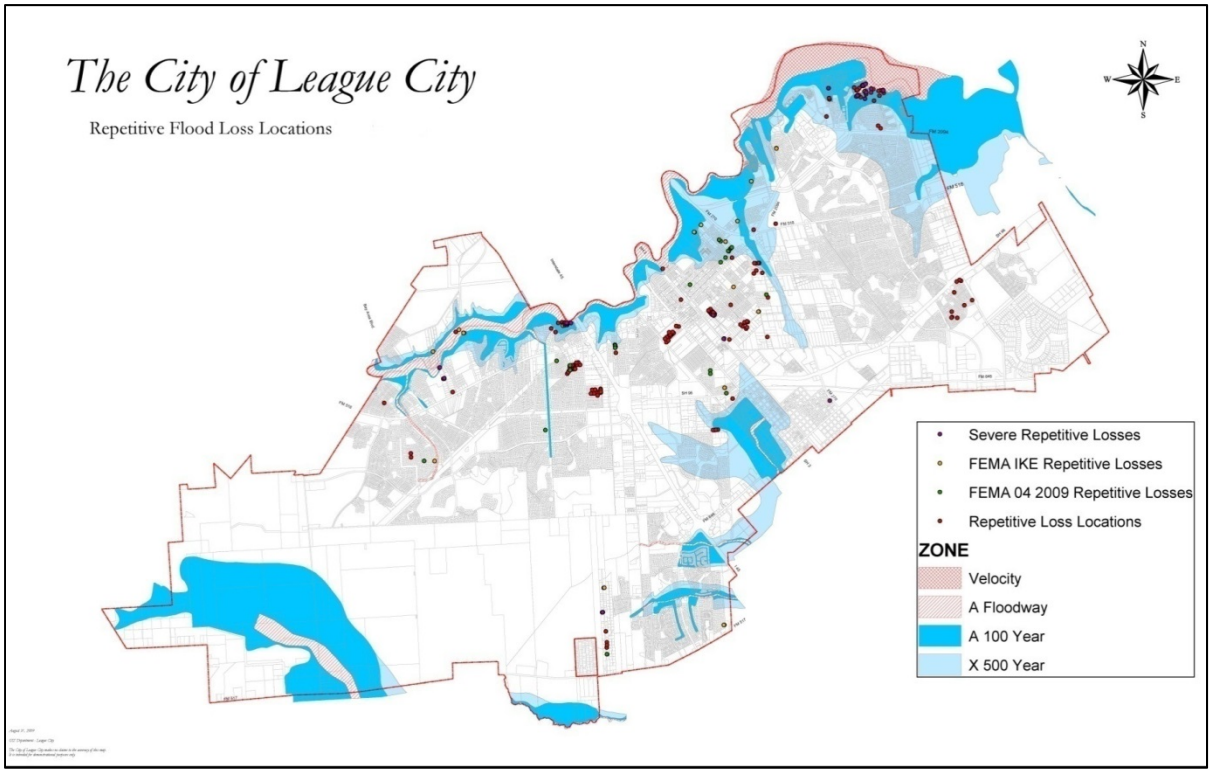
Figures 25.1 to 25.2 provide the general location of the repetitive flood properties that have been mapped by GIS for Friendswood and League City. The other jurisdictions are encouraged to develop GIS maps when feasible to further enhance their NFIP program.

Figure 25.1: Friendswood Repetitive Flood Properties



Source: City of Friendswood

Figure 25.2: League City Repetitive Flood Loss and Severe Repetitive Flood Loss Properties



Source: City of League City

Mitigating Repetitive Flood Properties

FEMA's Hazard Mitigation Grant Program (HMGP), Pre-Disaster Mitigation (PDM), and Flood Mitigation Assistance (HMA) provide funding to assist jurisdictions in mitigating properties prone to flooding. Table 25.5 provides a listing of eligible activities typically funded through these programs.

Table No. 25.5: Eligible Activities by Program

Eligible Activities	HMGP	PDM	FMA
Property Acquisition and Structure Demolition The voluntary acquisition of an existing at-risk structure and, typically, the underlying land, and conversion of the land to open space through demolition of the structure. The property must be deed-restricted in perpetuity to open space uses to restore and/or conserve the natural floodplain functions. For property acquisition and structure demolition projects, see Addendum A.	X	X	X
Property Acquisition and Structure Relocation The voluntary physical relocation of an existing structure to an area outside of a hazard-prone area, such as the Special Flood Hazard Area (SFHA) or a regulatory erosion zone and, typically, the acquisition of the underlying land. Relocation must conform to all applicable State and local regulations. The property must be deed-restricted in perpetuity to open space uses to restore and/or conserve the natural floodplain functions. For property acquisition and structure relocation projects, see Addendum, Part A.	X	X	X
Structure Evaluation Physically raising and/or retrofitting an existing structure to the Base Flood Elevation (BFE) or higher if required by FEMA or local ordinance. Elevation may be achieved through a variety of methods, including elevating on continuous foundation walls; elevating on open foundations, such as piles, piers, posts, or columns; and elevating on fill. Foundations must be designed to address properly all loads and be appropriately connected to the floor structure above, and utilities must be properly elevated as well. FEMA encourages Applicants and sub-applicants to design all structure elevation projects in accordance with the American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) 24-05, Flood Resistant Design, and Construction. For additional information about structure elevation projects, see Addendum, Part E.	X	X	X
Mitigation Reconstruction The construction of an improved, elevated building on the same site where an existing building and/or foundation has been partially or completely demolished or destroyed. Mitigation reconstruction is only permitted for structures outside of the regulatory floodway or coastal high hazard area (Zone V) as identified by the existing best available flood hazard data. Activities that result in the construction of new living space at or above the BFE will only be considered when consistent with the mitigation reconstruction requirements.			X

Eligible Activities	HMGP	PDM	FMA
Dry Floodproofing Techniques applied to keep structures dry by sealing the structure to keep floodwaters out. For all dry floodproofing activities, FEMA encourages applicants and sub-applicants to design all dry floodproofing projects in accordance with ASCE/SEI 24-05.			
- Dry Floodproofing of Historic Residential Structures Permissible only when other techniques that would mitigate to the BFE causing the structure to lose its status as a Historic Structure, as defined in 44 CFR Section 59.1.	X	X	X
Dry Floodproofing of Non-Residential Structures Must be performed in accordance with NFIP Technical Bulletin (TB) 3-93, *Non-Residential Floodproofing—Requirements and Certification*, and the requirements pertaining to dry floodproofing of non-residential structures found in 44 CFR Sections 60.3(b)(5) and (c)(4).	X	X	X
Minor Localized Flood Reduction Projects Projects to lessen the frequency or severity of flooding and decrease predicted flood damages, such as the installation or modification of culverts, and stormwater management activities, such as creating retention and detention basins. These projects must not duplicate the flood prevention activities of other Federal agencies and may not constitute a section of a larger flood control system.	X	X	X

Source: FEMA Hazard Mitigation Assistance Unified Guidance, July 12, 2013, and Addendum to the Hazard Mitigation Assistance Unified Guidance, July 12, 2013

Mitigation Actions identified by each jurisdiction that relate to either THE NFIP/CRS maintenance or compliance are provided in Section 24.