

HARRIS COUNTY FLOOD CONTROL DISTRICT  
September 2013 (Revised February 2014)

# MAIN REPORT AND ENVIRONMENTAL ASSESSMENT

## GENERAL REEVALUATION REPORT

*Environmental Assessment Document*



**WHITE OAK BAYOU, TEXAS**

**FEDERAL FLOOD DAMAGE  
REDUCTION PROJECT**

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## Acronyms and Abbreviations

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AAHU	average annual habitat units
ACHP	Advisory Council on Historic Preservation
AIRS	Current Emission Inventory Data
AOI	area of influence
APE	area of potential effect
ASTM	American Society of Testing Materials
BA	Biological Assessment
BMP	best management practices
BUG	Beneficial Uses Group
CAA	Clean Air Act
CAC	Citizens Advisory Committee
CAR	Coordination Act Report
CE	Categorical Exclusion
CE/ICA	Cost Effective and Incremental Cost Analysis
CFR	Code of Federal Regulations
COH	City of Houston
CWA	Clean Water Act
dbh	diameter at breast height
DSS	decent, safe, and sanitary
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FINDS	Facility Index System
FM	Farm-to-Market Road
FONSI	Finding of No Significant Impact
FPPA	Farmland Protection Policy Act
FTA	Federal Transit Administration
GBWMB	Greens Bayou Wetland Mitigation Bank
GLO	General Land Office
GRR	General Reevaluation Report
HCFCD	Harris County Flood Control District
HEP	habitat evaluation procedures
H-GAC	Houston-Galveston Area Council
HGB	Houston-Galveston-Brazoria
HHS	Health and Human Services

HOA	Home Owners Association
HSI	Habitat Suitability Index/Indices
HTRW	Hazardous, Toxic, and Radioactive Waste
HU	habitat units
ICT	Interagency Coordination Team
IH	Interstate Highway
IHW	Industrial Hazardous Waste
ISTEA	Intermodal Surface Transportation Efficiency Act
Ldn	day-night sound levels
LEP	Limited English Proficiency
LUST	leaking underground storage tank
MKTRR	Missouri, Kansas, and Texas Rails to Trails
MOA	Memorandum of Agreement
MPO	Metropolitan Planning Organization
MS4	municipal separate storm sewer system
MTP	Metropolitan Transportation Plan
NAAQS	National Ambient Air Quality Standards
NED	National Economic Development
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NO <sub>x</sub>	nitrogen oxides
NRCS	Natural Resources Conservation Service
NSB	Non-Structural Buyout
NWI	National Wetlands Inventory
OHWM	ordinary high water mark
OMRR&R	operations, maintenance, repair, replacement, and rehabilitation
PA	Programmatic Agreement
PAL	Planning Aid Letter
PM	particulate matter
RCRA	Resource Conservation and Recovery Act
REC	Records of Environmental Consideration
ROW	right-of-way
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SOC	species of concern
SW3P	Storm Water Pollution Prevention Plan

TAC	Texas Administrative Code
TARL	Texas Archaeological Research Laboratory
TCEQ	Texas Commission on Environmental Quality
THC	Texas Historical Commission
TIP	Transportation Improvement Plan
TMDL	total maximum daily load
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks & Wildlife Department
TPY	tons per year
TSP	total suspended particulates
TxDOT	Texas Department of Transportation
US	U.S. Highway
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDOT	U.S. Department of Transportation
USFWS	U.S. Fish and Wildlife Service
UST	underground storage tank
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
WEB	Watershed Environmental Baseline
WOBA	White Oak Bayou Association
WRDA	Water Resources Development Act

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## 1.0 PROJECT BACKGROUND

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### 1.1 INTRODUCTION

The Upper White Oak Bayou flood damage prevention project from Cole Creek upstream to the end of White Oak Bayou was authorized by the WRDA 1986 (Public Law 99-662) and based on *Buffalo Bayou and Tributaries Main Report on Upper White Oak Bayou Feasibility Report for Flood Damage Prevention* (USCOE, 1979). Subsequent to the WRDA 1986 authorization, the Harris County Flood Control District ("HCFCD"), the local sponsor, in cooperation the U.S. Army Corps of Engineers ("USACE"), Galveston District (the lead federal agency), was authorized under Section 211(f) of the Water Resources Development Act ("WRDA") of 1996 to evaluate alternatives to the 1986 authorized plan and to identify a Federal Flood Damage Reduction Project on White Oak Bayou. The alternatives were evaluated to provide a feasible and economically justified plan that would effectively reduce damages due to flooding along White Oak Bayou. Based on the alternatives evaluated, the Local Sponsor has developed a Recommended Plan proposed for cost-sharing as a Federal project. Under the authority of Section 211(f) and following all applicable Federal laws, regulations, and policies, HCFCD has conducted planning of components of the Recommended Plan. As local initiatives that have not yet been reviewed and accepted by the USACE, design and construction has occurred for several components for the federal project that have been identified in the planning efforts. This Environmental Assessment ("EA") assesses the social, economic, and environmental impacts associated with the Recommended Plan (RF-31), also considered to be the Environmentally Preferred Alternative, while considering current needs and policies. A study area, project area, and watershed map is provided as Exhibit 1-1.

This EA has been prepared in compliance with the NEPA Code of Federal Regulations ("CFR") §1500-1508. The focus of this EA is the detailed assessment and comparison of the potential impacts resulting from implementation of the Recommended Plan and the No Action Alternative.

The alternative plan development process is complex, having its roots in economics. However, as with all federal programs, the National Environmental Policy Act ("NEPA") requires full consideration of the process. In order to determine whether an EA or an Environmental Impact Statement ("EIS") was appropriate, the origin of the project (i.e., modifications to White Oak Bayou) is important. Potential plan components considered included structural measures, e.g., channel modifications, stormwater detention basins, bypass channels, flood protection levees, bridge modifications or replacements, and non-structural measures; e.g., no action, floodplain management, flood warning, flood-proofing, relocation, and permanent evacuation. Groups of components were evaluated individually for environmental impacts utilizing screening criteria—cultural resources, protected species, hazardous waste, wetlands, and other significant factors (e.g., public lands). This EA was prepared for the Recommended Plan of the White Oak Bayou Federal Flood Damage Reduction Project, based on the findings of the environmental screening investigation, which determined that components for the implementation of the White Oak Bayou project would not result in significant impacts to the environment. After distributing the February

2013 draft General Reevaluation Report and draft Environmental Assessment for public review, public comments resulted in the Local Sponsor deciding to change one of the components of the Tentatively Recommended Plan. The White Oak Bayou watershed originates in northwest Harris County, Texas, and flows southeast for approximately 25 miles through the city of Jersey Village and the city of Houston, where it outfalls into Buffalo Bayou in downtown Houston. For this study, White Oak Bayou is divided into three reaches—upper, middle, and lower. The upper reach is from Farm-to-Market Road ("FM") 1960 to HCFCD drainage channel E122-00-00, the middle reach is from E122-00-00 to Cole Creek, and the lower reach is from Cole Creek to the confluence with Brays Bayou. The White Oak Bayou watershed is approximately 110 square miles and approximately 90 percent developed. White Oak Bayou extends from its upstream headwaters at Huffmeister Road, downstream to its confluence with Buffalo Bayou in downtown Houston (approximately 25 miles in length). White Oak Bayou and the watershed boundary are identified in Exhibit 1-1.

The study area is defined as the area along White Oak Bayou based on the 500-year (0.2 percent) floodplain. The study area is identified in Exhibit 1-1.

The proposed action, entitled the Recommended Plan (RF-31) and the Environmentally Preferred Alternative, consists of a Locally Preferred Plan that resulted from a reduction in the size of one detention basin of the National Economic Development ("NED") Plan identified during the study, along with mitigation of wetlands impacts associated with the NED plan components, and a Recreation Plan also developed during the study. The reduction in the size of one detention basin was a result of public comments received concerning the third cell in one of the Tentatively Recommended Plan's four detention basins. The resulting Recommended Plan consists of the following flood control components - channel modifications of approximately 15.4 miles in length along the White Oak Bayou channel from upstream of Cole Creek to FM 1960, and the Jersey Village channel, and four detention basin complexes of approximately 353 total acres. Plantings of trees, shrubs, and grasses are included along the channel modifications and at the detention basins. Wetlands mitigation consists of the use of wetlands acreage that the Local Sponsor has at the Greens Bayou Wetlands Mitigation Bank. The Recreation Plan consists of trails along White Oak Bayou and recreation facilities at the detention basins. The project area is defined as the footprint of the area of the Recommended Plan (Exhibit 1-2).

The proposed action involves deepening and widening the existing grass-lined White Oak Bayou channel upstream of Cole Creek to FM 1960 (approximately 12.5 miles), deepening and widening the Jersey Village channel (approximately 2.9 miles), and construction of four detention basin complexes (353 acres). Additional right-of-way ("ROW") in the amount of 21.4 acres is required to implement the proposed action. The ROW acquisition includes 10.8 acres occurring from channel modifications between Cole Creek and Gessner Drive, and 10.6 acres at one of the detention basin complexes. ROW acquisition includes displacement of 23 structures, which include the following: 18 residences and one out-building along the channel, and two commercial structures located within one of the detention basin.

Recreational components would be included along White Oak Bayou from Hollister Road to West Road and within the detention basins.

Any action within the lower reach, below the confluence with Cole Creek, is not included in this EA. Components in the lower reach were initially considered, but were not carried through into the alternative building process due to poor performance in the plan formulation process. The lower reach is the location of an existing federal project constructed in 1971. Flood damage reduction planning for the major tributaries of White Oak Bayou are not considered in this study but are being considered by HCFCDD separate from this Section 211(f) study.

Since investigation of the Federal project began in January 1998, the baseline for investigations was identified as January 1, 1998. This date was also selected because the Local Sponsor intended to construct flood reduction measures along White Oak Bayou in advance of the completion of the Federal planning process and needed a baseline start date for environmental conditions prior to construction of these measures and for potential reimbursement of funds used to construct them. It should be noted that 73 acres of the North Houston-Roslyn Road and Fairbanks-North Houston Road basins and 44 acres of the Jersey Village channel (E200-00-00) were constructed prior to January 1, 1998, and are considered existing conditions. (The Jersey Village channel provided 850 acre-feet of temporary detention storage.) The components listed within the Recommended Plan consist of additional work in these locations. Exhibit 1-3 identifies those components within the Recommended Plan for which construction is complete or has already started since January 1, 1998.

The primary goal of the proposed action is to reduce damages due to flooding in the upper and middle reaches of White Oak Bayou that reasonably maximizes net economic benefits. Table 1-1 presents a summary of the project components, which are identified in Exhibits 1-2 and 1-2a. The table also identifies the status of construction of the components. Any construction that has occurred has been by the local sponsor in advance of USACE approving the conclusions of the federal study.

**Table 1-1**  
**Recommended Plan (RF-31) Component Summary**  
**White Oak Bayou Federal Flood Control Project, Harris County, Texas**

<b>Component/Number</b>	<b>Location</b>	<b>Description</b>
White Oak Bayou Channel Modification TG.2A1 E100-00-00	Cole Creek south of West Tidwell Road to Gessner Drive.	Approximately 7.0 miles of modifications. 10.8 acres of ROW acquisition required, resulting in 18 residential and one out-building displacement. Construction complete from E122 to Gessner Drive. Further widening required from Cole Creek to E122.
White Oak Bayou Channel Modification GE200.7A E100-00-00	Gessner Drive to existing HCFCDD drainage channel E200-00-00 (in Jersey Village).	Approximately 2.1 miles of modifications within the existing ROW. No construction started.



<b>Component/Number</b>	<b>Location</b>	<b>Description</b>
White Oak Bayou Channel Modification E200H.2A E100-00-00	Existing HCFCD drainage channel E200-00-00 to FM 1960.	Approximately 3.4 miles of modifications within the existing ROW. No construction started.
Jersey Village Channel Modification GE200.7A E200-00-00 and E141-00-00	Existing HCFCD drainage channel E200-00-00 from White Oak Bayou to Windfern Forest Drive and E141-00-00 from Windfern Forest Drive to White Oak Bayou.	Approximately 2.9 miles of modifications to two existing drainage channels (E200-00-00 and E141-00-00) within the existing ROW. Construction complete.
Detention Basin Hollister Road HOL.3B E500-03-00	East of Hollister Road and north of West Little York Drive-south of White Oak Bayou.	Excavation on 93.7 acres to provide 730 acre-feet of storage. Seven acres of wetlands created within the basin. Construction of flood storage complete. Planting of local wetland creation effort has not occurred.
Detention Basin Fairbanks-North Houston Road FNH.2 E500-01-00 and E500-02-00	East of Fairbanks-North Houston Road and north and south of White Oak Bayou.	Excavation on two properties totaling approximately 142 acres to provide 1,269 acre-feet of storage. Construction is complete.
Detention Basin Gessner Drive GBW.3 E500-10-00	North and south of Brookriver Drive, west of Gessner Drive, and east of Beltway 8.	Excavation on 51.0 acres to provide 519 acre-feet of storage and low-flow concrete lining. 10.6 acres of ROW acquisition required, resulting in 2 commercial displacements. 427 acre-feet of flood storage constructed. 92 acre-feet of storage remain to be completed.
Detention Basin Jones Road JR.4 E500-11-00 and E500-12-00	East and west of Jones Road.	Excavation on 65.8 acres to provide 420 acre-feet of storage and low-flow concrete lining. Construction of flood storage complete.
Recreation Plan	Linear parks from Hollister Road to north of West Road and within detention basins.	Provide new linear parks, multi-purpose trails, observation areas, interpretive kiosks, multi-purpose fields, play grounds, and picnic facilities. No construction has started.
Wetland Mitigation	Greens Bayou Wetland Mitigation Bank & Hollister Basin Wetlands Construction	Mitigation of wetland impacts through use of 4.99 acres at Subdivision A at mitigation bank. Local Sponsor Volunteer Mitigation - seven acres constructed wetlands at Hollister Road Basin, paid for 100 % by HCFCD.

## 1.2 PREVIOUS FLOOD CONTROL PROJECTS

In 1937, the first federal interest in flood control measures for Buffalo Bayou and its tributaries, including White Oak Bayou, was established. In 1938, the USACE submitted a plan to improve the lower reaches of White Oak Bayou within the city limits of the city of Houston and three reservoirs on Buffalo Bayou and White Oak Bayou upstream of the city. In 1951, USACE submitted a report that was a review of all previous reports, which included clearing, straightening, enlarging, and lining Buffalo Bayou and tributaries, including White Oak Bayou. Four White Oak Bayou channel rectification projects were prepared by the USACE from 1961 through 1964. In 1966, the first comprehensive master drainage plan for White Oak Bayou was prepared by the USACE. Between 1967 and 1971, from downstream of Cole Creek to the confluence of White Oak and Buffalo Bayous, 10.7 miles of the White Oak Bayou channel was enlarged, straightened, and concrete-lined. In 1979, the USACE submitted a feasibility report on upper White Oak Bayou, as referenced previously in Section 1.1.

A regional flood control plan for White Oak Bayou was initiated by the private sector in 1984 and adopted by HCFCD. The HCFCD began purchase of ROW for and construction of detention sites identified in this plan in 1985. A report for channel modifications was submitted in 1985 and updated in 1988. Portions of modifications outlined in the 1988 report were constructed between 1992 and 1994. The projects included:

1. Channel enlargements from Cole Creek to drainage channel E122-00-00 located upstream of North Houston-Rosslyn Road, completed in 1994.
2. Construction of a portion of the Fairbanks-North Houston Road detention basin complex (FNH.3/E500-01-00) located east of Fairbanks-North Houston Road and north of White Oak Bayou, completed in 1994, consisting of a volume of 360 acre-feet of storage within 34 acres.
3. Construction of the North Houston-Rosslyn Road detention basin complex (NHR/E500-04-00) located east of North Houston-Rosslyn Road, completed in 1994, consisting of a volume of 360 acre-feet within 26 acres.
4. Construction of a portion of the Tidwell Road detention basin complex (TWLY/E500-05-00) located north of West Tidwell Road and east of White Oak Bayou, completed in 1994, consisting of a volume of 160 acre-feet within 13 acres.

Construction of a major segment of the existing HCFCD drainage channel (Jersey Village channel/-00-00) located from east of Beltway 8 to White Oak Bayou in Jersey Village to serve as temporary detention storage was also completed in 1994. It provides 850 acre-feet of storage volume. The most recent plan for White Oak Bayou was developed in April 1998 by HCFCD. This new regional plan for White Oak Bayou was presented to identify a cost-effective series of projects to reduce potential flooding at the 10-year (10 percent) flood event for existing development. The locations of the existing facilities as of 1998 are shown on Exhibit 1-4.

## **1.3 GENERAL REEVALUATION OF WHITE OAK BAYOU**

Provisions of Section 211(f) of WRDA 1996 authorize the undertaking of the planning and implementation of a federal project by a local sponsor. In January 1999, HCFCD submitted a reconnaissance study report to the USACE Commander. The USACE reviewed the study report and found that it was generally consistent with the requirements for reports prepared under the authority of Section 905(b) of WRDA 1986. The USACE concluded that the report provided sufficient basis to indicate federal interest in conducting feasibility phase studies. A copy of this correspondence is included in Appendix C. In June 2002, HCFCD submitted a Draft General Reevaluation Report ("GRR") to the USACE Galveston District, the *White Oak Bayou Federal Flood Control Project, Harris County, Texas, Draft General Reevaluation Report (June 2002)*. Based on the review of the 2002 GRR provided by the USACE, the alternative formulation process was updated and the optimization process was reinitiated. That process is described as follows and resulted in the Tentatively Recommended Plan.

### **1.3.1 Alternative Formulation and Optimization Process**

During the initial stages of alternative formulation, flood control measures or components to reduce flood damages along White Oak Bayou were identified through hydraulic and hydrologic modeling and engineering analysis. The structural components included channel modifications, stormwater detention basins, bypass channels, flood protection levees, and bridge modifications or replacements. The non-structural components considered included no action, floodplain management, flood warning systems, flood-proofing, raising structures, and permanent evacuation/. Various combinations of the components were then further analyzed to determine their effectiveness and economic feasibility. Chapter 3.0 discusses the plan formulation process in detail.

Federal guidelines require that the alternative plan that reasonably maximizes net economic benefit while being consistent with protecting the nation's environment (i.e., the NED Plan) be identified. The amount that a project's annual benefits exceed the project cost is defined as net annual benefit. In the plan formulation process, the alternative plan that yields the greatest net annual benefit is identified as the NED Plan. All alternatives, including the NED Plan, must be evaluated from an environmental standpoint to determine if implementation would result in any significant impacts to environmental resources (Section 1.3.2 below). If any impacts are anticipated, mitigation options are considered and refined during the optimization process.

Findings of the economic analysis identified channel modifications, stormwater detention basins, and non-structural buyouts as the components that provided the greatest net economic benefit. A total of four primary alternative plans, including the No Action Alternative, TG.2 anchor plan (the Earthen Channel Plan), TG.8 anchor plan (the Concrete Channel Plan), and FNH.3+JR.4 anchor plan (the Detention Basin Plan), were subsequently developed using a combination of the components evaluated in the environmental screening. These four alternatives are summarized in Chapter 3.0. The alternative TG.2

anchor plan was optimized, resulting in the alternative TG.2A. This plan was further modified based on changes to certain plan components proposed by the Local Sponsor. This TG.2 plan, identified as Alternative RF-30 la NSB1, maximizes net economic benefit compared to all other plans and is identified as the NED Plan. This alternative along with the Recreation Plan and environmental mitigation comprises the Tentatively Recommended Plan (RF-30 LA NSB1). Later this plan was modified to result in the final Recommended Plan.

The alternatives described in this EA include the Recommended Plan and the No Action Alternative. Alternatives that failed to maximize the net economic benefit (Alternatives TG.8 and FNH.3+JR.4) were eliminated from further study. Certain components, such as bridge modifications and structure raising, were dropped from consideration. Detailed descriptions of all the alternatives, the iterative development process for each alternative, and the results of the optimization process are provided in the GRR. The Recommended Plan is discussed in detail in Chapter 3.0.

### **1.3.2 Environmental Screening Investigation**

An environmental screening investigation was completed for this White Oak Bayou Federal Flood Control Project. During the environmental screening investigation, individual components that might be considered for inclusion in the alternatives were evaluated to identify potentially significant environmental issues and/or constraints that could impact the inclusion of that individual component (Table 1-2). No significant impacts to the human environment were identified during the screening investigation. The following factors were identified as potential constraints to the design and construction of various alternatives.

- Large Numbers of Property Displacements
- Water Quality
- Waters of the U.S./Wetlands
- Floodplains
- Threatened and Endangered Species
- Texas Parks and Wildlife Department Vegetation Areas of Concern
- Cultural Resources
- Public Parkland
- Hazardous, Toxic, and Radioactive Waste

Components included in the environmental screening included the following: structural measures (channel modifications, stormwater detention basins, bypass channels, flood protection levees, and bridge modifications or replacements), and non-structural measures. Environmental screening factors were further investigated once the Recommended Plan was identified in order to avoid, minimize, and mitigate potential impacts. A copy of the Review of Environmental Screening Components Report is on file at the HCFCF office.

**Table 1-2  
January 1, 1998, Baseline Alternative Components Environmental Screening Results**

<b>White Oak Bayou Component</b>	<b>Potential Property Displacements</b>	<b>Existing Water Quality</b>	<b>Potential Impacts to Waters of the U.S./</b>	<b>Floodplain Location</b>	<b>Potential Threatened and Endangered Species</b>	<b>Texas Parks and Wildlife Department Vegetation Areas of Concern</b>	<b>Potential or Known Cultural Resources</b>	<b>Potential Impacts to Public Parkland</b>	<b>Potential Impacts to Hazardous, Toxic, and Radioactive Waste Sites</b>
Channel Modifications from the Confluence of Buffalo and White Oak Bayous to Cole Creek	8 residential	Poor	6 acres of wetlands	100- and 500-year floodplain	2 species of concern (SOC)	3 vegetation areas of concern	11 archeological sites 8-RR bridges 1 bridge 2 historic districts	8 trails (City of Houston Hike & Bike Trails)	Moderate to high risk
Levee/Vertical Wall from the Confluence of Buffalo and White Oak Bayous to Cole Creek	8 residential	Poor	1 water of the U.S.	100- and 500-year floodplain	2 SOC	0	0	0	Moderate to high risk
White Oak Bayou Bypass Channel	0	Poor	0	Outside 500-year floodplain	2 SOC	0	0	1 park	Moderate to high risk
Channel Modifications from Cole Creek to the transition structure between North Houston-Rossllyn and Fairbanks-North Houston	334 residential	Poor 3 wastewater treatment plants	20 acres of wetlands	100- and 500-year floodplain	1 endangered species 2 SOC	1 vegetation area of concern	24 archeological sites	3 parks	Low to moderate risk
Levee/Vertical Wall from Cole Creek to the transition structure	91 residential/ 0 residential	Poor 3 wastewater treatment plants	0	100- and 500-year floodplain	1 endangered species 2 SOC	0	0	0	Low to moderate risk

White Oak Bayou Component	Potential Property Displacements	Existing Water Quality	Potential Impacts to Waters of the U.S./	Floodplain Location	Potential Threatened and Endangered Species	Texas Parks and Wildlife Department Vegetation Areas of Concern	Potential or Known Cultural Resources	Potential Impacts to Public Parkland	Potential Impacts to Hazardous, Toxic, and Radioactive Waste Sites
Channel Modifications from the transition structure to Beltway 8	286 residential	Poor 5 wastewater treatment plants	68 acres of wetlands	100- and 500-year floodplain	2 endangered species 2 SOC	0	19 archeological sites	1 park	High
Levee/Vertical Wall from the transition structure to Beltway 8	56 residential/ 0 residential	Poor 5 wastewater treatment plants	0	100- and 500-year floodplain	2 endangered species 2 SOC	0	0	0	Moderate to high risk
Channel Modifications in Jersey Village	230 residential	Poor 4 wastewater treatment plants	7 acres of wetlands	100- and 500-year floodplain	3 SOC	0	1 archeological site	1 park 3 schools with play areas	Low risk
Jersey Village Bypass Channel	0	Poor	11 acres of wetlands	Outside 500-year floodplain	1 endangered species 2 SOC	0	1 archeological site	0	Low to moderate risk
Channel Modifications from West Road to Huffmeister Road	0	Poor	32 acres of wetlands	100- and 500-year floodplain	3 SOC	0	0	2 parks 1 recreation center	Moderate to high risk
TWLY (E500-05-00) Existing Detention Basin	0	N/A	10 acres of wetlands	100- and 500-year floodplain	1 SOC	0	0	0	Low to moderate risk
Fairbanks-North Houston FNH.3 (E500-01-00) Existing Detention Basin	0	N/A	7 acres of wetlands	100- and 500-year floodplain	1 endangered species 1 SOC	0	0	0	Moderate to high risk

<b>White Oak Bayou Component</b>	<b>Potential Property Displacements</b>	<b>Existing Water Quality</b>	<b>Potential Impacts to Waters of the U.S./</b>	<b>Floodplain Location</b>	<b>Potential Threatened and Endangered Species</b>	<b>Texas Parks and Wildlife Department Vegetation Areas of Concern</b>	<b>Potential or Known Cultural Resources</b>	<b>Potential Impacts to Public Parkland</b>	<b>Potential Impacts to Hazardous, Toxic, and Radioactive Waste Sites</b>
NHR (E500-04-00) Existing Detention Basin	0	N/A	3 acres of wetlands	100- and 500-Year floodplain	1 endangered species	0	0	0	Low risk
Hollister Road HOL.3B (E500-03-00) Proposed Detention Basin	0	N/A	7 acres of wetlands	100- and 500-year floodplain	2 endangered species 2 SOC	0	0	0	Moderate to high risk
Fairbanks-North Houston FNH.3 (E500-02-00) Proposed Detention Basin	0	N/A	3 acres of wetlands	100- and 500-year floodplain	0	0	0	0	Low risk
TWLY (E500-06-00) Proposed Detention Basin	0	N/A	2 acres of wetlands	100- and 500-year floodplain	1 endangered species 2 SOC	0	0	0	Under construction- all concerns addressed
Gessner Drive GBW.3 (E500-10-00) Proposed Detention Basin North of Brookriver Dr.	0	N/A	10 acres of wetlands	100- and 500-year floodplain	0	0	0	0	Moderate to high risk
Gessner Drive GBW.3 (E500-10-00) Proposed Detention Basin South of Brookriver Dr.	0	N/A	5 acres of wetlands	100- and 500-year floodplain	2 SOC	0	0	0	Moderate to high risk
D8 Proposed Detention Basin	0	N/A	24 acres of wetlands	100- and 500-year floodplain	1 endangered species 2 SOC	0	0	0	Low to moderate risk

<b>White Oak Bayou Component</b>	<b>Potential Property Displacements</b>	<b>Existing Water Quality</b>	<b>Potential Impacts to Waters of the U.S./</b>	<b>Floodplain Location</b>	<b>Potential Threatened and Endangered Species</b>	<b>Texas Parks and Wildlife Department Vegetation Areas of Concern</b>	<b>Potential or Known Cultural Resources</b>	<b>Potential Impacts to Public Parkland</b>	<b>Potential Impacts to Hazardous, Toxic, and Radioactive Waste Sites</b>
D9 Proposed Detention Basin	0	N/A	0	100- and 500-year floodplain	2 SOC	0	0	0	Low to moderate risk
D10 Proposed Detention Basin	0	N/A	23 acres of wetlands	100- and 500-year floodplain	2 endangered species 2 SOC	0	0	0	Moderate to high risk
Jones Road JR.4 (E500-11-00) Proposed Detention Basin	0	N/A	3 acres	100- and 500-year floodplain	3 SOC	0	0	0	Low to moderate risk
D12 Proposed Detention Basin	13	N/A	0	500-year floodplain	1 SOC	0	0	0	Low to moderate risk



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## **2.0 PURPOSE AND NEED OF THE PROPOSED ACTION**

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This chapter documents the need for flood control within the project area, the purpose that the proposed flood control is intended to serve, and it identifies the objectives and constraints to be addressed by the proposed action. This chapter of the EA also describes in detail the components of the proposed action.

### **2.1 HISTORIC FLOOD EVENTS AND THE NEED FOR THE PROPOSED ACTION**

The rapid expansion of urban development in northwest Harris County during the 1960's and 1970's exacerbated problems caused by flooding of White Oak Bayou. Despite the previous modifications, the channel is currently insufficient to carry even a 10-year (10 percent) flood event. Many damaging floods have occurred along White Oak Bayou in the past. The following is a summary of previous flood events that have occurred within the White Oak Bayou watershed since 1970.

In October 1970, flooding of more than 200 homes caused estimated property damages of \$1.10 million.

In March 1972, flooding damaged 292 homes with estimated damages of \$2.65 million.

Severe flooding has also occurred and was documented by the USACE and/or the HCFCD in May 1983, October 1984, May 1989, June 1989, and March 1992. An estimated 225 homes in the Arbor Oaks, Woodland Trails North, and Inwood Forest subdivisions were flooded during the May 1989 storm. Approximately 159 homes were flooded in June 1989. A total of 380 homes were flooded in March 1992 in these three subdivisions and Studemont, Inwood Pines, Bayou Bend, Candlelight Forest, and Mangum Manor subdivisions. All of the approximate 200 homes in Arbor Oaks flooded in 1992. The 1992 flood closed Interstate Highway ("IH") 10, disrupting traffic for an extended period, and resulted in significant property damage. Estimates of monetary damages from the 1989 and 1992 storms are not available. The HCFCD has estimated that both the 1989 and 1992 storms were equal to or more frequent than a 10-year (10 percent) flood event.

On September 11, 1998, approximately 1,200 homes were flooded during Tropical Storm Frances. Tropical Storm Frances caused approximately \$500 million worth of total damages, the majority of which was caused in Texas (Lawrence, 1998). The HCFCD estimated that regional work that was completed before the flood kept at least 1,000 homes from flooding, particularly in the areas previously discussed that flooded in 1989 and 1992.

On June 8 and 9, 2001, Tropical Storm Allison brought approximately 10 to 18 inches of rain to the watershed in only 12 hours. Severe residential flooding occurred. The storm flooded approximately 73,000 residences (homes, apartment units, and mobile homes) in the Houston area, with approximately 11,000 flooded residences in the White Oak Bayou watershed. Tropical Storm Allison was one of the most devastating storms to cause urban flooding in the U.S., causing \$5 billion worth of damages in the Houston region (Risk Management Solutions, 2001).

## 2.2 PLANNING OBJECTIVES AND CONSTRAINTS

Alternative plans were formulated and evaluated based on their contribution to national economic development consistent with protection of the nation's environment. In addition to these national objectives, additional local planning objectives evolved from meetings with area residents, local sponsor requirements, state and federal agencies, and from observations made in the area. Specific needs, desires, goals, and objectives were identified. The purpose of the proposed action is to reduce flood damages along the upper and middle reaches of White Oak Bayou, while being consistent with the following objectives and constraints. The following is a discussion of the project objectives and constraints followed in the process to develop the Recommended Plan for Federal participation.

### National Objectives

The fundamental national objective of Federal participation in water resources development projects is to assure that an optimum contribution is made to the welfare of all people. The Water Resources Council's Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies dated March 1983 and the National Environmental Policy Act of 1969 (NEPA) provide the basis for Federal policy for planning Federal water resources projects. Principles and Guidelines (P&G) state that the Federal objective of water and related land resources planning is to contribute to national economic development (NED) consistent with protecting the Nation's environment, in accordance with national environmental statutes, applicable executive orders, and other Federal planning requirements. National objectives are designed to assure systematic interdisciplinary planning, assessment, and evaluation of plans addressing natural, cultural, and environmental concerns, which would be responsive to Federal laws and regulations. Four national objectives were considered in this project. The four objectives considered are discussed as follows.

- (1) *NED*. The alternative plan that reasonably maximizes net economic benefits consistent with protecting the Nation's environment, the NED plan, shall be selected. The Assistant Secretary of the Army for Civil Works (ASA (CW)) may grant an exception when there are overriding reasons for selecting another plan based upon other Federal, State, local and international concerns.
- (2) *Effects on Environmental Quality (EQ)*. The Environmental Quality account identifies the non-monetary effects on significant natural and cultural resources (ER 1105-2-100).
- (3) *Regional Economic Development (RED)*. The Regional Economic Development (RED) account identifies changes in the distribution of regional economic activity.
- (4) *Other Social Effects (OSE)*. The Other Social Effects (OSE) account identifies the plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts (ER 1105-2-100).

## **Overall Local Objectives**

- To identify and recommend an effective, affordable, and environmentally-sensitive flood control project for White Oak Bayou.
- To conduct the necessary engineering, economic, and environmental analysis in a timely manner in order to obtain Congressional appropriation.

## **Specific Planning Objectives**

- Reduce residential and business flooding caused by flood flows in White Oak Bayou.
- Enhance or improve the aesthetics, environmental quality, and recreational opportunities where possible, given the limited authority of the HCFCD to fund such activities.
- Minimize adverse impacts on existing neighborhoods and wildlife habitat.
- Minimize the total project cost.
- Maximize the economic benefits to the community.
- Develop a project that satisfies federal criteria for financial participation.

## **Constraints**

- The project should have the general support of the affected citizens and businesses in the watershed.
- The project must conform to the mission of the HCFCD and be implemented by the HCFCD under existing laws, ordinances, and policies.
- The project must be developed following the applicable policies and guidelines of the USACE.
- No adverse flood impacts may be created by the implementation of the project.

## **2.3 PROJECT DESCRIPTION**

The project area for this EA includes those areas that may be impacted by the proposed action, the Recommended Plan (RF-31). The project includes the following components, which are summarized in Table 1-1 and shown on Exhibits 1-2 and 1-2a.

### **2.3.1 Channel Modifications**

1. White Oak Bayou Channel TG.2A1: Located along White Oak Bayou (E100-00-00) from Cole Creek, south of West Tidwell Road, to Gessner Drive. Modifications to 7.0 miles and 138 acres of the existing earthen channel would require 10.8 acres of additional ROW. The ROW acquisition would include displacement of 18 residences and one out-building. The modifications include widening the existing earthen channel to a trapezoidal channel with 3:1 side slopes. The channel bottom would be approximately 60 feet wide between Cole Creek and HCFCD drainage channel E122-00-00 (located west of Beltway 8), approximately 50 feet wide between E122-00-00 and Gessner Drive, and approximately 30 feet wide between Gessner Drive and Beltway 8.
2. White Oak Bayou Channel GE200.7A: Located along White Oak Bayou (E100-00-00) from Gessner Drive to E200-00-00. Modifications to approximately 2.1 miles and 41 acres of the

earthen channel would be completed within the existing ROW. The remaining part of the component is identified under Jersey Village Channel below. The modifications include widening the existing earthen channel above the Ordinary High Water Mark ("OHWM") to a trapezoidal channel with 3:1 side slopes and a bottom width of 30 feet. Gabion structures would be included in portions of the channel to address slope stability concerns.

3. White Oak Bayou Channel 200H.2A: Located along White Oak Bayou (E100-00-00) from E200-00-00 to FM 1960. Modifications to approximately 3.4 miles and 69 acres of the earthen channel would be completed within the existing ROW. Modifications include widening the existing earthen channel above the OHWM to a trapezoidal channel with 3:1 side slopes. The channel bottom would be 80 feet wide between E200-00-00 and West Road and 50 feet wide between West Road and FM 1960.
4. Jersey Village Channel GE200.7A: Modifications to two existing man-made HCFCD drainage channels within the existing ROW. This component begins at the confluence of White Oak Bayou (E100-00-00) and HCFCD drainage channel E141-00-00 (located at the confluence with White Oak Bayou in a segment west of Gessner Drive and east of Beltway 8), upstream along E141-00-00, connecting to E200-00-00, and terminating upstream at the confluence of White Oak Bayou and E200-00-00 in Jersey Village. This component is approximately 2.9 miles (including 1,500 feet of transition work on both ends) and 24 acres. The modifications include deepening and widening the existing earthen channels to a trapezoidal channel with 3:1 side slopes. The channel bottom would vary between 16 and 30 feet, generally being wider at the downstream end (E141-00-00) and narrower at the upstream end (E200-00-00).

### **2.3.2 Detention Basins**

1. Hollister Road (HOL.3B): Located east of Hollister Road and north of West Little York Drive on land south of White Oak Bayou. This detention basin complex provides 730 acre-feet of detention volume on approximately 93.7 acres. HCFCD has acquired the property for this detention basin complex. This component is identified as HCFCD Unit No. E500-03-00.
2. Fairbanks-North Houston Road (FNH.2): Located east and west of Fairbanks-North Houston Road on two properties totaling approximately 142 acres. This detention basin complex provides an estimated total detention volume of 1,269 acre-feet. The HCFCD has acquired the two properties north and south of White Oak Bayou. This component is identified as component HCFCD Unit Nos. E500-01-00 (north of White Oak Bayou) and E500-02-00 (south of White Oak Bayou).
3. Gessner Drive (GBW.3): Located north and south of Brookriver Drive, west of Gessner Drive, and east of Beltway 8 on three properties totaling approximately 51.0 acres. This detention basin

complex provides an estimated detention volume of 519 acre-feet. HCFCD has acquired the two properties north of Brookriver Drive; however, acquisition of 10.6 acres of additional ROW for the property south of Brookriver Drive is required. The ROW acquisition would include displacement of two commercial buildings. This component is identified as HCFCD Unit No. E500-10-00.

4. Jones Road (JR.4): Located east and west of Jones Road, this detention basin is located on two properties, totaling approximately 65.8 acres. This detention basin complex provides an estimated detention volume of 420 acre-feet. HCFCD has acquired the property for the detention basin complex. This component is identified as JR.4 and HCFCD Unit Nos. E500-11-00 (east of Jones Road) and E500-12-00 (west of Jones Road).

### **2.3.3 Recreation Plan**

The Recreation Plan was developed as follows. A recreation use inventory was conducted to evaluate the use of facilities along the bayou. Opportunities and constraints were identified, taking into account the flood damage reduction plan, environmental conditions along the bayou, and the recreation inventory. Recommendations for recreation facilities were made based on the opportunities and constraints. Using the estimated number of users, quality of experience, and construction budgets, the cost of the recreation plan was compared to the expected use of facilities proposed in the plan. The benefit cost ratio and net economic benefits were determined.

The Recreation Plan consists of the following components;

1. White Oak Bayou Channel: A proposed linear park/bikeway planned from the confluence of White Oak Bayou and Cole Creek upstream to Hollister Road. A new linear park trail would also be extended from Hollister Road to north of West Road, along channel modifications TG.2A1, GE200.7A, and E200H.2A. Parking would also be added.
2. Hollister Road (HOL.3B): A passive use park within the detention basin complex. In coordination with the wetlands created on-site as mitigation, two urban wetlands/wildlife interpretive kiosks and observation areas would be provided. Additionally, a multi-purpose trail would be created within the site to connect to White Oak Bayou to the north. Parking would be added along the west side.
3. Fairbanks-North Houston Road (FNH.2): Trail heads with parking and access points to the detention basin complex. The dry area of the basin would be used as open play/ multi-purpose fields. A multi-purpose trail would also be created within the site to connect to the White Oak Bayou multi-purpose trail. Interpretive kiosks would be added to include information about wetland habitat that exists at the basin.
4. Gessner Drive (GBW.3): Trail heads with parking would be created for access to the White Oak Bayou trail at the detention basin complex. Multi-purpose fields and play areas would be provided and a multi-purpose trail would be created within the site.

5. Jones Road (JR.4): A trail head would be created at the detention basin complex. This would be the termination point for the White Oak Bayou linear park. A multi-purpose trail would be created within the site and parking would be provided.

### **2.3.4 Wetlands Mitigation**

Wetlands were identified as the only significant resource warranting compensatory mitigation. Of the approximate 780 acres required for channel modifications and detention basin construction, a total of 18.03 acres are considered wetlands. A total of 13.17 acres of wetlands would be impacted during construction of the project, avoiding impacts to 4.86 acres of wetlands. Compensatory wetland mitigation would be provided for all or part of the 13.17 acres of wetlands that are impacted. Mitigation would occur within the Greens Bayou Wetland Mitigation Bank ("GBWMB"), Subdivision A. According to mitigation rule 33 CFR, the District Engineer of the USACE should give consideration to the use of mitigation banks when permitted impacts are located within the service area of the mitigation bank and the bank has the appropriate number and resource types available. The GBWMB is owned and operated by HCFCD and is approximately 18 miles east of the project area within the Greens Bayou watershed. The project impacts occur within the White Oak Bayou watershed and Harris County. Flows from both White Oak Bayou and Greens Bayou are part of the Buffalo Bayou watershed and ultimately discharge to the San Jacinto River watershed. The GBWMB includes all of Harris County in its service area, and service area descriptions read as follows: "Harris County excluding riparian corridors under saline influence and all brackish or saline wetlands." The project impacted wetlands are not brackish or saline; therefore, the GBWMB service area can accommodate the project impacts. The proposed mitigation plan is in accordance with WRDA 2007 Section 2036 (c), Wetlands Mitigation, dated 6 November 2008.

The proposed mitigation includes the purchase of acreage at the GBWMB to mitigate forested and emergent wetland impacts. The forested wetland component would mitigate both forested and scrub-shrub wetland impacts. The GBWMB is operated per the 1995 Memorandum of Agreement between the HCFCD and the members of the Mitigation Bank Review Team, consisting of the USACE, the Environmental Protection Agency, the United States Fish and Wildlife Service, the National Marine Fisheries Service, Texas Parks and Wildlife Department, Texas General Land Office, and the Texas Commission on Environmental Quality.

Seven acres of forested wetlands would also be created within the Hollister Road detention basin complex, with emergent wetlands also created among the forested wetlands. These wetlands, identified as Local Sponsor Volunteer Mitigation, are not part of the least-cost mitigation plan and are proposed to be a 100 percent local sponsor cost.

## **3.0 ALTERNATIVES**

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### **3.1 NO ACTION ALTERNATIVE**

The fundamental alternative to any flood control plan is the No Action Alternative. Adoption of this alternative implies acceptance of the costs and adverse effects of continued flooding. For White Oak Bayou, these estimated costs equate to over \$61 million annually in flood damages.

Currently, White Oak Bayou is a partially concrete-lined trapezoidal channel with a bottom width ranging from 50 to 80 feet located in the lower reach from the confluence with Buffalo Bayou upstream to Cole Creek (the existing federal channel) and an earthen trapezoidal channel with a bottom width ranging from 30 to 80 feet located in the reach upstream of the federal channel to Huffmeister Road. No modifications would be considered to be constructed within White Oak Bayou watershed under the No Action Alternative other than those completed prior to January 1, 1998. The No Action Alternative includes the following detention basins that are shown schematically on Exhibit 1-1:

1. Construction of a portion of the Fairbanks-North Houston Road detention basin complex (FNH.3/E500-01-00) located east of Fairbanks-North Houston Road and north of White Oak Bayou, completed in 1994, consisting of a volume of 360 acre-feet of storage within 34 acres.
2. Construction of the North Houston-Rosslyn Road detention basin complex (NHR/E500-04-00) located east of North Houston-Rosslyn Road, completed in 1994, consisting of a volume of 360 acre-feet within 26 acres.
3. Construction of a portion of the Hollister Road detention basin complex (HOL/E500-05-00) located north of West Tidwell Road and east of White Oak Bayou, completed in 1994, consisting of a volume of 160 acre-feet within 13 acres.
4. Construction of the existing HCFCD drainage channel (Jersey Village channel/-00-00) located from east of Beltway 8 to White Oak Bayou in Jersey Village to serve as temporary detention storage was also completed in 1994. It provides 850 acre-feet of storage volume.

The No Action Alternative would include routine channel maintenance such as mowing the ROW, slope repair, riprap or concrete slope protection, maintenance of inlet and outlet control structures, weed control, debris removal, turf maintenance, desilting, and backslope drain system repair. No new detention or recreation facilities would be included. Wetlands mitigation would only be proposed if impacts to wetlands occurred from routine maintenance activities. Residential and/or commercial development within the project area, outside of the floodway, may occur by other interests. Additionally, the No Action Alternative does not include any Federal funding.

Compared to the primary action alternatives (Detention Basin Plan FNH.3+JR.4, Concrete-Lined Plan TG.8, and Earthen Alternative TG.2A1-NED Plan), the No Action Alternative would have less



construction cost and cause less disruption to the natural environment by HCFCFCD. Under the No Action Alternative, the channel would continue to contain a 10-year (10 percent) probability flood event or less in some areas. Homes and businesses would continue to flood, resulting in billions of dollars in losses and an increased probability for loss of life. Based on these consequences, the No Action Alternative fails to meet the goals and objectives of the project. While the No Action Alternative fails to satisfy the goals and objectives of the proposed action, it is retained as an alternative for comparison with the action alternatives carried forward for further study.

## **3.2 PLAN FORMULATION PROCESS**

A summarized version of the plan formulation process is depicted in the three steps outlined below:

**Step 1** - Component Evaluation (component identification and elimination)

**Step 2** – Alternative Plan Development and Optimization

**Step 3** - Final Optimization and Identification of the NED Plan

### **3.2.1 Step 1 - Component Evaluation**

The initial step of the component analysis includes listing components that might fit into a flood damage reduction plan.

#### **3.2.1.1 Identification of the Individual Components for Analysis**

Structural and non-structural components identified to reduce flood damages along White Oak Bayou consist of the following categories:

##### Structural Components

Channel modification

Stormwater detention

Bridge modification

Flood protection levees

##### Non-Structural Components

Floodplain management

Flood warning

Flood proofing

Raising structures

Structure relocation/

#### **3.2.1.2 Channel Modification**

For the purposes of this study, White Oak Bayou is divided into three channel reaches including (1) the Lower Reach – the downstream partially concrete-lined channel that extends from the confluence with Buffalo Bayou to Cole Creek (the existing federal channel), (2) the Middle Reach – an earthen channel

that extends from the existing Cole Creek to the confluence with the existing HCFCFCD drainage channel E200-00-00 in Jersey Village. This reach also contains a bypass channel component that extends from Gessner Drive to Jersey Village, and (3) the Upper Reach – an earthen channel that extends from the confluence of HCFCFCD drainage channel E141-00-00 and White Oak Bayou, upstream along E141-00-00 connecting with E200-00-00 and terminating at the confluence of E200-00-00 and White Oak Bayou. The Lower Reach has been excluded from this study effort because it is the location of a previous federal project and HCFCFCD has a separate Buffalo Bayou Study currently underway that would address this reach along with Buffalo Bayou. It is appropriate in that study because the majority of the economic damages along White Oak Bayou are located within the upper and middle reaches. Additionally, analysis indicates that potential components in the lower reach impact flows and water surface elevations in Buffalo Bayou; therefore, it is more appropriate to consider the lower reach of White Oak Bayou in the Buffalo Bayou study. Locations of the reaches are identified on Exhibit 1-2.

The proposed channel modification components initially considered involve the upper and middle reaches and primarily utilize grass-lined earthen modifications with some concrete lining for erosion control or stability under bridges and near utility lines or partially concrete-lined modifications.

#### **3.2.1.3 Stormwater Detention**

Previous studies were reviewed to identify potential detention sites. Large, vacant tracts of land located closest to the bayou were identified as potential detention sites. Included in the evaluation were the expansion and/or modification of a number of existing detention basins constructed prior to January 1, 1998.

#### **3.2.1.4 Bridge Modification**

There are numerous bridges that provide access across White Oak Bayou within the study area. Bridge modification components consist of removal, replacement or modifications of existing bridges. Bridges with significant obstructions to the flow raise the water surface elevation upstream and cause damages. The bridge at North Houston-Rosslyn Road is the only bridge within the high damage area with substantial head loss and was the only bridge component analyzed.

#### **3.2.1.5 Flood Protection Levees**

Levee components consist of constructing levees around areas that have experienced repeated floods. The only type of levee that was determined to have a potential application was one that would form a ring around the floodprone area. Two areas were identified for potential levees. Both have two separate ring levees but are considered single components due to their proximity. One set would protect the Arbor Oaks and Inwood Forest subdivisions and one would protect the Woodland Trails North and Woodland Trails West subdivisions.

### **3.2.1.6 Floodplain Management**

Floodplain management requires the development of regulations that insure that uses of floodplain lands are compatible with the level of flood hazard. This alternative component did not require further consideration because the City of Houston, Harris County, and surrounding communities participate in the National Flood Insurance Program and have adopted ordinances and regulations that meet the requirements of FEMA. These ordinances are considered effective because the intent is to prevent increased flooding by requiring new structures' finished floor elevations to be 12 inches above base flood elevations within the floodplain and 18 inches above the base flood elevation if located within the floodway. Ordinances also do not allow new development to increase flood flows or encroach in floodplains and floodways.

### **3.2.1.7 Flood Warning**

Flood forecasting and temporary evacuation involves the determination of imminent flooding, implementation of a plan to warn the public, and organization of assistance in the evacuation of persons and some personal property when flooding is imminent. The HCFCD and the National Weather Service currently have flood warning systems in place, including 14 gages along White Oak Bayou and its tributaries. This component was not investigated further in this study.

### **3.2.1.8 Flood-Proofing**

Flood-proofing components help to protect personal property inside structures by preventing floodwaters from entering the structure. This option is most applicable where flooding is of short duration, shallow depth, low velocity, and infrequent occurrence. Typical techniques include watertight doors, window seals, seepage controls, check valves, and sandbagging. These techniques were not considered viable for flooding along White Oak Bayou.

### **3.2.1.9 Raising Structures**

One method of flood-proofing is raising structures at their existing site. Five elevating structure plans were developed as part of the component analysis. The plans considered raising the structures receiving damages from the 2, 4, 10, 20, and 50 percent floodplains.

### **3.2.1.10 Structure Relocation/Buyout**

Five structure relocation or buyout plans were developed as part of the component analysis. Structures were identified for buyout if they experienced flooding depths that exceeded their first floor elevations for specified events. The five plans evaluated buyout of the structures receiving damages resulting from the 2, 4, 10, 20, and 50 percent floods, respectively.

### 3.2.1.11 Component Evaluation Process, Optimization, and Results

Prior to developing alternatives, the effectiveness of each component was evaluated against each other in terms of conceptual design, hydrologic and hydraulic modeling, damage reduction, and net benefits. Components were optimized to determine the best performing size and/or volume. Table 3-1 summarizes the economic results for each best-performing size of each component.

**Table 3-1**  
**Summary of Economic Results for Best-Performing Components**

Alternative Components	Size	Annual Damage	Annual Damage Reduction	Construction Cost	Annual Cost	Net Economic Benefit	Benefit-Cost Ratio
No Action Alternative	N/A	\$53.9	\$0	\$0	\$0	\$0	0
<b>Channel Modifications</b>							
Middle Reach – TG.2	6 miles	47.5	11.9	33.8	2.5	9.4	4.84
Middle Reach – TG.8	7.1 miles	35.0	24.4	71.3	5.2	19.2	4.70
Middle Reach – GE200.0	4.5 miles	59.0	0.4	1.5	0.1	0.3	3.9
Upper Reach – E200H.2	3.3 miles	65.4	-6.0	11.1	0.8	N/A	N/A
<b>Detention Basins</b>							
Hollister Road (HOL.2)	94 acres	56.0	3.4	18.8	1.4	2.0	2.48
Fairbanks-North Houston Road (FNH.2)	142 acres	51.7	7.7	45.2	3.3	4.4	2.35
North Houston-Rosslyn Road (NHR.3)	83 acres	56.1	3.4	21.7	1.6	1.8	2.12
Tidwell/West Little York Road (TWLY.3)	69 acres	57.6	1.9	22.8	1.7	0.2	1.13
Gessner Drive (GBW.2)	51 acres	57.3	2.1	12.7	0.9	1.2	2.26
Rio Grand Avenue (RG.2)	26 acres	57.9	1.6	14.5	1.1	0.5	1.48
Jones Road (JR.4)	66 acres	54.2	5.2	17.2	1.3	4.0	4.18
<b>Other Components</b>							
Bridge Modification BR-NHR	N/A	53.9	0.04	2.1	1.3	-0.1	0.28
Levee LIA1.1	N/A	59.5	-.05	11.2	0.8	N/A	N/A
Levee LWT4.4	N/A	53.3	6.2	82.1	6.0	0.2	1.03
Elevating Structures ELEV-20%	N/A	49.2	10.2	117.9	8.6	1.6	1.19
Non-Structural Buyout NSB-50%	N/A	58.9	0.6	5.9	0.4	0.1	1.29

Notes:

1. All costs shown are in \$ million
2. All values shown are based on February 2002 costs and assessed values, and the year 2004 federal discount rate of 5.625%.

Regarding levees, all were found to be infeasible either for economic reasons or because of serious implementation issues with existing infrastructure, displacements, or relocations. Therefore, levee components were not carried through the full plan formulation process. Regarding the bridge modification, elevating structures, and non-structural buyout components, only the non-structural buyout component was carried through the plan formulation process. The construction cost of the elevating structures component was too high and the bridge modification component resulted in a negative net economic benefit.

The results indicate that the concrete-lined channel modification, TG.8, has the highest annual net economic benefits. This component was selected as the anchor component for the first formulated plan, meaning this would be the first component of the plan. The earthen-lined channel modification, TG.2, has the next highest annual benefits and is much preferred by the HCFCF. It was also selected as an anchor component for a second formulated plan. A plan that utilized detention components as an anchor for a formulated plan was also developed and preferred over a concrete-lined channel. The Fairbanks-North Houston Road (FNH.3) and Jones Road (JR.4) detention basin components each have strong economic benefits and are sufficiently far enough apart on the main stem as to not cause an adverse influence on each other. They were combined to form an anchor component for the third formulated plan.

### **3.2.1.12 Summary of Step 1**

Based on the Step 1 component analysis presented above, the following components were selected as anchor components of alternative plans:

Concrete-Lined Channel Modification Component TG.8  
Earthen-Lined Channel Modification Component TG.2  
Detention Component FNH.3+JR.4

## **3.2.2 Step 2 – Alternative Plan Development and Optimization**

For each anchor and first identified component, the plan was built in a logical and incremental fashion until the net benefits were maximized. At each iteration, the best performing combination of components from the previous iteration was combined and evaluated with each of the remaining components one at a time. As the remaining components were added, they were optimized to determine the most beneficial size and/or volume. The analysis continued in a cyclical fashion until no more components could be added that increased net annual benefits. The results of this analysis are presented below.

### **3.2.2.1 Concrete-Lined Channel Modification Alternative Plan TG.8**

The formulated alternative plan with TG.8 as the anchor component consists of three channelization components, six detention components, and a non-structural buyout component as listed below:

TG.8 + JR.4 + GBW.2 + E200H.3 + TWLY.3 + FNH.1 + GE200.0 + NSB\_20% + NHR.1 + RG.0.

The formulated alternative plan has annual economic benefits of \$35.5 million at a capital cost of approximately \$177 million. The plan has net annual economic benefits of \$22.6 million.

### **3.2.2.2 Earthen-Lined Channel Modification Alternative Plan TG.2**

The formulated alternative plan with TG.2 as the anchor component consists of three channelization components and six detention components as listed below:

TG.2 + JR.4 + HOL.3 + GBW.2 + FNH.1 + RG.2 + E200H.2 + GE200.0 + TWLY.2.

The formulated alternative plan has annual economic benefits of \$29.9 million at a capital cost of approximately \$144 million. The plan has net annual economic benefits of \$19.4 million.

### **3.2.2.3 Detention Component Alternative Plan FNH.3+JR.4**

The formulated alternative plan with FNH.3+JR.4 as the anchor component consists of five detention components and one channelization component as listed below:

FNH.3 + JR.4 + GBW.3 + HOL.3 + GE200.2 + RG.1.

The formulated alternative plan has annual economic benefits of \$24.3 million at a capital cost of approximately \$127 million. The plan has net annual economic benefits of \$15.1 million.

This formulated alternative plan yielded significantly lower net annual benefits. Because further optimization of the components for this plan was unlikely to result in net annual benefits that exceed either channel anchor alternative, the detention anchor alternative was not considered for further re-optimization. Only the formulated plans with TG.8 and TG.2 as anchors were carried forward for further re-optimization in the next step of the final optimization.

## **3.2.3 Step 3 - Final Optimization and Identification of the NED Plan**

### **3.2.3.1 Final Optimization**

The channel anchor alternative plans presented in the previous section underwent a final optimization to verify that each component was still providing positive net benefits to the formulated plan and to check that the optimum size and reach had been selected for each component. The two final optimization steps were:

1. Analysis of each last-added component
2. Final optimization and review of each component

The analysis of each last-added component considered the individual effect of each isolated component in comparison to the net economic benefits of the formulated plan with all the components in place. A "tighter" range of sizes was considered by reviewing the previous range of sizes used to optimize the component in the formulated plan. For channel components, in addition to optimizing the channel width, where appropriate, the upstream and downstream limits of the channel component were also optimized.

For the TG.8 plan, each component was re-optimized and the final optimized alternative plan (TG8-RF25) has annual economic benefits of \$30.8 million, capital costs of \$167 million, and net annual economic benefits of \$18.6 million.

For the TG.2A plan, each component was re-optimized and the re-optimized alternative plan has annual economic benefits of \$32.3 million, capital costs of \$169 million, and net annual economic benefits of \$20.0 million.

Following these steps, the HCFCD decided that for the TG.2 plan, additional modifications to components TG.2A, GE200.7 and HOL.2 would be evaluated for flood damage reduction and economic benefits and to reflect local interests.

Modifications to these components consisted of the following:

1. TG.2A – The channel cross-section was modified in the reach from Station 77625 near the Hollister (HOL) detention basin to Gessner Drive and an alternative smaller reach length.
2. GE200.7 – The combined Jersey Village Channel E200-00-00 and E141-00-00 channel were added to GE200.7. This modification was in response to collaboration with the Jersey Village government.
3. HOL.2 – The storage volume was initially increased to as much as 1,100 acre-feet within the land area for HOL.2. The increased volume would be added by deepening the basin, without additional land acquisition.

Additional optimization of components occurred based on updated 2009 construction costs and economics data. These updates resulted in two components being removed from the TG.2A1 plan because they did not add net economic benefits. The costs and economic data were updated again to 2012 levels. The final optimized TG.2A1 Plan, identified as Plan RF-30 LA NSB1, has annual economic benefits of \$39 million, capital costs of \$145 million, and net annual economic benefits of approximately \$31.6 million. Based on net annual economic benefits, this alternative plan was the best-performing of all alternative plans.

### **3.2.3.2 Identification of the National Economic Development Plan**

The TG.2A1 plan, Plan RF-30 LA NSB1, is the alternative that best meets the planning goals and objectives and is identified as the NED Plan. It is also the plan initially supported by HCFCD, the local sponsor. The plan provides substantial flood damage reduction, does not create adverse impacts downstream of the project, and has been favorably received by the public. The project provides opportunities to incorporate recreation elements into the flood damage reduction project, which have been included as the Recreation Plan.

### **3.2.3.3 Locally Preferred Plan**

The NED Plan (RF-30 LA NSB1) was identified as the Tentatively Recommended Plan described in the previous section. This plan was documented in the February 2013 draft of the GRR and the EA. This version of the GRR and EA was distributed to required agencies, interested parties and to the public for review and comment as part of the NEPA process. Significant public comment was received in opposition to the acquisition of the area identified as the FNH.3-W cell for construction of additional detention storage at the Fairbanks-North Houston detention basin site. Acquisition of this area would require relocation of 11 residences. Concerns were raised regarding the historical, social, and environmental significance of the area to be acquired. Based on these concerns the Local Sponsor reviewed the performance of the flood protection plan resulting from the removal of this area from the plan. Damages are reduced approximately \$35.6 million in comparison to the NED damage reduction of \$37.4. Net benefits are approximately \$22.1 million in comparison to the NED net benefits of \$23.7 million. The benefit-cost ratio is 2.73 in comparison to the NED benefit-cost ratio of 2.74. Based on these comparisons, it was decided that the flood protection and economic performance of the Tentatively Recommended Plan would not be significantly impacted by removing this area. It was decided to adopt the resulting plan which contains all the features of the NED Plan (RF-30 LA NSB1) except the FNH.3-W cell as the Locally Preferred Plan (RF-31) and the Recommended Plan. This plan meets the planning objectives and provides similar flood protection benefits in comparison to the NED Plan at a lower cost. It also avoids the social, historical, and environmental impacts in a sensitive area.

The costs presented here in this section are based on the Corps' procedures used throughout the Plan Formulation process and are not based on costs related to actual construction that has occurred. Actual costs related to construction that has occurred and estimated future construction costs are discussed in Section 8.3. Damages and resultant benefits were updated to FY2013 price levels and 3.75 interest rate for the Locally Preferred Plan and Recommended Plan (RF-31). They are also presented in Section 8.3. The Recommended Plan is shown on Exhibits 1-2 and 1-2a.



### 3.2.4 Evaluation and Comparison of Alternative Plans

Along with the No Action Plan (without project), three alternative plans were developed as described in the previous sections of this chapter. As presented in Section 4.10.2, the final re-optimization of the two channel component anchor component plans consists of channel modifications, detention, and permanent relocation. Table 3-1a is a comparative summary of the two channel plans, the detention plan and the No Action Plan, that includes the plan description, hydraulic/engineering effects, economic results, environmental impacts, and other social effects.

The plans presented in Table 3-1a were compared and evaluated on characteristics that demonstrate the four evaluation criteria described in the P&G (Reference 9): completeness, effectiveness, efficiency, and acceptability. In terms of all four of the evaluation criteria the No Action Plan is the least favorable of the plans because it does not in any way meet the primary objective of reducing flooding along White Oak Bayou. In terms of completeness nothing is accomplished. Regarding effectiveness and efficiency it is not achieving either, and to do nothing is not acceptable. Of the two channel plans, TG.2 provides higher performance and effectiveness and is more complete and more acceptable. With regard to flood risk management, the TG.2 Plan is a more complete plan in terms of reducing flooding and not creating adverse flood impacts; the plan is only slightly more costly and is more efficient than TG.8, and TG.8 creates significant adverse hydraulic and economic damage impacts along the lower reach of White Oak Bayou downstream of the proposed channel modifications. The TG.2 plan creates no adverse impacts.

The TG.8 Plan has significant adverse hydrologic and environmental consequences and incurs significant environmental mitigation costs, primarily due to proposed concrete lining of the channel. The TG.8 Plan would add over 500 newly flooded structures to the 4 percent floodplain, over 800 newly flooded structures to the 1% floodplain and increase flooding to over 900 structures within the 4% floodplain with depths increasing on average from 0.12 to 0.79 feet and 2,700 structures within the 1% floodplain with depths more than doubling from 0.74 to 1.93 feet. These impacts result in a less complete, less effective and less acceptable plan.

The TG.2 plan (TG2-RF31), on the other hand, provides a higher level of flood protection, reducing average annual damages by \$34.0 million compared to the \$30.8 million for the TG.8 Plan, without creating any adverse impacts downstream of the proposed project. Its first cost is only slightly greater than the TG.8 Plan and produces net EA benefits that are approximately \$3.3 million greater than Plan TG.8.

The FNH + JR Detention Plan provided significantly less flood protection, reducing average annual damages by \$24 million, compared to over \$30 million for the two channel plans. Net benefits were also significantly less than the two channel plans. Because of the relatively poor performance in comparison to the two channel plans it was eliminated from further consideration.

**Table 3-1a. Summary Comparison of Alternative Plans**

	No Action	TG.8 Plan	TG.2A1 Plan	FHN +JR Plan (Detention Plan)
Plan Components	none	TG.8, JR.4, GBW.1, E200H.3A, TWLY.3, FNH.1, GE200.0, NHR.1, RG.0, NSB1	TG.2A1, JR.4, HOL.3B, GBW.3, FNH.2, E200H.2A, GE200.7	FNH.3+JR.4+GBW.3+HOL.3+GE200.2+RG.1
Plan Description	No Action / Without Project Condition	--7 miles concrete-lined channel modifications --5.5 miles earthen channel modifications --5 detention basins providing 2,187 ac-ft storage --permanent relocation of 1 property	--15.4 miles earthen channel modifications --4 detention basins providing 2,938 ac-ft storage	-2 miles earthen channel - 5 detention basins providing 3,663 ac-ft storage
<b>Hydraulic/Engineering Conditions</b>				
Flood Damage Reduction	None.	58%	64%	43%
Adverse Impacts to Buffalo Bayou for storms smaller than the 1% flood	N/A	Flow increase of 1,974 cfs for 1% flood and 1,198 cfs for 10% flood.	None.	None.
Adverse Impacts within White Oak Bayou for storms smaller than the 1% flood	N/A	Water surface increases of 0.5 to 1.5 ft downstream of channel modifications.	None.	None
<b>Economic Conditions</b>				
Capital Cost (\$1,000)	\$0	\$166,729	\$166,946	\$126,585
Expected Annual Cost (\$1,000)	\$0	\$12,146	\$12,161	\$9,221
Expected Annual Damages (\$1,000)	\$53,430	\$22,679	19,372	\$29,689
Net Expected Annual Benefits (\$1,000)	\$0	\$18,605	\$21,897	\$15,071
Benefit-Cost Ratio	N/A	2.53	2.80	2.63
<b>Environmental / Social / Other Effects</b>				
Induced Flooding	N/A	Over 500 newly flooded structures for 4% event, over 800 newly flooded structures for 1% event.	None.	None
Life, Health and Safety	No adverse impacts. Continued flood damage.	Increased safety risk downstream of project due to induced flooding.	No adverse impacts. Potential benefit from reduced flood damages.	No adverse impacts. Potential benefit from reduced flood damages
Aesthetics, environmental quality	No adverse impacts.	Concrete-lined channel will damage aquatic environment, remove the already limited habitat areas, decrease dissolved oxygen and increase water temperature.	Limited adverse impacts during construction. Opportunity exists to enhance or improve existing conditions.	Limited adverse impacts during construction. Opportunity exists to enhance or improve existing conditions.

- Notes: (1) All values shown are based on February 2002 costs and assessed values, and the year 2004 Federal discount rate of 5.625%.
- (2) Base year equivalent cost is based on a 7-year construction period and interest during construction based on the 2004 Federal discount rate of 5.625%.
- (3) Flood Damage Reduction is based on average annual dollar damages.
- (4) Damages and resultant benefits were updated to FY2013 price levels and 3.75 interest rate for the selected plan identified later in this EA.

As mentioned above, regarding Environmental Quality effects, the TG.8 Plan has significant detrimental consequences associated with the concrete-lining, in comparison to the earthen channel modifications in the TG.2 Plan. The concrete lining in the TG.8 Plan would produce negative aesthetic impacts, damage or reduce aquatic habitat, decrease dissolved oxygen, and increase water temperature. Plan TG.2 would only have limited adverse impacts to aquatic habitat during construction and can be designed to improve existing habitat conditions. It would have no significant long-term negative aesthetic impacts. The TG.2 Plan is the most efficient plan and provides the greatest opportunity for enhancement of aesthetics and environmental resources within the project study area. In addition, there is much greater public support (acceptability) for earthen channel modifications (TG.2 Plan) than for concrete-lined channel modifications (TG.8 Plan).

Regarding the Other Social Effects, as mentioned above, the TG.8 Plan will induce additional downstream flooding for over 500 structures at the 4% event and over 800 structures for the 1% event. The plan would indirectly reduce job productivity and would reduce the quality of life for impacted residents, and would result in increased safety risks. On the other hand the TG.2 Plan does not increase flooding and provides significant benefits by reducing flood damages. It also increases job productivity, improves the quality of life, and reduces safety risks.

Regarding Regional Economic Development impacts in the area, the TG.8 and TG.2 plans would increase the potential for economic development, due to reduced risk of flooding and resulting economic damages in the area. Also, both would increase economic development due to the construction investment in the project area. However, the TG.8 plan would induce additional flooding, causing a negative economic impact.

### **3.3 RECOMMENDED PLAN**

The Recommended Plan (RF-31), which is also considered to be the Environmentally Preferred Alternative, (Exhibits 1-2 and 1-2a) consists of the following components for which federal cost-sharing is being sought:

**Channel TG.2A1:** Approximately 7.0 miles of earthen channel modifications from Cole Creek, south of West Tidwell Road, to Gessner Drive. A total of 10.8 acres of additional ROW is required, resulting in 18 residential and one out-building displacement.

**Channel GE200.7A:** Approximately 2.1 miles of earthen channel modifications, within the existing ROW, from Gessner Drive to existing HCFCD drainage channel E200-00-00.

**Channel E200H.2A:** Approximately 3.4 miles of earthen channel modifications, within the existing ROW, from existing HCFCD drainage channel E200-00-00 to FM 1960.

**Jersey Village Channel GE200.7A:** Approximately 2.9 miles, including 1,500 feet of transition, of channel modifications along two existing HCFCD drainage channels, E200-00-00 and E141-00-00.

**Hollister Road Detention Basin HOL.3B (E500-03-00):** Detention basin complex providing 730 acre-feet of detention volume on 93.7 acres located at Hollister Road on land south of the bayou. Seven acres of wetlands are being created in the basin. These wetlands are not part of the least-cost mitigation plan and are not proposed for cost-sharing with the Federal government.

**Fairbanks-North Houston Road Detention Basin FNH.2 (E500-01-00 and E500-02-00):** Detention basin complex east of Fairbanks-North Houston Road on two properties totaling 142 acres and providing an estimated total detention volume of 1,269 acre-feet.

**Gessner Drive Detention Basin GBW.3 (E500-10-00):** Detention basin complex on three properties totaling 51.0 acres located north and south of the bayou west of Gessner Drive and east of Beltway 8 and providing an estimated detention volume of 519 acre-feet. A total of 10.6 acres of additional ROW is required resulting in two commercial displacements.

**Jones Road Detention Basin JR.4 (E500-11-00 and E500-12-00):** Detention basin complex on two properties totaling approximately 65.8 acres located north and south of White Oak Bayou and east and west of Jones Road, providing an estimated detention volume of 420 acre-feet.

**Recreation Plan:** Creation of linear park/bikeway between Hollister Road to north of West Road. Recreational opportunities would also be provided within the detention basins such as multi-purpose trails, observation/teaching facilities, multi-purpose fields, and play areas.

**Mitigation:** Mitigation of wetlands by utilizing 4.99 acres of wetlands at the GBWMB, Subdivision A. This component would be cost-shared to the extent of the least-cost mitigation developed as part of the Wetlands Mitigation Cost Analysis, presented in EA Appendix E. Seven acres of wetlands, identified as Local Sponsor Volunteer Mitigation, would also be created within the Hollister Road detention basin. These wetlands are not part of the least-cost mitigation plan and are a 100 percent local sponsor cost.

The following sections describe in further detail the engineering and design considerations associated with each of these components.

### **3.3.1 Earthen Channel Modifications**

The proposed channel modifications consist of approximately 15.4 miles of earthen channel modifications from Cole Creek, south of West Tidwell Road, to FM 1960. The proposed alignment of the channel modifications would follow the alignment of the existing channel. The channel flow line would be lowered to the elevation of the existing federal low-flow channel at the downstream reach at West Tidwell Road. A 200-foot transition length would be assumed at changes in channel bottom width (i.e., the ends of the channel modifications). The proposed channel modifications generally consist of a trapezoidal channel with 3 horizontal to 1 vertical side slopes, 0.001 foot/bottom slope, and 30-foot maintenance berms. The majority of the vegetation adjacent to the channel within urban areas consists of maintained grasses. Various utility crossings would have to be relocated or adjusted as part of the channel modifications.

The channel modifications would include a low-flow, geomorphologic channel that would prevent sediment buildup and allow sediment to move through the channel. Concrete-lined channels would be

used minimally under bridges as required. The bayou stream would appear to have a more natural meandering flow within the boundaries of the channel bottom.

The following sections describe specific aspects of the channel modification components.

### **Channel TG.2A1**

Channel TG.2A1 (HCFCD No. E100-00-00) consists of approximately 7.0 miles of earthen channel modifications from Cole Creek, south of West Tidwell Road, to Gessner Drive, with a total of 10.8 acres of additional ROW required in various locations.

Two locations describe the channel modifications:

1. Cole Creek (Station 56231) to drainage channel E122-00-00 (Station 77129): 60-foot bottom width.
2. Drainage Channel E122-00-00 (Station 77129) to Gessner Drive (Station 86621): 30-foot bottom width.

### **Channel GE200.7A**

Channel GE200.7A (HCFCD number E100-00-00) consists of approximately 2.1 miles of earthen channel modifications from Gessner Drive to existing HCFCD drainage channel E200-00-00, within the existing ROW. Conveyance modifications to the existing channel would be made by providing a uniform channel flow line with approximate 30-foot bottom width. Portions of the channel would be gabion-lined due to slope stability concerns.

### **Channel E200H.2A**

Channel E200H.2A (HCFCD No. E100-00-00) consists of approximately 3.4 miles of earthen channel modifications from the existing HCFCD drainage channel E200-00-00 to FM 1960 within the existing ROW.

Two reaches describe the channel modifications:

1. Drainage channel E200-00-00 (Station 105000) to Jones Road (Station 116549): 80-foot bottom width.
2. Jones Road (Station 116549) to FM 1960 (Station 122498): 50-foot bottom width.

### **Jersey Village Channel GE200.7A**

Jersey Village channel GE200.7A consists of approximately 2.9 miles of channel modifications along two existing HCFCD drainage channels, E200-00-00 and E141-00-00. The modifications, within the existing ROW, connect from White Oak Bayou at its confluence with existing HCFCD drainage channel E200-00-00 in Jersey Village to existing HCFCD drainage channel E141-00-00 west of Gessner Drive. Conveyance modifications to E200-00-00 and E141-00-00 include deepening and widening the channels with bottom-widths that vary between 16 feet and 30 feet and by removing obstructions to the flow.

### **3.3.2 Detention Basin Modifications**

Four detention basin complexes providing an estimated total storage volume of 2,938 acre-feet are proposed. The detention basin complexes would be constructed on a total of 353 acres of land. The detention basins were designed with 3 horizontal to 1 vertical side slopes, a spillway or side weir to divert runoff into the detention basin, and low-flow pilot channel sloped to drain toward a low-flow outfall pipe. A maintenance berm surrounding the detention basin is designed with backslope drains and perimeter maintenance drainage swales to control erosion of the side slopes. Actual maintenance berm widths and detention basin side slopes would be varied to enhance the appearance of the detention basin and to accommodate environmental and recreational features.

The following sections describe the specific aspects of each detention basin.

#### **Hollister Road Detention Basin**

The Hollister Road detention basin complex (HOL.3B and HCFC No. E500-03-00) consists of a detention basin complex on a 93.7-acre site currently owned by the HCFC east of Hollister Road. An Exxon/pipeline divides the property into approximately 57 acres between the pipeline and the bayou, and approximately 37 acres between the pipeline and West Little York Road. This off-line detention basin would provide an estimated volume of 730 acre-feet. Seven acres of forested wetlands, identified as Local Sponsor Volunteer Mitigation, would be created within the Hollister Road detention basin complex, with emergent wetlands also created among the forested wetlands. These wetlands are not part of the least-cost mitigation plan and are proposed to be a 100 percent local sponsor cost.

#### **Fairbanks-North Houston Detention Basin**

The Fairbanks-North Houston Road detention basin complex (FNH.2 and HCFC Nos. E500-01-00 [north basin] and E500-02-00 [south basin]) consists of one property located north of the bayou and one property located south of the bayou east Fairbanks-North Houston Road, totaling approximately 142 acres. The detention basin complex is designed as two separate storage cells with a total estimated detention volume of 1,269 acre-feet. HCFC has acquired the property.

Detention north of the bayou is on an 86-acre site with a total estimated storage volume of 843 acre-feet. This detention is an expansion of the existing 360 acre-foot detention basin E500-01-00.

Detention south of the bayou is one property located east of Fairbanks-North Houston Road. The property, located east of Fairbanks-North Houston Road, is a 428 acre-foot detention basin on a 56-acre tract.

### **Gessner Drive Detention Basin**

The Gessner Drive detention basin complex (GBW.3 and HCFCD No. E500-10-00) is located between Gessner Drive and Beltway 8 on three properties, totaling 51.0 acres and would provide an estimated detention volume of 519 acre-feet. This complex is located adjacent to White Oak Bayou and contains cells both north and south of the bayou.

The detention basin south of the bayou consists of one 24-acre property located between White Oak Bayou and Brookriver Drive and a second 10.6-acre property located south of Brookriver Drive. This south basin is configured as three storage cells with a diversion weir to convey floodwaters into the basin. Pipes to equalize storage of runoff would interconnect the storage cells. A 21-inch sanitary sewer line crosses through the middle of the first property located between White Oak Bayou and Brookriver Drive. This utility would not be adjusted; therefore, the first property has been designed to contain two cells. A total of 10.6 acres of land acquisition is required for this third cell.

The detention basin north of the bayou, located at the confluence of the existing HCFCD drainage channel E141-00-00 and White Oak Bayou, is an in-line basin with a total area of approximately 16 acres.

### **Jones Road Detention Basin**

The Jones Road detention basin (JR.4 and HCFCD Nos. E500-11-00 [east of Jones Road] and E500-12-00 [west of Jones Road]) is a detention basin complex on two properties. The first property is located north of White Oak Bayou and west of Jones Road and the second property is located south of White Oak Bayou and east of Jones Road. The HCFCD has completed ROW acquisition of this detention component. The first property provides an estimated storage volume of 200 acre-feet on approximately 30 acres. The second property provides an estimated storage volume of 220 acre-feet on approximately 36 acres.

### **3.3.3 Recreation Plan**

The Recreation Plan was developed as follows. A recreation use inventory was conducted to evaluate the use of facilities along the bayou. Opportunities and constraints were identified, taking into account the flood damage reduction plan, environmental conditions along the bayou, and the recreation inventory. Recommendations for recreation facilities were made based on the opportunities and constraints. Using the estimated number of users, quality of experience, and construction budgets, the cost of the recreation plan was compared to the expected use of facilities proposed in the plan. The benefit cost ratio and net economic benefits were determined.

The recreation plan includes various parkways, bikeways, multi-purpose fields, and play areas. Coordination would be conducted with the City of Houston to construct the proposed linear park/bikeway planned from the confluence of White Oak Bayou and Cole Creek upstream to Hollister Road. However, the City of Houston is not a sponsor of the recreation plan. A new linear park trail would also be extended from Hollister Road to north of West Road, along channel modifications TG.2A1, GE200.7A and E200H.2A. Hike and bike trails would be provided along each of the detention basins. The Hollister

Road (HOL.3B) and Fairbanks-North Houston Road (FNH.2) detention basin complexes would provide urban wetlands/wildlife observation areas. The Fairbanks-North Houston Road (FNH.2), Gessner Drive (GBW.3), and Jones Road (JR.4) detention basin complexes would provide open play/multi-purpose fields. The Jones Road (JR.4) detention basin would also provide open play/multi-purpose fields within the site.

The components of the recreation plan are contained within the proposed project area, specifically within the channel modifications and detention basins. Therefore, the affected environment and environmental consequences of the proposed recreation plan are included in evaluations of the channel modifications and detention basins.

### **3.3.4 Wetlands Mitigation**

A total of 13.17 acres of wetlands would be impacted during construction of the project, avoiding impacts to 4.86 acres of wetlands. Compensatory wetland mitigation would be provided for all or part of the 13.17 acres of wetlands that are impacted. Mitigation would occur within the GBWMB, Subdivision A by utilizing 4.99 acres of wetlands. This component would be cost-shared only to the extent of the least-cost mitigation. The process to develop the least cost wetlands mitigation plan was performed using the USACE's IWR Planning Suite software to evaluate eight alternative mitigation plans and is described in Section 5.16.1 and EA Appendix E.

No prior Federal funds have been used for the design or construction of the GBWMB, Subdivision A. Seven acres of forested wetlands, identified as Local Sponsor Volunteer Mitigation, would also be created within the Hollister Road detention basin complex, with emergent wetlands also created among the forested wetlands. These wetlands are not part of the least-cost mitigation plan and are proposed to be a 100 percent local sponsor cost.

### **3.3.5 Soil Placement Sites**

Historically, HCFCD, through the use of private contractors, has been successful in placing excavated soil at sites such as landfills, sandpits, and urban development projects such as road construction, residential subdivisions, and business parks. This practice reduces the total project cost and the amount of acreage required, which reduces the amount of potential impacts to habitat in and around Harris County. From the start of the proposed action (January 1, 1998) to December 2005, consistent records regarding soil placement sites were not successfully maintained. During this time, approximately 3,753,805 cubic yards of soil was excavated for construction of the proposed action. Communications with the contractors involved indicate that the vast majority of the soil went to private developments, building pads, road projects, landfills, and sandpits from January 1, 1998 to December 2005. Specifically one subdivision, Lakes of Jersey Village, received approximately 58,000 cubic yards of soil. Prior to receiving soil disposal, the Lakes of Jersey Village subdivision was formerly a golf course. Additionally, approximately 795,900 cubic yards of soil was disposed of at a licensed sandpit off Fairbanks-North Houston Road.



Beginning in December 2005, HCFCD has records documenting where soil was being disposed of, and they reviewed these sites regarding wetlands, hazardous materials, cultural resources, and threatened and endangered species. Data review, in conjunction with site visits, enables HCFCD to effectively assess the potential environmental impacts to potential disposal sites. Each proposed disposal site has been visited and reviewed to ensure soil placement would not impact significant resources, including cultural resources, threatened and endangered species, hazardous materials, or wetlands. If a site was identified to contain any significant resources such as wetlands, the site was rejected for use as a disposal site. The use of these requirements means that the vast majority of soil is located at previously-disturbed sites or on projects that have the appropriate NEPA documentation.

From December 2005 to February 2011, 66 proposed soil disposal sites have been approved to receive approximately 1,723,051 cubic yards of soil from construction of the proposed action. Of these sites, 33 were previously impacted by other construction projects before federal soil was disposed of on-site. A list of the disposal sites used from January 1, 1998, to February 2011 is provided in Table 3-2 below and on Exhibit 3-1. No significant resources were impacted from soil disposal resulting from the proposed action at any of the 66 sites.

**Table 3-2  
Soil Disposal Sites**

<b>Disposal Site Location</b>	<b>Approximate Acres</b>	<b>Description</b>
<b>January 1998 to December 2005</b>		
Lakes of Jersey Village HCFC No. E535-01-00/RG.1	23	Prior to being developed into a subdivision, the site was a former golf course.
Sprint Sand and Clay 7240 Fairbanks-North Houston Road	N/A	The site is a licensed sandpit.
<b>December 2005 to February 2011</b>		
14990 Yorktown Plaza Drive	7	The site was previously impacted from an ongoing construction project.
29300 Hempstead Road	91	A portion of the site was approved for soil disposal. The site was dominated by grasses. The remaining portion of the site was a wetland, which was avoided as a soil disposal location for the proposed action.
19500 SH 249	29	The site was previously cleared for a future office building and parking garage complex.
12907 North Eldridge Road	43	The site was previously impacted and the soil disposal used to fill the previously impacted area (Sprint Sand and Clay).
9220 Fairbanks-North Houston Road	108	The soil disposal was used to fill a licensed sandpit (Sprint Sand and Clay). The sandpit is the final location of the soil disposal.
10919 Louetta Road	10	A portion of the site was approved for soil disposal that was previously impacted. The remaining portion of the site was a forested wetland, which was avoided.
700 Town & Country Way	5	The site was previously impacted by others; cleared and leveled (Town & Country Center).
10343 Sam Houston Parkway Drive	63	The site was dominated by grasses and was previously impacted; cleared and leveled.
11130 Neeshaw	11	The site was dominated by young, second-growth trees and privet and was previously impacted; cleared.
6356 Clara Road	7	Although the site was not previously impacted, the site was accepted for soil disposal.
2870 Gessner Drive	6	The site was previously impacted by others; cleared and leveled.
11640 Hammond Drive	3	The site was previously impacted; cleared and leveled.
11560 Hammond Drive	2	The site was previously impacted; cleared and leveled.
1300 Block of Windfern Drive	2	Although the site was not previously impacted, the site was regularly mowed and maintained. The site was accepted for soil disposal.
10305 Round Up Lane, #A	12	A portion of the site was previously impacted. The remainder of the site was a potential wetland, which was avoided as a soil disposal location for the proposed action.
11070 Bridgedown Drive	5	The site was previously impacted; cleared and leveled.

<b>Disposal Site Location</b>	<b>Approximate Acres</b>	<b>Description</b>
13002 Northpoint Boulevard	13	The site was previously impacted; cleared and leveled.
20329 Tomball Parkway	2	The site was previously impacted; cleared and leveled.
14401 and 14411 West Road	2	The site was previously impacted; cleared and leveled.
6911 Fairbanks-North Houston	15	The site was previously impacted; cleared and leveled.
1220 W. 43rd	2	The site was previously impacted; cleared and leveled.
11191 Clay Road	2	The site was previously impacted; cleared and leveled.
20320 Northwest Freeway	8	The site was previously impacted; cleared and leveled.
1254 Enclave Parkway	2	The site was previously impacted; cleared and leveled.
10919 Louetta Road	5	The site was previously impacted; cleared and leveled.
18220 Tomball Parkway	2	The site was previously impacted; cleared and leveled.
10602 W. Sam Houston Parkway North	17	The site was previously impacted; cleared and leveled.
16518 Jersey Drive	10	The site was previously impacted; cleared and leveled.
11050 W. Little York Drive	7	The site was previously impacted; cleared and leveled.
14990 Yorktown Plaza	23	The site was previously impacted; cleared and leveled.
700 Town and County Drive	5	The site was previously impacted; cleared and leveled.
29300 Hempstead Road	178	The site was previously impacted; cleared and leveled.
K158-00-00-X003	1,400 linear feet	Site was approved for soil disposal.
K500-01-00 (12907 N. Eldridge)	27	The site was previously impacted; cleared and leveled.
9220 Fairbanks-North Houston	N/A	The site was previously impacted; cleared and leveled.
E500-03-00-E001 608 E. Tidwell	1	The site was approved for soil disposal.
E500-03-00-E001 10595 Hammerly Boulevard	12	The site was approved for soil disposal.
E500-03-00-E001 3602 Hollister	5	The site was approved for soil disposal.
E500-03-00-E001 1400 W. 43 <sup>rd</sup> Street	<1	The site was approved for soil disposal.
E500-03-00-E001 1600 Studemont	<1	The site was approved for soil disposal.
E500-11-00-E001 10410 Veterans Memorial	14	The site was approved for soil disposal.
E500-11-00-E001 301 N. Drennan	9	The site was approved for soil disposal.
E500-11-00-E001 1310 Rankin Road	1	The site was approved for soil disposal.
E500-11-00-E001 2525 Appelt	1	The site was approved for soil disposal.
E500-11-00-E001 16800 Huffmeister, Cypress	25	The site was approved for soil disposal.
E500-11-00-E001 930 Lamonte Lane	<1	The site was approved for soil disposal.
E200-00-00-E003 19500 Tuckerton	15	The site was approved for soil disposal.
E200-00-00-E003 10135 West Road	1	The site was approved for soil disposal.

<b>Disposal Site Location</b>	<b>Approximate Acres</b>	<b>Description</b>
E200-00-00-E001 10310 W Little York	3	The site was approved for soil disposal.
E000-00-00-E001 13900 Humble/Exxon Road	12	The site was approved for soil disposal.
E500-03-00-E001 1201 Silber	7	The site was approved for soil disposal.
E200-00-00-E001 2045 Gessner	7	The site was approved for soil disposal.
E200-00-00-E001 818 Alexander	<1	The site was approved for soil disposal.
E200-00-00-E001 13250 West Road	4	The site was approved for soil disposal.
E500-03-00-E001 5306 Washington Avenue	<1	The site was approved for soil disposal.
E500-03-00-E001 3641 Inverness	<1	The site was approved for soil disposal.
E500-03-00-E001 501 Westlake Boulevard	2	The site was approved for soil disposal.
E200-00-00-E001 6019 Crawford	4	The site was approved for soil disposal.
E500-03-00-E001 7835 Fairview	<1	The site was approved for soil disposal.
E500-03-00-E001 6085 Yale Street	<1	The site was approved for soil disposal.
E500-03-00-E001 5 Raydon Lane	<1	The site was approved for soil disposal.
E500-00-03-E001 2911 W. Sam Houston Tollway	1	The site was approved for soil disposal.
E500-00-03-E001 2910 W. Sam Houston Tollway	2	The site was approved for soil disposal.
E500-03-00-E001 1221 Malone	<1	The site was approved for soil disposal.
E500-03-00-E001 10202 Memorial	1	The site was approved for soil disposal.

Records of Environmental Consideration ("REC") have been used to document approved soil disposal after June 2007 to ensure full NEPA compliance. The REC process utilizes USACE approved checklists and report formats to review areas for potential wetlands, archeological resources, historic resources, threatened or endangered species, or impacts from hazardous materials. Specifically, a desktop review of available environmental and cultural resources data is conducted using the HCFCD Watershed Environmental Baseline ("WEB") Program. The WEB is updated using information obtained from the THC and the USACE each year. During the analysis to complete a REC, if it is discovered that there is a potential to impact hazardous materials or if significant resources such as wetlands or cultural resources are identified on the proposed disposal site, the disposal site would be rejected for federal project use. If the site is clear after the REC investigation, a REC for the disposal site would be kept on file at HCFCD. Soil placement sites are only used if the REC shows that the site is "exempt" from doing a Categorical

Exclusion ("CE") or an EA. An example of the REC used for soil placement sites is shown in Appendix H.

Excavated soil from the proposed action, the Recommended Plan, is disposed of through a contractor. The contractor would then be directed to use the following two disposal sites if sites cleared through a REC are not available. The two disposal sites are a landfill and a sand pit. Both operations are fully functioning, licensed vendors who have stated they are available to receive the excavated material.

Waste Management Fairbanks Landfill  
8205 Fairbanks-North Houston Road  
Houston, Texas 77040/(713) 849-2902

Sprint Sand and Clay  
7240 Fairbanks-North Houston Road  
Houston, Texas 77040/(713) 465-4322

If alternative soil disposal sites are used, the HCFCD would conduct environmental investigations using REC to assure the soil disposal locations are free of environmental concerns. If the proposed location is not free of environmental concerns, the site would be rejected as a soil disposal site.

### **3.3.6 Operation and Maintenance Considerations**

Typical operations, maintenance, repair, replacement, and rehabilitation ("OMRR&R") activities primarily consist of mowing the ROW, slope repair, riprap or concrete slope protection, maintenance of inlet and outlet control structures, weed control, debris removal, turf maintenance, desilting, and backslope drain system repair. The annual OMRR&R costs associated with the flood damage reduction components of the Recommended Plan is approximately \$328,000.

### **3.3.7 Construction Schedule**

A preliminary implementation schedule for the remaining unconstructed components of the project was prepared based on the following assumptions:

1. The start of construction of the project is 2018.
2. Approximately \$20 million (federal and local funds) would be available per year to fund the project.
3. Channel modifications would be broken into four discrete segments costing approximately \$11 million each. Construction would generally begin at the downstream end and progress upstream, except where upstream construction is ready to begin and is feasible without adversely impacting downstream reaches.
4. Each detention basin complex would be constructed as a discrete segment. Construction is completed or partially completed on all detention basins, with the exception of Gessner/ 8 (GBW.3) south of Brookriver Drive.

### **3.3.8 Construction Access and Staging Areas**

No temporary or permanent access easements are planned for the project construction or soil placement; however, if areas are identified during the construction phase, they would be evaluated subject to full compliance with NEPA requirements.

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## **4.0           AFFECTED ENVIRONMENT**

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The focus of this EA is the detailed assessment and comparison of the potential impacts resulting from implementation of the proposed action, the Recommended Plan (RF-31), and the No-Action Alternative. This EA has been prepared in compliance with the NEPA of 1969, as amended. This chapter describes the White Oak Bayou project area and its existing flood problems from a broad perspective. The material discussed includes information ranging from the general terrain and climate of the watershed and study area to a summary of the socioeconomic status of the project area.

Several of the discussions in this chapter are general in nature and would apply to the entire region; however, for those sections that required fieldwork and are specific in nature to the Recommended Plan, the discussion applies only to the project area.

### **4.1           DEFINITION OF THE STUDY AREA AND PROJECT AREA**

The study area is defined as the area along White Oak Bayou based on the 500-year (0.2 percent) floodplain. White Oak Bayou extends from its upstream headwaters at Huffmeister Road, downstream to its confluence with Buffalo Bayou in downtown Houston (approximately 25 miles in length). The study area is identified in Exhibit 1-1.

The project area is defined as the footprint of the Recommended Plan (RF-31). This includes the White Oak Bayou channel upstream of Cole Creek (south of West Tidwell Road) to FM 1960, the Jersey Village channel, and four detention basin complexes. The proposed action, the Recommended Plan, totals approximately 15 miles in length and approximately 780 acres, including detention basin complexes (353 of 780 acres). The Recommended Plan project area is identified in Exhibit 1-2.

#### **4.1.1       Existing Conditions**

White Oak Bayou is located within an urban setting and the majority of the vegetation adjacent to the channel consists of maintained grasses. As described in Section 2.1, numerous flood control projects have been implemented along White Oak Bayou. The baseline for investigations was determined by the USACE and HCFCF to be January 1, 1998. Prior to this date, as a local effort, HCFCF has constructed three detention basins, West Tidwell Road (E500-05), North Houston-Rosslyn Road (E500-04), and Fairbanks-North Houston Road (E500-01-00), totaling 137 acres. In addition, a portion of the Jersey Village channel totaling approximately 44 acres along the project area was also constructed prior to January 1, 1998.



### **4.1.2 Current Conditions**

Between January 1, 1998 and 2011, in advance of the federal project being approved, HCFCD has completed or partially completed construction on four detention basin complexes within the Recommended Plan, including Hollister Road, Fairbanks-North Houston Road (north and south), Gessner/ 8, and Jones Road (east and west). In addition to detention basin construction, channel modifications have also been constructed along White Oak Bayou from North Houston-Rosslyn Road (near channel E122-00-00) to Beltway 8. The construction was initiated by HCFCD as a local effort to alleviate future flooding along White Oak Bayou after severe damage occurred in the project area from Tropical Storm Frances in September 1998 and Tropical Storm Allison in June 2001. All construction has been compatible with the Recommended Plan.

### **4.1.3 Proposed Conditions**

Once project construction is complete, net annual benefits of approximately \$38 million would be achieved. The size of the 100-year floodplain would be reduced by channel modifications and detention basin components. Therefore, 22 percent of the homes that are currently in the floodplain would be located outside of the 100-year floodplain. Additionally, 52 percent of the homes that are currently within the 25-year (4 percent) floodplain would now be located outside of the 25-year (4 percent) floodplain, and 96 percent of the homes that are currently within the 10-year (10 percent) floodplain would now be located outside of the 10-year (10 percent) floodplain. Average annual damages would be reduced by 62 percent. In addition, more recreational opportunities and wildlife habitat would be created within the study area.

## **4.2 PHYSICAL DESCRIPTION**

### **4.2.1 General Location**

White Oak Bayou is an integral part of the rapidly-expanding Houston Metropolitan Area. Houston is the nation's fourth largest city. Houston has rapidly diversified with residential and commercial development and retail support services along major thoroughfares and multi-family dwelling development, which has contributed to increased population density.

The White Oak Bayou watershed is located northwest of the Houston Central Business District and originates in northwest Harris County, Texas. White Oak Bayou collects stormwater runoff from an approximate 110-square-mile drainage area, and the treated effluent from 41 wastewater treatment plants. White Oak Bayou is a major tributary in the Buffalo Bayou watershed and drains an area that is considered 90 percent developed within the city of Houston and surrounding areas. The White Oak Bayou channel is 25 miles in length and flows in a northwest/direction from the Cy-Fair communities through unincorporated areas of Harris County, the city of Jersey Village, into the city of Houston, and joins Buffalo Bayou in downtown Houston. White Oak Bayou is an earthen channel from the

northernmost limit of Huffmeister Road to Cole Creek and is a combination of concrete- and grass-lined channel from Cole Creek to the southernmost limit of the confluence of White Oak and Buffalo Bayous.

#### **4.2.2 Climate**

The White Oak Bayou watershed is situated within a humid region of Texas, which maintains subtropical weather during all parts of the year, especially the summer, primarily due to the proximity of the Gulf of Mexico. The region is subject to intense local thunderstorms of short duration, general storms extending over a period of several days, and torrential rainfall associated with hurricanes and other tropical disturbances, which periodically cause flooding of local streams.

According to the National Climatic Service, temperatures range from a mean summer average of about 92° Fahrenheit to a winter average of about 44° Fahrenheit. Freezing temperatures are uncommon, thus a growing season on the average of 271 days is prevalent in Harris County. During a typical year, about seven days have temperatures at 32° Fahrenheit or less. Prevailing winds are from the south and southeast, flowing landward off the Gulf of Mexico and causing high humidity and a uniform climate. Mean annual precipitation in the Houston area is about 46 inches per year.

The major storms experienced in the study area are produced by heavy rainfall from frontal-type storms, which generally occur in the spring and summer months, but major flooding can also be produced by intense rainfall associated with localized thunderstorms. These localized thunderstorms may occur at any time during the year, but they are also more prevalent in the spring and summer months.

#### **4.2.3 Geology**

Harris County, which includes White Oak Bayou, is irregular in shape, measuring about 35 miles from north to south and 50 miles from east to west. It covers 1,765 square miles, or 1,129,600 acres.

White Oak Bayou lies within the Gulf Coastal Plains geologic area, which is characterized as a flat, basically treeless plain extending along the Texas Coast. According to the *U.S. Department of Agriculture Natural Resources Conservation Service's ("NRCS") Soil Survey of Harris County, Texas*, the parent material within Harris County consists of unconsolidated sediment of Holocene, Pleistocene, and Pliocene age. According to the *Geologic Atlas of Texas (Bureau of Economic Geology, University of Texas)*, the two formations underlying the White Oak Bayou watershed are Pleistocene in age and are identified as Lissie and Beaumont.

The Lissie formation has a surface area that is fairly flat and featureless, except for numerous rounded shallow depressions and pimple mounds. Near the surface layer consists of clay, silt, and very minor siliceous gravel of granule and small pebble-sized gravel, which is more abundant northwestwardly. It is locally calcareous and fluviatile. Concretions of calcium carbonate, iron oxide and iron manganese oxides are common in the zone of weathering. Beneath the surface layer consists of clay, silt, sand, and a

minor amount of gravel. The gravel is slightly coarser than compared to the surface layer. It is non-calcareous and fluviatile. Iron oxide concretions are more abundant than in the upper part. The Lissie formation is very gently rolling with a thickness of  $\pm 200$  feet.

The Beaumont formation has an almost featureless surface and is characterized by relict river channels shown by meander patterns and pimple mounds on meanderbelt ridges, separated by areas of low, relatively smooth, featureless, backswamp deposits without pimple mounds. This formation is comprised of silt, sand, and clay, and includes mainly stream channel, point-bar, natural levee, backswamp, and to a lesser extent, coastal and mud-flat deposits. There are concentrations of calcium carbonate, iron oxide, and iron manganese oxides found in the zone of weathering. This layer has a thickness of approximately 100 feet.

Elevations in the watershed vary from approximately 116 feet at the upstream limits to approximately 30 feet at the confluence with Buffalo Bayou; the average streambed slope is about 4 feet per mile.

#### 4.2.4 Soils and Farmland Protection Policy Act

##### 4.2.4.1 Soils

According to the *NRCS Soil Survey of Harris County, Texas*, the soils in the project area generally consist of Addicks-loam, Addicks-Urban land complex, Aris-Gessner complex, Aris-Urban land complex, Clodine loam, Clodine-Urban land complex, Gessner loam, Gessner-Urban land complex, Nahatche loam, Urban land, and Vamont-Urban land complex, which are described in Table 4.1 below.

**Table 4-1**  
**Descriptions of Soil Series Occurring Within the Project Area**

Soil Series	Slope (Majority)	Hydric <sup>1</sup>	Description
Addicks loam (Ad)	0-1 (0.3)	Yes	Poorly drained, surface runoff slow
Addicks-Urban land complex (Ak)	0-1 (0.3)	Yes	Intricately mixed
Aris-Gessner complex (Ar)	Nearly level	Yes	In large irregular areas 100 to 1,000 acres in size
Aris-Urban land complex (As)	0-1 (0.3)	Yes	In broad irregular areas 30 to 1,000 acres in size
Clodine loam (Cd)	0-1 (0.5)	Yes	Nearly level soil on broad areas, generally low on the landscape
Clodine-Urban land complex (Ce)	0-1 (0.6)	Yes	In broad irregular areas from 20 to several hundred acres in size
Gessner loam (Ge)	0-1	Yes	Pimple mounds with depressions between

<b>Soil Series</b>	<b>Slope (Majority)</b>	<b>Hydric<sup>1</sup></b>	<b>Description</b>
Gessner-Urban land complex (Gu)	0-1	Yes	In broad nearly level areas and in depressions
Nahatche loam (Na)	0-1 (0.6)	Yes	In floodplains of major streams and tributaries
Urban land complex (Ur)	N/A	No	Altered and obscured
Vamont-Urban land complex (Vn)	N/A	No	In long and narrow gently sloping areas leading to low terraces

1 Hydric characteristics were determined from the Harris County, Texas, Hydric Soils List, Map Units with Hydric Components (July 2011).

#### **4.2.4.2 Farmland Protection Policy Act**

The purpose of the Farmland Protection Policy Act ("FPPA"), Subtitle I of Title XV of the Agricultural and Food Act of 1981 (Pub. L. 97-98), is to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of prime, unique, and other farmlands of statewide or local importance to non-agricultural uses.

Three mapped soil units in the project area are identified as prime and other important farmlands in Harris County by the NRCS, and are considered potentially subject to the FPPA. These mapped soil units include the Aris-Gessner complex, Clodine loam, and Gessner loam. These mapped soil units are only identified as prime farmland if drained.

### **4.3 LAND USE**

The White Oak Bayou watershed is a diverse and highly-developed urban drainage channel located in Harris County. Existing land use within the study area consists of residential homes (single, multi-family, and mobile); commercial businesses including restaurants, gas stations, strip shopping centers, etc.; light industrial; six fire stations; two police stations; one hospital, the Medical Arts Hospital; five post offices; Glenwood, Washington, and Hollywood cemeteries; Union Pacific, Missouri Railroad, Texas and Kansas Railroad, Southern Pacific Railroad, and Fort Worth Denver Railroad.

The following schools are located within the study area: University of Houston Downtown campus, Dow Elementary, Brock Elementary, Sherman Elementary, Marshall Junior High School, Lamar Elementary, Davis Senior High School, Lee Elementary, Travis Elementary, Crockett Elementary, Hogg Junior High School, Harper Elementary, Eighth Avenue Elementary, Inwood Elementary, J. Ruth Smith Elementary, Harrison Elementary, Eisenhower Senior High School, Ermel Elementary, E. S. Post Elementary, Jersey Village Senior High School, Cook Junior High School, and Bang Elementary.

The following parks are located within the study area: Championship (HCFCD), Hogg (City of Houston ["COH"]), Woodland (COH), Stude/Oak (COH), Lawrence (COH), Timbergrove Manor (Home Owners Association ["HOA"]), Little Thicket (COH), T. C. Jester Parkway (COH), Highland (COH), Woodland Trails (HOA), Woodland Trails West (HOA), Clark W. Henry (HOA), Winchester Country Rio Grande (HOA), Greenwater (HOA), and Wortham Villages Recreation Center (HOA).

The following roadways, U.S. Highway ("US") 290 and IH 45, are major arterials that run parallel to the bayou. The Sam Houston Parkway (Beltway 8), IH 610, and IH 10 are major arterials that traverse the bayou. Major commercial strip shopping centers and shopping malls are located along these major arterials.

Based on 2010 aerial photographs, approximately 90 percent of the study area is developed. As of 2006, there were approximately 24,751 residential structures, 1,860 commercial buildings, and 117 public facilities located in the study area.

## **4.4 BIOLOGICAL RESOURCES**

### **4.4.1 Vegetation**

Much of the study area has been disturbed through past channel improvement projects and urban development. Commercial and residential development or City of Houston roadway ROW extends to the edge of the existing maintained HCFCD ROW along much of the channel. As a result of urban development, the majority of the native vegetation along the channel is fragmented and/or has been replaced with invasive species and ornamental plantings.

White Oak Bayou, within the project area, is highly developed. According to the *Vegetation Types of Texas* (1984) Texas Parks and Wildlife Department ("TPWD") map, White Oak Bayou lies within the region designated as "Urban." Other than the urban land, habitat types present in the project area as of January 1, 1998 include upland pine-hardwood forest, upland hardwood forest, upland scrub-shrub, forested and herbaceous wetland communities, and grasses. Without construction of the Recommended Plan in the project area, the vegetation habitat breakdown in 2012 would not differ significantly from what was observed prior to construction. Acreage of vegetation may have been less in 2012 due to other development occurring within the project area. Table 4-2 identifies the habitat (by acreage) within the project area. The habitat is broken down by Recommended Plan components below.

**Table 4-2  
Habitat Within the White Oak Bayou Project Area  
from West Tidwell Road (Cole Creek) to FM 1960**

Habitat Classification	Total Habitat Area (acres) Baseline January 1, 1998
Emergent Wetland-Fringe	2.30
Emergent Wetland-Depressional	7.15
Forested Wetland <sup>1</sup>	8.58
Maintained Grasses	449.97
Upland Pine-Hardwood Forest	211.05
Upland Hardwood Forest	13.63
Upland Scrub-Shrub	31.58
Remnant Prairie	0.44
Aquatic <sup>2</sup>	55
<b>Total</b>	<b>779.7</b>

<sup>1</sup> The forested wetland classification includes Chinese tallow-tree (*Sapium sebiferum*) dominated scrub-shrub wetlands.

<sup>2</sup> The aquatic habitat classification includes only the stream and no vegetation.

#### **4.4.1.1 White Oak Bayou Channel**

The primary habitat types along the channel itself include maintained grasses and herbaceous wetland vegetation.

The maintained grasses primarily include Bermuda grass (*Cynodon dactylon*), Johnsongrass (*Sorghum halepense*), brown-seed paspalum (*Paspalum plicatulum*), panicgrass (*Dichanthium annulatum*), curly dock (*Rumex crispus*), and white clover (*Trifolium repens*).

Herbaceous wetland vegetation communities exist within the channel. The herbaceous wetland vegetation includes water-hyssop (*Bacopa monnieri*), horsetail (*Equisetum hyemale*), torpedograss (*Panicum repens*), alligator weed (*Alternanthera philoxeroides*), smartweed (*Polygonum hydropiperoides*), and black willow (*Salix nigra*).

#### **4.4.1.2 Jersey Village Channel**

The primary habitat types along the Jersey Village channel include maintained grasses and herbaceous wetland vegetation.

The maintained grasses primarily include Bermuda grass, Johnsongrass, brown-seed paspalum, panicgrass, curly dock, and white clover.

Typical herbaceous wetland vegetation within the channel includes cattail (*Typha* sp.), sand spikerush (*Eleocharis montevidensis*), marsh seedbox (*Ludwigia palustris*), river seedbox (*Ludwigia leptocarpa*), and marsh flatsedge (*Cyperus pseudovegetus*).

#### 4.4.1.3 Detention Basins

The primary habitat types of the land adjacent to the channel, which would be utilized as detention basins, includes upland pine-hardwood forest, upland hardwood forest, upland scrub-shrub, forested and herbaceous wetland communities, and a small area (0.44 acre) with prairie seed plantings.

The upland pine-hardwood forest and upland hardwood forest communities adjacent to White Oak Bayou are dominated by loblolly pine (*Pinus taeda*), Texas sugarberry (*Celtis laevigata*), cottonwood (*Populus deltoides*), American elm (*Ulmus americana*), water oak (*Quercus nigra*), post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), red oak (*Quercus rubra*), bastard white oak (*Quercus sinuata* var. *sinuata*), mockernut hickory (*Carya tomentosa*), green ash (*Fraxinus pennsylvanica*), Chinese tallow-tree (*Sapium sebiferum*), and yaupon (*Ilex vomitoria*).

Other vegetation occurring within the understory of the upland pine-hardwood forest community includes wax-leaf ligustrum (*Ligustrum quihoui*), Chinese privet (*Ligustrum sinense*), poison ivy (*Toxicodendron radicans*), southern dewberry (*Rubus trivialis*), saw greenbrier (*Smilax bona-nox*), common greenbrier (*Smilax rotundifolia*), trumpet creeper (*Campsis radicans*), common dayflower (*Commelina communis*), broad-leaved wood-oats (*Chasmanthium latifolium*), common ragweed (*Ambrosia artemisiifolia*), tall golden-rod (*Solidago altissima*), and Japanese honeysuckle (*Lonicera japonica*).

The upland hardwood forest typically includes trees such as black willow (*Salix nigra*), Texas sugarberry (*Celtis laevigata*), Chinese tallow-tree, hackberry (*Celtis occidentalis*), water oak, pecan (*Carya illinoensis*), boxelder (*Acer negundo*), red maple (*Acer rubrum*), sugarberry (*Celtis laevigata*), live oak (*Quercus virginiana*), yaupon, privet (*Ligustrum sinense*), and palmetto (*Sabal minor*) as well as smilax vines.

Vegetation in the upland scrub-shrub habitat type is dominated by Johnsongrass, southern carpetgrass (*Axonopus affinis*), Bahia grass (*Paspalum notatum*), dewberry (*Rubus trivialis*), Brazilian vervain (*Verbena brasiliensis*), false dandelion (*Krigia dandelion*), Carolina coral beads (*Cocculus carolinus*), goosegrass (*Galium aparine*), coreopsis (*Coreopsis tinctoria*), annual ragweed (*Ambrosia artemisiifolia*), poison ivy, rough-leaved dogwood (*Cornus drummondii*), Chinese tallow-tree, and yaupon.

The forested wetland communities, including wetland scrub-shrub, are dominated by water oak, Chinese tallow-tree, American elm, green ash, Alabama supplejack (*Berchemia scandens*), marsh seedbox, marsh flatsedge, and viscid, fragrant golden-rod (*Euthamia camporum*).

The herbaceous wetland communities are dominated by various species of rush (*Eleocharis* sp. and *Juncus* sp.), and sedge (*Cyperus* sp. and *Carex* sp.). These include soft rush (*Juncus effusus*), white-root rush (*Juncus brachycarpus*), small-fruit spikerush (*Eleocharis microcarpa*), sand spikerush (*Eleocharis montevidensis*), marsh flatsedge, chintul (*Cyperus articulatus*), and Cherokee sedge (*Carex cherokeensis*).

Based on field investigations, the remnant prairie community, including the 0.44-acre subject site, predominantly contained non-native herbaceous and woody scrub-shrub species. Emergent herbaceous species included Gulf cordgrass (*Spartina spartinae*), grass-leaf groundsel (*Senecio glabellus*), small-fruit spikerush (*Eleocharis microcarpa*), and Alabama supplejack (*Berchemia scandens*). Several herbaceous non-natives, such as coastal Bermuda (*Cynodon dactylon*), King Ranch bluestem (*Bothriochloa ischaemum*) and Paraguayan windmill grass (*Chloris canterai*), were also present. The upland scrub-shrub community contained a dominance of approximately 30 percent woody vegetation. Species within this area included eastern false-willow (*Baccharis halimifolia*), yaupon (*Ilex vomitoria*), sugar hackberry (*Celtis laevigata*) and other woody species, which are transforming the site from prairie to scrub-shrub habitat. This transformation from native prairie to mixed woods began in the late 1970s with the cessation of heavy cattle grazing. Due to its small size, isolation within an urbanized area, and continuing degradation of function and values as prairie, this remnant is not considered a significant resource.

#### **4.4.1.4 Soil Disposal**

The proposed soil disposal sites are commercial facilities within the study area. The sites are a fully-functioning landfill and a sand pit located in the study area with little vegetation.

#### **4.4.2 Wildlife**

The White Oak Bayou watershed lies within the Houston Metropolitan Area, which has been highly impacted by human activities. The degree and extent of the changes in habitat have directly influenced the numbers and species of wildlife found in the area. Indiscriminate hunting, predator control, use of pesticides, and various forms of air, water, and land pollution have been responsible for declines in wildlife resources. Wildlife that remains lives in a modified natural habitat within the immediate influence of an encroaching urban complex. The wildlife species found in the watershed are typical of those found in highly urbanized areas. In residential areas within the study area, common wildlife species tolerant of man's activities include the following terrestrial and aquatic species identified below.

A U.S. Fish and Wildlife Service ("USFWS") Coordination Act Report ("CAR") was completed in April 2002 (Appendix A). The CAR states that because much of the project area is comprised of existing channels and detention basins, habitat for wildlife is relatively poor. The vegetated and forested buffers surrounding the detention basin complexes and a relatively mature forested area located just north of W. Tidwell Road (Site 8 in the CAR) is considered medium- to high-quality habitat. These identified habitats are limited in both type and size. Subsequent coordination with the USFWS resulted in an agreement between the USFWS and HCFCD that a Planning Aid Letter ("PAL") would be prepared in lieu of updating the 2002 CAR. The PAL was sent to USACE on November 9, 2011. The PAL identifies wildlife located within the project area and makes recommendations to improve wildlife habitat as part of the proposed project. The CAR, PAL, and HCFCD's response regarding the PAL are included in Appendix A. A summary table of PAL recommendations and responses is also included in Section 5.16 Mitigation.



#### **4.4.2.1 Terrestrial Species**

Wildlife resources in the study area are limited due to extensive urban development and consist of species adapted to an urban setting where disturbance and adaptations to foraging, nesting, and loafing habitats can be made.

Typical resident species of mammals within the study area would include the eastern fox squirrel (*Sciurus niger*), eastern gray squirrel (*Sciurus carolinensis*), eastern cottontail (*Sylvilagus floridanus*), swamp rabbit (*Sylvilagus aquaticus*), common raccoon (*Procyon lotor*), beaver (*Castor canadensis*), hispid cotton rat (*Sigmodon hispidus*), deer mouse (*Peromyscus maniculatus*), white-tailed deer (*Odocoileus virginianus*), and domestic feral hog (*Sus scrofa*).

Typical resident species of amphibians and reptiles within the study area would include the northern green treefrog (*Hyla cierea*), cricket frog (*Acris crepitans*), gulf coast toad (*Bufo valliceps*), green anole (*Anolis carolinensis*), ground skink (*Scincella lateralis*), red-eared slider (*Chrysemys scripta elegans*), Texas rat snake (*Elapheobsoleta lindheimeri*), diamondback water snake (*Nerodia rhombifer rhombifer*), eastern hog-nosed snake (*Heterodon platyrhinos*), Gulf Coast ribbon snake (*Thamnophis proximus*), cottonmouth (*Agkistrodon piscivorus*), yellow-bellied water snake (*Nerodia erythrogaster*), broad-banded water snake (*Nerodia fasciata*), spiny soft-shelled turtle (*Trionyx spiniferus*), and common snapping turtle (*Chelydra serpentina*).

Typical resident species of birds within the study area would include the red-bellied woodpecker (*Melanerpes carolinus*), blue jay (*Cyanocitta cristata*), Carolina chickadee (*Poecile carolinensis*), tufted titmouse (*Baeolophus bicolor*), Carolina wren (*Thryothorus ludovicianus*), northern cardinal (*Cardinalis cardinalis*), eastern meadowlark (*Sturnella magna*), red-shouldered hawk (*Buteo jamaicensis*), red-tailed hawk (*Buteo jamaicensis*), house sparrow (*Passer domesticus*), northern mockingbird (*Mimus polyglottos*), snowy egret (*Egretta thula*), great blue heron (*Ardea herodias*), yellow-crowned night heron (*Nycticorax violaceus*), anhinga (*Anhinga anhinga*), white ibis (*Eudocimus albus*), American kestrel (*Falco sparverius*), belted kingfisher (*Ceryle alcyon*), black-necked stilt (*Himantopus mexicanus*), and wood duck (*Tringa carolinensis*).

#### **4.4.2.2 Aquatic Species**

Flow within White Oak Bayou is primarily derived from urban rainfall runoff and wastewater treatment plant effluent. As a result, White Oak Bayou generally provides a poor aquatic habitat. This low habitat value can be attributed to the sources of stream flow, fluctuating water levels, high nutrient levels and algal growth, shallow water depths, and high water temperatures.

The following species of fish were identified by the Texas Commission on Environmental Quality ("TCEQ") during White Oak Bayou field investigations: mosquito fish (*Gambusia affinis*), sailfin molly

(*Poecilia latipinna*), sheephead minnow (*Cyprinodon variegatus*), shiners (*Cyprinella* spp. and *Notropis* spp.), young green and bluegill sunfish (*Lepomis* spp.), and channel catfish (*Ictalurus punctatus*). The common plecostomus (*Hypostomus plecostomus*) was also identified during field investigations. Bordering wooded areas along the bayou also provide several indirect benefits to the fishery. Leaf litter washed into the channel and creeks is assimilated into the ecosystem. Stream bank erosion, concomitant with associated high turbidities, is also reduced by the roots of bank side vegetation.

#### **4.5 THREATENED AND ENDANGERED SPECIES**

Federal and state listed threatened and/or endangered species indigenous to Harris County include the Houston toad (*Bufo houstonensis*), the American peregrine falcon (*Falco peregrinus anatum*), Arctic peregrine falcon (*Falco peregrinus tundrius*), bald eagle (*Haliaeetus leucocephalus*), brown pelican (*Pelecanus occidentalis*), peregrine falcon (*Falco peregrinus*), red-cockaded woodpecker (*Picoides borealis*), white-faced ibis (*Plegadis chihi*), white-tailed hawk (*Buteo albicaudatus*), whooping crane (*Grus americana*), wood stork (*Mycteria americana*), creek chubsucker (*Erimyzon oblongus*), smalltooth sawfish (*Pristis pectinata*), Louisiana black bear (*Ursus americanus luteolus*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), red wolf (*Canis rufus*), Louisiana pigtoe (*Pleurobema riddellii*), sandbank pocketbook (*Lampsilis satura*), Texas pigtoe (*Fusconaia askewi*), alligator snapping turtle (*Macrochelys temminckii*), green sea turtle (*Chelonia mydas*), Kemp's Ridley sea turtle (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), smooth green snake (*Liochlorophis vernalis*), Texas horned lizard (*Phrynosoma cornutum*), timber/rattlesnake (*Crotalus horridus*), and Texas prairie dawn-flower (*Hymenoxys texana*).

The most recent (March 31, 2011) USFWS list for federal species in Harris County and the most recent (February 28, 2011) TPWD list for state species in Harris County were used for the threatened and endangered species surveys. Site visits to the project area have been conducted between 1998 and 2012. Texas prairie dawn-flower was the only threatened or endangered species or species of concern ("SOC") ever observed during on-site surveys. Detailed information on the Texas prairie dawn-flower is described below and in the Biological Assessment ("BA") located in Appendix B. The federal and state listed threatened and endangered species and SOC for Harris County are provided in Table 4-3. The bald eagle and brown pelican are on the list due to their state status listing. Locations of the previously identified Texas prairie dawn-flower populations and potential habitat within the project area are identified in Exhibit 4-1.

**Table 4-3  
Federal/State Listed Threatened/Endangered Species in Harris County, Texas**

<b>Species</b>	<b>Scientific Name</b>	<b>USFWS Federal Status</b>	<b>TPWD State Status</b>	<b>Habitat</b>	<b>Habitat Present within Project Area</b>
<b>Amphibians</b>					
Houston toad	<i>Anaxyrus houstonensis</i>	LE	E	Sandy soil, breeds in ephemeral pools	No
<b>Fishes</b>					
American eel	<i>Anguilla rostrata</i>			Most aquatic habitats with access to ocean	No
Creek chubsucker	<i>Erimyzon oblongus</i>		T	Variety of small rivers and creeks, prefers headwaters	No
Smalltooth sawfish	<i>Pristis pectinata</i>	LE	E	Variety of salinity regimes, temperatures and water depths	No
<b>Birds</b>					
American peregrine falcon	<i>Falco peregrinus anatum</i>	DL	T	Potential migrant	No
Arctic peregrine falcon	<i>Falco peregrinus tundrius</i>	DL		Potential migrant	No
Bald eagle	<i>Haliaeetus leucocephalus</i>	DL	T	Near water areas, in tall trees	Yes
Black rail	<i>Laterallus jamaicensis</i>			Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps	No
Brown pelican	<i>Pelecanus occidentalis</i>	DL	E	Island near coastal areas	No
Henslow's sparrow	<i>Ammodramus henslowii</i>			Weedy fields with bunch grasses	No
Mountain plover	<i>Charadrius montanus</i>			Nests on high plains or shortgrass prairie	No
Peregrine falcon	<i>Falco peregrinus</i>	DL	T	Potential migrant	No
Red-cockaded woodpecker	<i>Picoides borealis</i>	LE	E	Nests in older pines (60+ years)	No
Snowy plover	<i>Charadrius alexandrinus</i>			Coast beaches and bayside mud or salt flats	No

Species	Scientific Name	USFWS Federal Status	TPWD State Status	Habitat	Habitat Present within Project Area
Southeastern snowy plover	<i>Charadrius alexandrinus tenuirostris</i>			Coast beaches and bayside mud or salt flats	No
White-faced ibis	<i>Plegadis chihi</i>		T	Freshwater marshes, but some brackish or salt marshes	No
White-tailed hawk	<i>Buteo albicaudatus</i>		T	Coastal prairies	No
Whooping crane	<i>Grus americana</i>	LE	E	Winters in Aransas NWR	Yes
Wood stork	<i>Mycteria americana</i>		T	Prairie ponds and flooded pastures	No
<b>Mammals</b>					
Louisiana black bear	<i>Ursus americanus luteolus</i>	LT	T	Bottomland hardwoods; large, undisturbed forested areas	No
Plains spotted skunk	<i>Spilogale putorius interrupta</i>			General; woods, fields, prairies, shrub	Yes
Rafinesque's big-eared bat	<i>Corynorhinus rafinesquii</i>		T	Roosts in cavity trees of bottomland hardwoods, concrete culverts, and abandoned man-made structures	Yes
Red wolf	<i>Canis rufus</i>	LE	E	Extirpated, brushy, forested areas, coastal prairies	No
Southeastern myotis bat	<i>Myotis austroriparius</i>			Roosts in cavity trees of bottomland hardwoods, concrete culverts, and abandoned man-made structures	Yes

Species	Scientific Name	USFWS Federal Status	TPWD State Status	Habitat	Habitat Present within Project Area
<b>Mollusks</b>					
Little spectaclecase	<i>Villosa lienosa</i>			Creeks, rivers, and reservoirs, sandy substrates in slight to moderate current	No
Louisiana pigtoe	<i>Pleurobema riddellii</i>		T	Streams and moderate-sized rivers, usually flowing on substrates of mud, sand, and gravel	No
Pistolgrip	<i>Tritogoniaverrucosa</i>			Stable substrate, rock, hard mud, silt, and soft bottoms	No
Rock-pocketbook	<i>Arcidens confragosus</i>			Mud, sand, and gravel substrates of medium to large rivers in standing or slow-flowing water	No
Sandbank pocketbook	<i>Lampsilis satura</i>		T	Small to large rivers with moderate flows and swift current on gravel, gravel-sand, and sand bottoms	No
Texas pigtoe	<i>Fusconaia askewi</i>		T	Rivers with mixed mud, sand, and fine gravel in protected areas associated with fallen trees or other structures	No
Wabash pigtoe	<i>Fusconaia flava</i>			Creeks to large rivers on mud, sand, and gravel from all habitats except deep, shifting sands	No
<b>Reptiles</b>					
Alligator snapping turtle	<i>Macroclmys temmincki</i>		T	Deep water of rivers and canals	Yes
Green sea turtle	<i>Chelonia mydas</i>	LT	T	Gulf and bay system	No
Gulf saltmarsh snake	<i>Nerodia clarkii</i>			Coastal bays	No
Kemp's Ridley sea turtle	<i>Lepidochelys kempii</i>	LE	E	Gulf and bay system	No
Leatherback sea turtle	<i>Dermochelys coriacea</i>	LE	E	Gulf and bay system	No
Loggerhead sea turtle	<i>Caretta caretta</i>	LT	T	Gulf and bay system	No

Species	Scientific Name	USFWS Federal Status	TPWD State Status	Habitat	Habitat Present within Project Area
Smooth green snake	<i>Liochlorophis vernalis</i>		T	Mesic coastal prairie vegetation, prefers dense vegetation	Yes
Texas horned lizard	<i>Phrynosoma cornutum</i>		T	Open, semi-arid regions with bunch grass	No
Timber/canebrake rattlesnake	<i>Crotalus horridus</i>		T	Swamps/of hardwood/pine	No
Vascular Plants					
Coastal gay-feather	<i>Liatris bracteata</i>			Prairie remnants	No
Giant sharpstem umbrella sedge	<i>Cyperus cephalanthus</i>			Coastal prairie remnants	No
Houston daisy	<i>Rayjacksonia aurea</i>			Mima mounds in coastal prairies or barren to somewhat vegetated grasslands	No
Texas meadow rue	<i>Thalictrum texanum</i>			Mesic woodlands or forests	No
Texas prairie dawn-flower	<i>Hymenoxys texana</i>	LE	E	Poorly drained areas in open grasslands; pimple mounds	No*
Texas windmill-grass	<i>Chloris texensis</i>			Open to barren areas in prairies and grasslands	No
Threeflower broomweed	<i>Thurovia triflora</i>			Remnant grasslands and tidal flats	No

\*During the April 2011 survey performed by Dr. Larry Brown, it was documented that the population present in the FNH.3 detention basin site last recorded in 2002, no longer existed. The disappearance was not due to any impact from the project. No other suitable habitat or populations have been identified within the project area.

LE, LT - Federally Listed Endangered/Threatened

P/E, P/T - Federally Proposed Endangered/Threatened

E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance

DL - De-Listed

C1 - Federal Candidate, Category 1, information supports proposing to list as endangered/threatened

E, T - State Endangered/Threatened

"blank" - under State Status, Rare, but with no regulatory listing status

"blank" - under Federal Status, not listed by USFWS.

*Species appearing on these lists do not all share the same probability of occurrence. Some species are migrants or wintering residents only, or may be historic or considered extirpated.*

Based on field surveys, aerial photographs and research review of threatened and endangered species or SOC, the project area has been altered and is highly urbanized and lacks the suitable habitat to support a resident population of bald eagles (*Haliaeetus leucocephalus*), whooping crane (*Grus americana*), and plains spotted skunk (*Spilogale putorius interrupta*). The project area may be considered a temporary layover for these species; however, no effect is anticipated to these species from the proposed project.

Rafinesque's big-eared bat (*Corynorhinus rafinesquei*) and southeastern myotis bat (*Myotis austroriparius*) are known to roost within abandoned buildings, under bridges, and in the cavities of trees. These bats are associated with deciduous forest, pine, and hardwood forest habitat. No known occurrence of these bats has been recorded within the project area and none were identified during the site visits. Therefore, no effect is anticipated to these species from the proposed project.

The alligator snapping turtles (*Macrolemys temmincki*) habitat consists of slow-moving, deep water of rivers, sloughs, oxbows, canals, and lakes. Alligator snapping turtles occur under or in log jams, beneath undercut banks, under rock shelters, or in deep holes. These turtles are highly aquatic and rarely are found out of the water, except during nesting (TPWD, 2012). Nesting is associated with sand mounds along the river banks to sandbars within the stream. The project area lacks the suitable nesting habitat to support a resident population of alligator snapping turtles; therefore, no effect is anticipated to these turtles from the proposed project.

The smooth green snake (*Phrynosoma cornutum*) has been found near sea level in habitats described as open shortgrass prairie or meadows. Only ten specimens have been collected in Austin, Chambers, Harris, and Matagorda counties (Werler and Dixon, 2000). No known occurrence of this snake has been recorded within the project area and none were identified during the site visits. Therefore, no effect is anticipated to this snake from the proposed project.

No federal or state listed threatened or endangered species or SOC were observed within the project area with the exception of Texas prairie dawn-flower (*Hymenoxys texana*).

Field investigations for Texas prairie dawn-flower were conducted within the project area by Dr. Larry E. Brown between April 1998 and October 2011. Texas prairie dawn-flower populations that have been discovered and documented within the project area are described below.

In 1998, one area with associated species and potential habitat was first located by Dr. Larry Brown, plant taxonomist, within the Hollister Road (HOL.3B-south) detention basin (Brown, 1998). See Exhibit 4-1 for the location of this area. Subsequent surveys in 2002 and 2011 confirmed the potential habitat area still exists (Brown, 2002a and 2011c). However, this potential habitat area located within the Hollister Road detention basin was determined by Dr. Brown to have a low probability of occurrence due to lack of a seed source. Since monitoring began in 1998, the Texas prairie dawn-flower has never been observed at this area. The Texas prairie dawn-flower potential habitat area located within the Hollister Road

detention basin was avoided during project design. Short-term impacts occurred within the area during implementation of local project construction. However, construction is complete and, as stated, the area was confirmed to persist.

In 2002, one colony of Texas prairie dawn-flower was found by Dr. Brown within the Fairbanks-North Houston Road (FNH.3) detention basin (Brown, 2002b). However, during the latest site visits to this area in April and July 2011 and April 2012, the site no longer contained Texas prairie dawn-flower or suitable habitat (Brown, 2011a and 2011b). Per Dr. Brown's survey report (2011a), the site had become too densely-vegetated to sustain Texas prairie dawn-flower species as of 2006. Per guidance from USFWS, since the *Hymenoxys texana* location has been absent for more than five years, the habitat is no longer considered suitable existing habitat (see record of communication in Appendix A of the Biological Assessment). Therefore, the suitable habitat at this basin no longer exists, but has the potential to be restored. The disappearance was not due to any impact associated with the project activities. See Exhibit 4-1 for the approximate location of this previous habitat area.

No other populations or suitable habitat areas were determined to exist within the project area.

Coordination with USFWS and TPWD is provided in Appendix C. Coordination with Dr. Larry Brown is on file at HCFCFCD.

## **4.6 FLOODPLAINS, DRAINAGE, AND WATER QUALITY**

### **4.6.1 Floodplains**

The calibrated FEMA floodplain boundaries are used to illustrate the existing 100- and 500-year floodplain within the White Oak Bayou study area. The 500-year floodplain is identified in Exhibit 1-1. The FEMA maps for the study area are 48201C0690L, 48201C0670L, 48201C0665L, 48201C0655L, 48201C0465L, 48201C0445L, 48201C0635L, 48201C440L, and 48201C0420L.

### **4.6.2 Drainage**

The White Oak Bayou study area occupies flat, poorly drained terrain at about 116 feet above sea level at FM 1960, descending to about 75 feet above sea level at Cole Creek. White Oak Bayou and its tributaries are part of the San Jacinto River drainage system. White Oak Bayou flows southeast into Buffalo Bayou, which joins the San Jacinto River. These streams ultimately drain into Galveston Bay southeast of the project area. Natural streams within the study area include:

1. Little White Oak Bayou (E101-00-00), which enters from the north near stream mile 1.3, at Quitman Street; drains approximately 21.45 square miles.
2. Brickhouse Gully (E115-10-00), which enters from the east near stream mile 8.8, 1 mile upstream of 34th Street; drains approximately 11.76 square miles.



3. Cole Creek (E117-00-00), which enters from the west near stream mile 10.6 (south of West Tidwell Road); drains approximately 9.53 square miles.
4. Vogel Creek (E121-00-00), which enters from the north near stream mile 12.1, at West Little York Road; drains approximately 8.79 square miles.
5. Rolling Fork Creek (E125-00-00), which enters from the north near stream mile 17.1, 1 mile upstream of Fairbanks-North Houston Road; drains approximately 3.12 square miles.

### **4.6.3 Water Quality**

According to the TCEQ, the White Oak Bayou watershed is part of the San Jacinto River Basin Segment Number 1017 (White Oak Bayou above Tidal). According to the 2008 Texas Water Quality Inventory, Segment Number 1017 is a freshwater stream encompassing 23 miles, from a point immediately upstream of the confluence of Little White Oak Bayou in Harris County to a point 3.0 kilometers (1.9 miles) upstream of FM 1960. No fish kills are identified in the 2008 Texas Water Quality Inventory.

#### **TCEQ Segment Number 1017**

This segment does not meet the assigned water quality standards for bacteria, and elevated levels of ammonia, nitrite, orthophosphorus, and total phosphorus have also been identified. Waterbody uses include aquatic life use, general use, and recreation use; however, recreation use is not supported. No concerns were identified for aquatic life use; however, general use had identified concerns, including nutrient screening levels for ammonia, nitrate, orthophosphorus, and total phosphorus. According to the TCEQ, swimming and wading is called contact recreation in the state's standards for water quality, referring to all recreation in which people come in direct contact with the water. Elevated fecal coliform and E. coli bacteria levels cause non-support of the recreation use. This segment is affected by urban stormwater runoff and numerous municipal point source discharges.

As described above, water quality in White Oak Bayou and its tributaries is generally poor. The water quality is representative of an urbanized basin in which the streamflow consists primarily of effluent from 41 active wastewater treatment plants within the study area, wastewater discharges from 10 domestic facilities and 31 industrial facilities, and urbanization located along the channel. Non-point source pollutants, such as stormwater runoff from roadways, runoff from other creeks within the watershed, and fertilizer, pesticide, and herbicide use in the area, are also representative of the watershed. These point source and non-point source pollutants contribute to excess nutrients, elevated fecal coliform counts, and reduced dissolved oxygen concentrations within the watershed, which ultimately result in water quality degradation.

Currently, the TCEQ is studying improvement of the water quality in the Houston area. Specifically, due to elevated bacteria levels, the TCEQ initiated a total maximum daily load ("TMDL") project in 2001 to determine the measures necessary to support recreational uses in the Buffalo and White Oak Bayou watersheds. According to the TMDL project report, Buffalo Bayou (Segments 1013 and 1014) and White

Oak Bayou (Segment 1017) are considered impaired water bodies for contact recreation because they do not meet pathogen water quality standards. As a result, the two bayous were placed on the Texas Clean Water Act 303(d) List in 1996 and are listed on the 2008 and draft 2010 Texas 303(d) list. The goal of a TMDL project is to determine the amount (or load) of a pollutant that a body of water can receive and still support its designated uses. The load is then allocated among all the potential sources of pollution within the watershed, and measures to reduce pollutant loads are developed as necessary.

According to TCEQ TMDL programs personnel, there are 149 wastewater treatment plants along Buffalo and White Oak Bayous. The TMDL project is to make efforts to ensure the plants are operating efficiently and effectively. On April 8, 2009, the TCEQ adopted TMDLs for Buffalo and White Oak Bayous. The EPA approved the TMDLs on June 11, 2009, at which time the TMDLs became part of the State's Water Quality Management Plan.

HCFCFCD will continue expanding upon the current stormwater management programs through the Joint Task Force (JTF) Permit. The TCEQ "planned" TMDL project is to make efforts to ensure the wastewater treatment plants along White Oak Bayou are operating efficiently and effectively. The Recommended Plan will have no effect on wastewater treatment plants; therefore, the Recommended Plan and currently approved EPA TMDL implementation plan are in agreement. A Section 404(b)(1) application has been prepared for water quality certification and is included in Appendix D. The water quality certification was received from the TCEQ on May 24, 2013.

## **4.7 AQUATIC ENVIRONMENT**

### **4.7.1 Streams**

As noted previously, five natural streams are located within the study area from the confluence of Buffalo and White Oak Bayous to Huffmeister Road. Of these streams, Little White Oak Bayou, Cole Creek, Vogel Creek and Rolling Fork Creek are located within the project area. The entire watershed, including the project area, is very urbanized and the streams are channelized.

In addition to the above-mentioned streams, a 379-linear-foot natural stream channel that drains into drainage channel E130-00-00 is located north of the Jones Road detention basin, JR.4-east. Also, 0.07 acre of the Jersey Village channel, E200-00-00, contains flows from White Oak Bayou below the OHWM.

### **4.7.2 Wetlands**

#### **Determinations**

Recent USGS topographic survey maps, National Wetland Inventory ("NWI") maps, and aerial photography were reviewed in order to identify and evaluate wetlands within the project area. Additionally, on-site wetland determinations were conducted throughout the project area between 2004

and 2007. Conditions in 2011, should no construction have occurred within the project area by HCFCD, would not be expected to differ significantly compared to what was observed between 2004 and 2007. Some wetlands may have been impacted or filled by other construction projects. Section 404 (b) evaluations are provided in Appendix D.

No wetland determinations were conducted within Brickhouse Gully or Little White Oak Bayou, as these streams are downstream of Cole Creek and not part of the Recommended Plan. No wetland determinations were conducted within Cole, Vogel, or Rolling Fork Creeks, as these creeks are not a part of the Recommended Plan and only intersect with White Oak Bayou in the Recommended Plan. No distinction was made between isolated and/or adjacent or jurisdictional and/or non-jurisdictional wetlands.

Habitat evaluation procedures ("HEP") modeling, developed by the USFWS, was conducted to determine the habitat quality and to help quantify any impacts to the wetlands within the project area. The habitat quality is expressed in habitat units ("HU"). The first step in the HEP analysis is the baseline assessment, which is based on January 1, 1998, conditions. The baseline assessment describes the habitat conditions in terms of HU's for the project area. The following species' Habitat Suitability Indices ("HSI's") were used to determine HU's based on habitat conditions present during baseline assessments: downy woodpecker, barred owl, swamp rabbit, eastern gray squirrel, yellow warbler, American woodcock (wintering), and great egret. All HEP models used in this evaluation were appropriate for the project area, are approved models by the USFWS, and were not modified. The next step involves projecting future habitat conditions in terms of HU's and comparing the future habitat conditions with the proposed action to the future habitat conditions without the proposed action. The impact of the proposed action is equal to the difference between the future "without project" HU's and the future "with project" HU's. The quantitative project impact value is then used to determine the mitigation acreage required to compensate for the wetland habitat lost as a result of the proposed action.

Table 4-4 identifies the wetland habitat classification, total wetland habitat area, and the wetland habitat quality in HU's. The results of the analysis are discussed below. Impacts to wetlands and wetland habitat quality are discussed in Chapter 5, Section 5.6.2. Mitigation of wetland impacts are discussed in Chapter 5, Section 5.16.2 and are located in Appendix E - Wetland Cost Effective and Incremental Cost Analysis ("CE/ICA").

**Table 4-4**  
**Wetland Habitat and Quality within the Project Area**  
**from Cole Creek (South of West Tidwell Road) to FM 1960**

<b>Habitat Classification</b>	<b>Total Wetland Area Within Site (Acres)</b>	<b>Wetland Habitat Quality in Habitat Units</b>
<b>Emergent Wetland-Fringe</b> Located within the White Oak Bayou Channel Modifications E100-00-00	<b>2.30</b>	<b>0.64</b>
<b>Emergent Wetland-Depressional</b> Located within Detention Basins:		
Fairbanks-North Houston Road-North FNH.3/E500-01-00	1.70	
Fairbanks-North Houston Road-South FNH.3/E500-02-00	4.70	
Gessner-Beltway 8-South GBW.3/E500-10-00	0.75	
<b>Total Emergent Wetland Depressional</b>	<b>7.15</b>	<b>5.36</b>
<b>Forested Wetland, including Scrub-Shrub</b> Located within Detention Basins:		
Hollister Road HOL.3B/E500-03-00	2.76	
Fairbanks-North Houston Road-North FNH.2/E500-01-00	0.50	
Fairbanks-North Houston Road-South FNH.2/E500-02-00	3.00	
Gessner-Beltway 8-North GBW.3/E500-10-00	2.25	
Jones Road-East JR.4/E500-11-00	0.07	
<b>Total Forested Wetland, including Scrub-Shrub</b>	<b>8.58</b>	<b>7.51</b>
<b>Total Wetlands</b>	<b>18.03</b>	<b>13.51</b>

#### **4.7.2.1 White Oak Bayou Channel Modifications**

On-site wetland determinations were conducted along White Oak Bayou from Cole Creek to FM 1960, approximately 12 miles in length and 249 acres. The wetland determinations resulted in scattered and fringe wetlands located within and along both banks of the bayou totaling 2.3 acres. The HEP analysis resulted in 0.64 HU's for emergent fringe wetlands.

#### **4.7.2.2 Jersey Village Channel**

On-site wetland determinations were conducted along the Jersey Village channel along the existing HCFCD drainage channel E141-00-00 (west of Gessner Drive) and the existing HCFCD drainage channel

E200-00-00 (in Jersey Village), which combined is approximately 2.9 miles in length and 24 acres. The Jersey Village channel is a man-made drainage channel excavated from uplands between 1989 and 1994. The E200-00-00 portion of the Jersey Village channel has no normal flow from White Oak Bayou; it only has flow from high flood events. Additionally, the channels that drain into the E200-00-00 portion of the Jersey Village channel are also man-made. The E141-00-00 portion of the Jersey Village channel contains an OHWL and backflow from White Oak Bayou.

#### **4.7.2.3 Detention Basins**

On-site wetland determinations were conducted within the four detention basin complexes, totaling 353 acres. The wetland determinations resulted in emergent and forested wetlands located within the basins, totaling 15.73 acres—7.15 acres of emergent wetlands and 8.58 acres of forested wetlands. The location of the 15.73 acres is provided in Table 4-4 above. The HEP analysis resulted in 5.36 HU's for emergent wetlands within the detention basins and 7.51 HU's for forested wetlands, including scrub-shrub, within the detention basins.

#### **4.7.2.4 Soil Disposal**

Any excavated soil would be disposed of in the pre-specified landfill and/or sand pit. These soil disposal sites were not identified to contain any wetlands or any other significant resource.

#### **4.7.3 Navigable Waters**

Section 9 of the Rivers and Harbors Act of 1899 prohibits the construction or modification of any bridge or causeway across a navigable waterway of the U.S. without approval from the U.S. Coast Guard ("USCG"). Coordination with the USCG was initiated on February 5, 2002, and again on April 15, 2002, for potential bridge replacements/located downstream of IH 610. These bridge replacements/have since been eliminated from further consideration for this study and are being evaluated as part of a current federal study of Buffalo Bayou being undertaken by HCFCD. However, the USCG responded in letters dated February 8, 2002, and April 19, 2002, respectively. According to the USCG, White Oak Bayou is considered a navigable waterway within the study area. Since the location of White Oak Bayou is in the USCG advance approval category for the construction of bridges pursuant to 33 CFR 115.70, a specific USCG bridge permit would not be required for the proposed action if bridge modifications were proposed. Coordination letters are located in Appendix C.

#### **4.7.4 Wild and Scenic Rivers**

There are no rivers or river segments listed on the U.S. Department of Interior's National Inventory of River Segments in the National Wild and Scenic River System in the vicinity of the study area.

#### **4.7.5 Coastal Consistency**

The study area is not within the boundaries of the Coastal Zone Management Plan; therefore, coordination with the Coastal Coordination Council is not required for the proposed action.

#### **4.7.6 Coastal Barriers**

There are no coastal barriers within the study area.

### **4.8 CULTURAL RESOURCES**

Section 106 of the National Historic Preservation Act of 1966, as amended, requires that federal agencies take into account the effect an undertaking would have on historic properties. Historic properties includes historic or prehistoric archaeological sites as well as historic cultural resources, such as buildings, structures, objects, sites, and districts included in or eligible for inclusion in the NRHP. In accordance with the Advisory Council on Historic Preservation ("ACHP") regulations pertaining to the protection of historic properties (36 CFR 800.4), federal agencies are required to identify and evaluate such properties. If historic properties are determined eligible through consultation with the State Historic Preservation Officer ("SHPO"), then consultation would continue regarding the project's potential to affect sites of significance. Identification of historic cultural resources has been undertaken for this project in accordance with the Secretary of the Interior's Standards for Archaeology and Historic Preservation (48FR 44716). Additionally, a Programmatic Agreement ("PA") has been prepared and signed between USACE, HCFCD, and the SHPO (see Appendix G). The PA addresses archeological and historical resources to ensure that the most recent guidance, policies and interpretation are utilized.

#### **4.8.1 Archeological Resources**

##### **4.8.1.1 Results of Archival Research and Records Review**

An intensive archival search was conducted to identify previously-recorded archeological sites, historical sites, and potential sites within the project area to meet the requirements of Section 106 of the National Historic Preservation Act of 1966 and other relevant cultural resources guidelines and regulations applicable to this particular project. Historic properties are those buildings, structures, objects, sites, and districts included in or eligible for inclusion in the NRHP. In accordance with the Advisory Council on Historic Preservation ("ACHP") regulations pertaining to the protection of historic properties (36 CFR 800.4), federal agencies are required to identify and evaluate such properties. If historic properties are determined eligible through consultation with the State Historic Preservation Officer ("SHPO"), then consultation would continue regarding the project's potential to affect sites of significance.

Identification of historic properties has been undertaken for this project in accordance with the Secretary of the Interior's Standards for Archaeology and Historic Preservation (48 CFR 44716). This effort focused on the identification of extant properties listed or eligible for NRHP listing. To accomplish this task of identifying previously-recorded archaeological sites, historical sites, and potential sites within the project area, the site records on file at TARL were reviewed. The records at the Texas Historical Commission ("THC") were also consulted. Additionally, readily available historic USGS 7.5-minute topographic quadrangle maps were also reviewed to identify any potential sites. Field investigations were also conducted within the project area. Detailed results of these investigations are included in Appendix G. Table 4-5 summarizes the findings of the archival research, and records review per Recommended Plan component.

**Table 4-5**  
**Results of Archival Research and Records Review by Recommended Plan Component**

Component	Results	Future Recommendations
White Oak Bayou Channel Modification From Cole Creek to FM 1960	37 previously-recorded sites; however, all are presumed destroyed.	Qualified archeologist should monitor all future construction between Cole Creek and West Road involving surface disturbance deeper than 75 centimeters.
Jersey Village Channel Modification E200-00-00 and E141-00-00	No potentially significant archeological deposits encountered.	None.
Detention Basin Hollister Road E500-03-00	4 previously-recorded sites; however, all are presumed destroyed.	THC has requested that they be contacted if any plans for ground disturbances are made or the placement of fill is planned for the northern buffer zone and/or the vegetated areas not currently included in the design plans.
Detention Basin Fairbanks-North Houston Road E500-01-00 and E500-02-00	No potentially significant archeological sites identified.	
Detention Basin Gessner Drive E500-10-00	No potentially significant archeological sites identified; however, right-of-entry was not granted for entire basin.	Further testing recommended once right-of-entry is obtained.
Detention Basin Jones Road E500-11-00 and E500-12-00	No potentially significant archeological deposits encountered.	None.

The THC concurred with the findings of the investigations. Copies of all THC correspondence are included in Appendix G.

#### **4.8.1.2 Summary of Archival Research and Records Review**

The following components of the project have been cleared for cultural resources: White Oak Bayou channel modifications from Cole Creek to FM 1960, Jersey Village channel modifications; the Hollister Road detention basin (HOL.3B), and the Jones Road detention basin (JR.4). However, archaeological monitoring was recommended along White Oak Bayou between Cole Creek and West Road for any surface disturbance greater than 75 centimeters. Further testing is recommended for the Gessner Drive detention basin (GBW.3) once right-of-entry is obtained.

#### **4.8.2 Historical Resources**

Section 106 of the National Historic Preservation Act of 1966, as amended, requires that federal agencies take into account the effect an undertaking would have on historic properties. Historic properties are those buildings, structures, objects, sites, and districts included in or eligible for inclusion in the NRHP. In accordance with the Advisory Council on Historic Preservation ("ACHP") regulations pertaining to the protection of historic properties (36 CFR 800.4), federal agencies are required to identify and evaluate such properties. If historic properties are determined eligible through consultation with the State Historic Preservation Officer ("SHPO"), then consultation would continue regarding the project's potential to affect sites of significance.

Identification of historic properties has been undertaken for this project in accordance with the Secretary of the Interior's Standards for Archeology and Historic Preservation (48FR 44716). This effort focused on the identification of extant properties listed or eligible for NRHP listing. In accordance with the Secretary of the Interior's Standards, a field survey of historic buildings, structures, and objects at least 50 years old was conducted within the project's Area of Potential Effects ("APE"), which is defined as the project area.

For the purposes of this assessment, properties over 50 years old within the APE (the existing ROW for the channel modifications from Cole Creek to FM 1960, the 10.81 acres of additional ROW along the channel from Cole Creek to Gessner Drive, and the actual area of the four detention basin complexes were identified in the field survey and documented.

In 2005, a historic structures survey was conducted by Anna Mod, Historic Preservationist, for White Oak Bayou from West Road to FM 1960. Results of the investigation revealed that there were no aboveground historic sites, objects, or buildings observed either during the site visit or through the research conducted of the channel within the above-referenced limits. All of the bridge crossings over the channel, the housing types on both banks, as well as the commercial and institutional buildings can be dated from the late 1950's or 1960's and later. The THC concurred with the findings on April 18, 2005.



In 2006, Joe C. Freeman, Architect, compiled a report of investigations conducted for historic structure surveys for White Oak Bayou from Cole Creek to West Road. The investigations were conducted in December 2000, January 2001, and June 2006. The investigations included the existing ROW of the White Oak Bayou channel from Cole Creek to West Road, the 10.81 acres of additional ROW required from Cole Creek to Gessner Drive, and the four detention basin complexes. The findings concluded that no additional work is necessary in the project area prior to construction. Hazardous, Toxic, and Radioactive Waste

A Hazardous, Toxic, and Radioactive Waste ("HTRW") Assessment of the project area was performed to identify potential environmental impacts, to evaluate current conditions, and to provide a report of findings and recommendations. This HTRW Assessment was conducted in general accordance with procedures described in the USACE Document ER 1185-2-132, Water Resources Policies and Authorities - Hazardous, Toxic, and Radioactive Waste Guidance for Civil Works Projects (USACE, 1992), including standards set by the American Society for Testing and Materials E 1527-05 ("ASTM"). The objective of this HTRW Assessment is to identify the existence of (and potential for) HTRW contamination of lands in the project area, or external contamination, that could impact or be impacted by the proposed action.

The findings and recommendations presented in the HTRW Assessment are based on a regulatory agency database review conducted by ESA Specialists of America in 2005. The HTRW report is on file at HCFCD. A site visit to the project area in 2011 did not identify any additional hazardous material sites. Table 4-6 below summarizes the HTRW by component.

**Table 4-6  
Potential Impacts from Hazardous, Toxic, and Radioactive Waste (HTRW) Sites**

<b>Component/ Identification Number (Listing Agency)</b>	<b>UST (TCEQ)</b>	<b>LUST (TCEQ)</b>	<b>RCRIS Generators (EPA)</b>	<b>VCP (TCEQ)</b>	<b>AIRS (TCEQ)</b>	<b>FINDS (EPA)</b>	<b>IHW (TCEQ)</b>	<b>Hazardous Materials Risk</b>
Earthen Channel TG.2A1/E100-00-00 W. Tidwell Road to FM 1960 (¼-mile radius)	38	18	23	4	1	22	11	Moderate risk of groundwater impacts
Jersey Village Channel GE200.7A E200-00-00 and E141-00-00 (¼- to ½-mile radius)	2	1	1	0	0	0	0	Low risk of groundwater impacts
Detention Basin Hollister Road HOL.3B/E500-03-00 (¼-mile radius)	4	2	5	1	0	0	0	Low risk of groundwater impacts

<b>Component/ Identification Number (Listing Agency)</b>	<b>UST (TCEQ)</b>	<b>LUST (TCEQ)</b>	<b>RCRIS Generators (EPA)</b>	<b>VCP (TCEQ)</b>	<b>AIRS (TCEQ)</b>	<b>FINDS (EPA)</b>	<b>IHW (TCEQ)</b>	<b>Hazardous Materials Risk</b>
Detention Basin Fairbanks-North Houston Road - FNH.3 E500-01-00 and E500-02-00 (¼-mile radius)	2	1	3	1	0	4	1	Moderate risk of groundwater impacts
Detention Basin Gessner/Beltway 8 GBW.3/E500-10-00 (¼-mile radius)	4	1	1	0	0	1	0	Low to Moderate risk of groundwater impacts
Detention Basin Jones Road - JR.4 E500-11-00 and E500-12-00 (¼-mile radius)	5	1	2	1	1	1	0	High risk of soil and groundwater impacts

Source: ESA Specialists of America, Inc.

### 4.8.3 Summary of HTRW Records Review

Within a varying radii of 1/4 mile to 1-mile from the project area, the HTRW assessment identified 55 Underground Storage Tank ("UST") sites, 24 Leaking Underground Storage Tank ("LUST") sites, 35 Resource Conservation and Recovery Act ("RCRA") sites, seven Voluntary Cleanup Program ("VCP") sites, two Current Emission Inventory Data ("AIRS") sites, 28 Facility Index System ("FINDS") sites, and 12 Industrial Hazardous Waste ("IHW") sites.

The following HTRW sites of concern are located within the project area and are identified on Exhibit 4-1.

Two LUST sites located between West Tidwell Drive and Gessner Drive may present an environmental concern to the area based on their distance from the area and the presence of groundwater contamination. The two sites are a Shell Fuel Facility and a Chevron gas station (Handi Plus). Based on the 2011 site visit, the Chevron gas station is now a Citgo gas station.

One VCP site (Pilgrim Cleaners) located between Gessner Drive and FM 1960 presents an environmental concern based on its distance from the project area and the presence of groundwater contamination. A file review to determine the extent of the soil contamination, depth to groundwater, groundwater gradient, and plume size was conducted in April 2006. The file review concluded that a Limited Phase II would be necessary to determine if any subsurface impacts from the VCP site are present. A Limited Phase II investigation was conducted on July 20, 2006, and a subsequent investigation was conducted in August

2006. The investigation concluded that the excavation depths planned at the Jones Road detention basin are located above the impacted groundwater. The investigation indicated a small rate of infiltration between the groundwater and the basin. Based on sampling and analysis coordinated with the TCEQ, there is no expectation that contaminated groundwater will impact the basin.

One LUST site (Diamond Shamrock-Little Buddy gas station) may present an environmental concern based on its distance from the Fairbanks-North Houston Detention Basin and the presence of groundwater contamination.

#### 4.9 AIR QUALITY

The study area is located within the Metropolitan Planning Area Boundary for the Houston-Galveston Area Metropolitan Planning Organization (Houston-Galveston Area Council ["H-GAC"]). The eight counties (Brazoria, Chambers, Fort Bend, Galveston, Harris, Liberty, Montgomery, and Waller) within this boundary are in attainment for all National Ambient Air Quality Standards ("NAAQS") criteria pollutants except ozone, for which these counties are designated as being in moderate non-attainment. The NAAQS set by the EPA are provided in Table 4-7.

**Table 4-7  
National Ambient Air Quality Standards (EPA, 2011)**

Pollutant	Primary Standards		Secondary Standards		Notes
	Averaging Time	Level <sup>a</sup>	Averaging Time	Level <sup>b</sup>	
Carbon Monoxide (CO)	8-Hour	9 ppm (10 mg/m <sup>3</sup> )	None	None	Not to be exceeded more than once per year.
	1-Hour	35 ppm (40 mg/m <sup>3</sup> )	None	None	Not to be exceeded more than once per year.
Lead (Pb)	Rolling 3-Month Average	0.15 µg/m <sup>3</sup>	Rolling 3-Month Average	0.15 µg/m <sup>3</sup>	
Nitrogen Dioxide (NO <sub>2</sub> )	Annual (Arithmetic Mean) <sup>c</sup>	0.053 ppm (53 ppb) (100 µg/m <sup>3</sup> )	Annual (Arithmetic Mean) <sup>c</sup>	0.053 ppm (53 ppb) (100 µg/m <sup>3</sup> )	
	1-hour	100 ppb	None	None	
Particulate Matter (PM <sub>10</sub> ) <sup>d</sup>	24-Hour	150 µg/m <sup>3</sup>	24-hour	150 µg/m <sup>3</sup>	Not to be exceeded more than once per year on average over 3 years.
Particulate Matter (PM <sub>2.5</sub> ) <sup>e</sup>	Annual (Arithmetic Mean) <sup>c</sup>	15.0 µg/m <sup>3</sup>	Annual (Arithmetic Mean) <sup>c</sup>	15.0 µg/m <sup>3</sup>	To attain this standard, the 3-year average of the weighted annual mean PM <sub>2.5</sub> concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m <sup>3</sup> .

Pollutant	Primary Standards		Secondary Standards		Notes
	Averaging Time	Level <sup>a</sup>	Averaging Time	Level <sup>b</sup>	
	24-Hour	35 µg/m <sup>3</sup>	24-Hour	35 µg/m <sup>3</sup>	To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m <sup>3</sup> .
Ozone	8-Hour	0.08 ppm (85 ppb)	8-hour	0.08 ppm (85 ppb)	To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
	8-hour	0.075 ppm (75 ppb)	8-hour	0.075 ppm (75 ppb)	
	1-hour	0.12 ppm (120 ppb)	1-hour	0.12 ppm (120 ppb)	
Sulfur Dioxide (SO <sub>2</sub> )	Annual (Arithmetic Mean) <sup>c</sup>	0.03 ppm (35 ppb)	3-hour	0.5 ppm	
	24-Hour	0.14 ppm (145 ppb)	3-hour	0.5 ppm	Not to be exceeded more than once per year.
	1-Hour	0.075 ppm (75 ppb)	None	None	Not to be exceeded more than once per year.

- a The levels of air quality necessary, with an adequate margin of safety, to protect the public health.
  - b The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects.
  - c Arithmetic means is the most common measure of the central tendency. It is the sum of the data collected during the given period divided by the number of observations in the same period.
  - d PM<sub>10</sub> = Particles with an aerodynamic diameter less than or equal to 10 micrometers and greater than 2.5 micrometers. The EPA changed this pollutant from total suspended particulates ("TSP") on July 1, 1987.
  - e PM<sub>2.5</sub> = Particles with an aerodynamic diameter less than or equal to 2.5 micrometers.
- ppm = parts per million  
ppb = parts per billion  
mg/m<sup>3</sup> = milligrams per cubic meter  
ug/m<sup>3</sup> = micrograms per cubic meter

The EPA established the General Conformity Rule in Title I, Section 176, of the Clean Air Act ("CAA"). The regulatory citations for the General Conformity Rule can be found in Title 40 of the CFR Part 51, Subpart W, and in Title 30 of the Texas Administrative Code ("TAC") 101.30. These rules mandate that the federal government not engage, support, provide financial assistance for licensing or permitting, or approve any activity not conforming to an approved CAA implementation plan in coordination with and as part of the NEPA process.

The General Conformity Rule applies to all federal actions except programs and projects requiring funding or approval from the U.S. Department of Transportation ("USDOT"), the FHWA, the Federal Transit Administration ("FTA"), or a Metropolitan Planning Organization. The Recommended Plan is a federal action to which the General Conformity Rule applies. In Harris County, Texas, the current approved CAA implementation plan is the *Revisions to the State Implementation Plan for the Control of Ozone Air Pollution, Houston-Galveston-Brazoria ("HGB") Eight-Hour Ozone Nonattainment Area* dated September 23, 2009. The Houston-Galveston area is categorized as a moderate non-attainment area for ozone.

#### **4.10 AMBIENT NOISE LEVELS**

Noise is identified as "unwanted sound." Noise emanates from many different sources, such as transportation noise, industrial noise, construction noise, household noise, and people and animal noise. In the past, the EPA coordinated all federal noise control activities through its Office of Noise Abatement and Control. However, in 1981, the Administration at that time concluded that noise issues were best handled at the state or local government level. As a result, the EPA phased out the office's funding in 1982 as part of a shift in federal noise control policy to transfer the primary responsibility of regulating noise to state and local governments. However, the Noise Control Act of 1972 and the Quiet Communities Act of 1978 were not rescinded by Congress and remain in effect today, although essentially unfunded.

The majority of the proposed action is paralleled by existing roadways with adjacent residential communities and commercial areas at major intersections. Therefore, traffic noise is the major contributor to ambient noise levels in the study area. The EPA's *Protective Noise Levels* document identifies that for most urban dwellers (roughly 135 million people, more than half the U.S. population) 87 percent live in areas of day-night sound levels ("Ldn") of 48 and higher from traffic noise alone.

The FHWA *Highway Construction Noise: Measurement, Prediction, and Mitigation* states that criteria for evaluating construction noise have not been developed. Therefore, users of their manual should select criteria considering the following factors:

- The difference between the existing noise environment and the expected construction noise levels
- The absolute level of expected construction noise
- Adjacent land uses
- The duration of construction

The EPA lists typical construction site equipment sound levels including those that would be associated with earth-moving and construction activities for the White Oak Bayou project. Table 4-8 below presents a partial list of equipment possibly used for channel and detention basin excavation. The equipment sound levels listed in Table 4-8 appear to be above those of ambient noise levels. However, after

adjustment for distance, attenuation, length of exposure, and corresponding indoor noise levels, the actual sound levels would be lower.

**Table 4-8  
Typical Construction Site Equipment Sound Levels (in DBA)**

<b>Type of Construction Equipment</b>	<b>Typical Sound Level at 50 Feet</b>
Pile Driver	101
Truck	88
Dozer	87
Paver	89
Scraper	88
Backhoe	85
Pneumatic Tool	85
Mobile Crane	83

Source: ORI (1980) Construction Noise Control Technology Initiatives Task Report.  
Prepared for the EPA Office of Noise Abatement and Control.

## **4.11 SOCIAL AND ECONOMIC ANALYSIS**

### **4.11.1 Social**

Since the environmental baseline date is January 1, 1998, construction began after this date, and the study area was over 90 percent developed before the 2000 Census, data from the 2000 Census was used to determine the social and economic impacts. No updated census data have been provided because current population and development conditions are very similar to year 2000 conditions. The impacts to populations at the time of construction are best represented by the 2000 Census data. The population of Harris County, based on Year 2000 U.S. Department of Commerce, Bureau of the Census (2000 Census), is 3,400,578 individuals. A diverse population, with respect to race, age, and income level, lives and work in Harris County where ethnic minorities comprise 57.8 percent of the population. According to the 2000 Census, the median household income for Harris County is \$42,598.

The White Oak Bayou watershed contains 97 census tracts with a population of 515,528, of which 66 percent are ethnic minorities. The study area contains 36 census tracts with a population of 191,731, of which 53.5 percent are ethnic minorities. Finally, the project area contains 15 census tracts with a population of 104,275, of which 52.8 percent are ethnic minorities. Population, race, and ethnicity of the census tracts within the project area are identified for the analysis (see Table 4-9).

**Table 4-9  
Population, Race, and Ethnicity for the White Oak Bayou Project Area**

Area/2000 Census Tract	Total 2000 Population	White		Black/African American		Native American/ Alaska Native		Asian		Native Hawaiian or Other Pacific Islander		Some Other Race <sup>1</sup>		Hispanic or Latino	
		Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage
5301	7,017	1,550	22.1%	855	12.2%	15	0.2%	62	0.9%	1	0.0%	81	1.2%	4,453	63.5%
5319	3,594	14	0.4%	2,903	80.8%	1	0.0%	2	0.1%	0	0.0%	45	1.3%	629	17.5%
5320	9,025	1,383	15.3%	5,518	61.1%	16	0.2%	83	0.9%	2	0.0%	89	1.0%	1,934	21.4%
5322	3,787	599	15.8%	2,103	55.5%	6	0.2%	34	0.9%	0	0.0%	37	1.0%	1,008	26.6%
5323	4,373	2,405	55.0%	751	17.2%	5	0.1%	241	5.5%	0	0.0%	63	1.4%	908	20.8%
5324	5,637	3,142	55.7%	308	5.5%	16	0.3%	155	2.7%	0	0.0%	37	0.7%	1,979	35.1%
5325	12,145	4,033	33.2%	1,088	9.0%	21	0.2%	1,011	8.3%	3	0.0%	143	1.2%	5,846	48.1%
5327	4,001	1,815	45.4%	1,374	34.3%	7	0.2%	163	4.1%	1	0.0%	70	1.7%	571	14.3%
5328	2,124	833	44.2%	635	25.8%	2	1.3%	120	0.0%	0	0.0%	26	0.8%	458	27.9%
5342	10,609	6,570	61.9%	541	5.1%	36	0.3%	1,054	9.9%	3	0.0%	179	1.7%	2,226	21.0%
5516	7,191	3,497	48.4%	926	12.0%	16	0.2%	602	9.0%	1	0.0%	11	1.9%	2,038	28.6%
5517	18,550	11,498	62.0%	1,381	7.4%	33	0.2%	2,699	14.5%	14	0.1%	355	1.9%	2,570	13.9%
5518	4,823	4,217	87.4%	58	1.2%	7	0.1%	221	4.6%	3	0.1%	57	1.2%	260	5.4%
5519	4,278	2,621	61.3%	491	11.5%	15	0.4%	261	6.1%	1	0.0%	90	2.1%	799	18.7%
5520	7,190	4,978	69.2%	465	6.5%	6	0.1%	676	9.4%	2	0.0%	125	1.7%	938	13.0%
<b>Total Project Area</b>	<b>104,275</b>	<b>49,211</b>	<b>47.2%</b>	<b>19,226</b>	<b>18.4%</b>	<b>225</b>	<b>0.2%</b>	<b>7,310</b>	<b>7.0%</b>	<b>30</b>	<b>0.0%</b>	<b>1,524</b>	<b>1.5%</b>	<b>26,749</b>	<b>25.7%</b>
<b>Total Study Area</b>	<b>191,731</b>	<b>89,133</b>	<b>46.5%</b>	<b>27,790</b>	<b>14.5%</b>	<b>422</b>	<b>0.2%</b>	<b>9,359</b>	<b>4.9%</b>	<b>58</b>	<b>0.0%</b>	<b>2,435</b>	<b>1.3%</b>	<b>62,534</b>	<b>32.6%</b>
<b>Total Watershed</b>	<b>515,528</b>	<b>175,309</b>	<b>34.0%</b>	<b>91,365</b>	<b>17.7%</b>	<b>957</b>	<b>0.2%</b>	<b>21,384</b>	<b>4.1%</b>	<b>137</b>	<b>0.0%</b>	<b>5,433</b>	<b>1.1%</b>	<b>220,943</b>	<b>42.9%</b>

<sup>1</sup> – Some Other Race also includes population of two or more races.  
Source: 2000 Census

According to the 2000 Census, the median household income of census tracts within the project area ranges from \$26,534 to \$89,441. The median household income of the census tracts within the project area is \$51,835. The median household income within the study area is \$44,365. See Table 4-10 for household income data within the project area.

**Table 4-10**  
**Household Income Percent Distribution for the White Oak Bayou Project Area**

<b>2000 Census Tract/Area</b>	<b>Total Households</b>	<b>Households of &lt;\$15,000</b>	<b>Households of \$15,000 to \$49,999</b>	<b>Households of &gt;\$50,000</b>	<b>Median Household Income</b>
5301	2,525	21.6	61.6	16.8	\$27,051
5319	1,135	26.3	48.2	25.6	\$26,650
5320	3,587	25.1	52.9	21.9	\$26,534
5322	1,391	21.2	56.1	22.7	\$27,926
5323	2,238	11.8	48.1	40.0	\$43,101
5324	1,917	6.8	38.1	55.1	\$53,613
5325	3,552	4.9	45.3	49.8	\$49,746
5327	1,603	5.4	40.0	54.6	\$54,219
5328	797	9.8	36.4	53.8	\$55,417
5342	3,761	7.2	33.4	59.3	\$61,069
5516	2,344	4.4	42.7	52.9	\$51,835
5517	6,427	2.7	23.8	73.8	\$71,936
5518	1,678	3.1	19.1	77.8	\$89,441
5519	2,378	13.3	45.8	40.9	\$42,337
5520	2,648	3.5	30.5	66.0	\$69,559
<b>Total Project Area*</b>	<b>37,981</b>	<b>10.0</b>	<b>39.8</b>	<b>50.2</b>	<b>\$51,835</b>
<b>Total Study Area* (500 yr floodplain)</b>	<b>69,231</b>	<b>11.8</b>	<b>41.3</b>	<b>46.9</b>	<b>\$44,365</b>
<b>Total Watershed*</b>	<b>175,305</b>	<b>16.8</b>	<b>44.7</b>	<b>38.5</b>	<b>\$38,417</b>
<b>Harris County</b>	<b>1,206,423</b>	<b>14.9</b>	<b>42.0</b>	<b>43.1</b>	<b>\$42,598</b>

\*Exhibit 1-1 shows the project area, study area, and watershed boundary.

#### **4.11.2 Economic Environment**

According to *Harris County, Texas, Popular Annual Financial Report for the Fiscal Year Ended February 28, 2005*, Harris County maintains a favorable economic environment due to the expansion and diversification away from the oil and gas industry. There has since been growth in the high technology industries, medical research, health care, and professional services. The county's traditional dependence



on the energy sector is projected to continue to decrease since economic expansion is also fueled by the county's proximity to the Gulf of Mexico, as well as by the important role the area plays as a major manufacturing, shipping, and tourism center.

Today, Harris County's economy is largely based on a broad spectrum of industries, including oil and gas exploration, basic petroleum refining, petrochemical production, medical research and health care delivery, high technology, government (including NASA), international import and export, commercial fishing, agriculture, education, banking and finance, manufacturing distribution, and related service industries.

According to the Census Bureau, total employment in Harris County was 1,653,892 in year 2000. According to the Greater Houston Partnership, Houston is home to the Central Business District in downtown Houston, which employs 153,000 people, and the Texas Medical Center with 61,041 employees, not including some 10,000 professionals and support personnel who work in adjacent professional buildings.

A survey of the economic conditions of the study area within the 500-year (0.2 percent) probability floodplain was performed. Under the No Action Alternative, there are approximately 15,141 residential units and 1,032 commercial and industrial facilities potentially impacted by flooding along White Oak Bayou between Huffmeister Road and the confluence with Buffalo Bayou. Approximately 5,600 residences are located in the 100-year (1.0 percent) exceedance probability floodplain.

The total value of the structures, including contents located within the 500-year (0.2 percent) probability floodplain, is approximately \$2.32 billion. For the 100-year (1.0 percent) probability floodplain, the value is \$1.35 billion. Flood damages have been estimated to be approximately \$857 million for the 500-year (0.2 percent) probability flood and \$422 million for the 100-year (1.0 percent) probability flood. Average annual damages resulting from flooding are estimated to be \$60 million.

## **4.12 ENVIRONMENTAL JUSTICE**

### **4.12.1 Minority and Low-Income Populations**

Executive Order ("EO") 12898, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," requires federal agencies to identify and address as appropriate, any adverse and disproportionate impacts of their programs, policies, and activities on the health or environment of minority and low-income populations (Federal Register, Vol. 59, Number 32, February 16, 1994).

A minority population is defined as a group of people and/or a community experiencing common conditions of exposure or impact that consists of persons classified by the U.S. Bureau of the Census as

Negro//American; Hispanic; Asian or Pacific Islander; American Indian, Eskimo, or Aleut; or other non-White persons.

According to the U.S. Bureau of the Census, a low-income population is defined as a group of people and/or community, which as a whole, lives below the national poverty level. Based on Health and Human Services ("HHS") data, the average poverty level threshold for a family of four people living in the 48 contiguous states and D.C. in year 2012 was a total annual income of \$23,050.

Census tracts adjacent to the project area were compared to census tracts adjacent to the study area. Table 4-9 shows the presence of minority populations within the project area. The project area total shows that the population consists of White persons (47.2 percent), followed by Hispanic or Latino persons (25.7 percent), Black persons (18.4 percent), Asian (7.0 percent), Some Other Race (1.5 percent), Native American/Native persons (0.2 percent), and Native Hawaiian or Other Pacific Islander (less than 0.01 percent). The project area total is similar to the study area total with a population of 46.5 White persons, 32.6 Hispanic or Latino persons, 14.5 percent Black persons, 4.9 percent Asian persons, 1.3 percent Some Other Race, 0.2 percent Native American/Native, and less than 0.01 percent Native Hawaiian or Other Pacific Islander. The White Oak Bayou watershed area has a population that is comprised of 42.9 percent Hispanic or Latino persons, followed by 34.0 percent White persons, 17.7 percent Black persons, 4.1 percent Asian persons, 1.1 percent Some Other Race, 0.2 percent Native American/Native, and less than 0.01 percent Native Hawaiian or Other Pacific Islander.

It should be noted that the percentage of minorities within the following census tracts within the project area were greater than 50 percent: 5301, 5319, 5320, 5322, 5325, 5327, 5328, and 5516. The percentage of minorities of the census tracts within the project area (total project area) (52.8 percent) was greater than 50 percent. However, the minority population is less than the minority population of the census tracts within the study area and the watershed area, 53.3 percent and 66 percent, respectively.

The median household income for the project area is \$51,835. The average median household income of the study area is \$44,365. Both the project area and study area median incomes are above the HHS poverty guideline. Additionally, no census tracts within the project area have a median household income below the HHS poverty guideline.

Census 2000 data indicates that the project area has a lower percentage of persons living below the poverty level (21 percent) than the study area (24 percent) and the watershed (31 percent).

#### **4.12.2 Limited English Proficiency**

EO 13166, "Improving Access to Services for Persons with Limited English Proficiency ('LEP')," signed by President Clinton on August 11, 2000, calls for all agencies to ensure that their federally conducted programs and activities are meaningfully accessible to LEP individuals.

According to the 2000 U.S. Department of Commerce, Bureau of the Census data for "Ability to Speak English" for the population of age five years and over indicates 7 percent of the population within the project area speaks English "Not Well" or "Not at All." The languages spoken by LEP populations include Spanish (82 percent), Asian and Pacific Island languages (16 percent), and Indo-European languages (2 percent).

#### **4.13 RECREATIONAL RESOURCES**

The recreation sponsor for the White Oak Bayou Federal Flood Control Project is Harris County Precinct 4 under Commissioner Jerry Eversole (Appendix C). Existing recreational resources in the White Oak Bayou watershed are primarily man-made facilities due to the extensive urban development within the watershed. Very limited natural areas still remain within the watershed.

As noted previously, there are many public parks and privately maintained recreational areas within the study area (Exhibit 4-2). Specifically, there are five parks located within the project area. The parks include Highland Park, Woodland Trails Park, Woodland Trails West Park, Clark W. Henry Park, and Winchester Rio Grande Park. A hike and bikeway network is also located within the study area. These facilities are described below.

Highland Park is a City of Houston park located north of DeSoto Street and south of Garapan Street. Highland Park consists of two tennis courts, a softball field, picnic shelters, and a playground. The channel is earthen and the bayou is varied in width. The bayou is flanked predominantly by residential developments and wooded, undeveloped lots. The overall aesthetic evaluation rating of this area results in a medium value level.

Woodland Trails Park is located west of North Houston-Rosslyn Road and south of White Oak Bayou, and Woodland Trails West Park is located east of Fairbanks-North Houston Road and south of White Oak Bayou. Both parks are homeowners' association neighborhood parks. The channel is an earthen corridor. There are three areas along this corridor that have been designated as flood storage areas. There are two neighborhood parks within this area. Woodland Trails Park consists of playground equipment, picnic tables with grills, a pool, a restroom/building, and a picnic pavilion. Near this park are utilities crossing the bayou and a water treatment plant. The second park, Woodland Trails West Park, consists of a pair of tennis courts, playground equipment, and picnic tables. It also acts as a trailhead along the bayou.

Clark W. Henry Park is a homeowners' association neighborhood park located west of Beltway 8 and south of White Oak Bayou. White Oak Bayou through the City of Jersey Village is lined with subdivisions on each side. The bayou is not channelized and the banks are in a natural state with wild flowers and native grasses growing along most of the bayou. The main feature of this corridor is Jersey Lake. The lake is surrounded by single-family housing and is suitable for light recreation. Recreational

opportunities at Clark W. Henry Park include picnicking, basketball, swimming, and baseball/. The corridor is well used by the citizens of Jersey Village.

Winchester Country Rio Grande Park is a homeowners' association neighborhood park located at Rio Grande Avenue south of West Road. This corridor is characterized by its natural channel, veins of hardwoods, and utility crossings. Wetland vegetation lines the bayou at its wider points. Most of the bayou in this area is lined with residential housing. Recreational opportunities at Winchester Country Rio Grande Park include picnicking and playground equipment. There are a few access points in this area, but no recreational facilities.

The City of Houston Hike and Bikeway Network encompasses planned projects or projects currently under construction along White Oak Bayou beginning at the confluence of Buffalo and White Oak Bayous in downtown Houston and terminating at West Little York Road. These projects were part of the Intermodal Surface Transportation Efficiency Act ("ISTEA") and are funded through the FHWA with matching funds from the City of Houston and coordination through the Texas Department of Transportation ("TxDOT"). The existing and/or proposed hike-and-bike trails are described in detail below and are located on Exhibit 4-2.

1. Houston Heritage Corridor Bayou Trail West: This proposed trail begins at the confluence of Buffalo and White Oak Bayous in downtown Houston and extends north to meet the proposed Missouri, Kansas, and Texas Rails to Trails ("MKTRR") project. This trail is not located within the project area.
2. MKT/SP: This proposed hike-and-bike trail begins at Houston Avenue and terminates at T. C. Jester Road. This trail is not located within the project area.
3. West White Oak Bayou Trail: This completed 4.86-mile trail begins at 11th Street and terminates at Pinemont Street. This trail is not located within the project area.
4. West White Oak Bayou Trail Extension: This proposed bikeway extension project begins south of Pinemont Street and terminates at West Little York Road. Approximately 3.5 miles of the 9.81-mile West White Oak Bayou Trail Extension project is located within the project area.

In addition, the HCFCD, Harris County Precinct 4, and the City of Jersey Village have partnered together to provide the community with an approximate 1-mile-long by 10-foot-wide asphalt hike-and-bike trail along White Oak Bayou between Equador Street and Gulf Bank Road. The hike-and-bike trail is known as the Jersey Village Hike-and-Bike Trail (Exhibit 4-2).

#### **4.14 TRAFFIC CONTROL AND SAFETY**

As a highly urbanized area of the fourth largest city in the country, the study area experiences moderate to heavy traffic on a regular basis. Several major thoroughfares, highways, and railroads traverse the watershed and study area. Coordination would be required with the city, state, and railroad officials to ensure continuous operations for the traveling public.

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## **5.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION**

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The following sections discuss the anticipated environmental impacts, both beneficial and adverse effects, associated with the implementation of the proposed action, i.e., the Recommended Plan (RF-31), also considered to be the Environmentally Preferred Alternative. The Recommended Plan has been designed to follow mitigation sequencing of avoidance, minimization, and compensation for unavoidable impacts to resources, with first priority being avoidance of impacts. Secondly, unavoidable impacts would be minimized to the extent possible, and compensation would be provided for those impacts that are unavoidable and cannot be further minimized.

### **5.1 FARMLAND PROTECTION POLICY ACT IMPACTS**

Of the 11 mapped soil units located within the project area, three of the soils are listed as prime farmland, if drained. Therefore, an NRCS-CPA-106 form was completed for the proposed additional ROW required to implement the Recommended Plan (RF-31). Since the total corridor assessment totaled zero points, coordination with the NRCS is not warranted and no substantial impacts to prime, unique, or other farmlands of statewide or local importance are anticipated. Additionally, the proposed project is located within urban use areas; therefore, coordination with the NRCS is not required. The NRCS-CPA-106 form is on file at HCFCFCD.

The No Action Alternative would involve no direct soils impacts and would involve no prime, unique, or other farmlands or statewide or local importance impacts.

### **5.2 LAND USE IMPACTS**

Due to the fact that 90 percent of the watershed is developed, available land necessary to accommodate proposed channel modifications is limited. Channel modifications have been designed to minimize impacts to existing structures and/or displacements of residences or businesses by alternating the side of the channel for proposed modifications and by varying the width of the proposed modifications. Most structural components of the Recommended Plan are below the view shed of passersby. The channel modifications would be below the existing high bank of the bayou section.

The four detention basin complexes total approximately 353 acres of land. The construction of the four detention basin complexes would change land into a basin-type structure. The detention basins would be grass-lined and when not containing water storage would generally remain "green." Recreation facilities are proposed within some portions of the basins.

The two proposed soil disposal sites are licensed vendors located within the study area. The land use of these sites would not be changed by implementation of the Recommended Plan.

Implementation of the Recommended Plan would not result in adverse impacts to schools or parklands within the project area. Impacts to residences and businesses include 21 displacements, which are discussed in detail in Section 5.11 - Acquisition and Displacement Impacts.

The No Action Alternative would not involve any impacts to land use within the project area. However, future development by others may occur, causing impacts to land use.

### **5.3 IMPACTS ON BIOLOGICAL RESOURCES**

In general, terrestrial and aquatic resources in the project area have been modified extensively by urban development and previous stream channelization. These modifications have impacted the existing fish and wildlife habitats, which as a result are generally considered low quality. The following sections discuss additional impacts, if any, to these biological resources that would result from implementing the Recommended Plan (RF-31), also considered to be the Environmentally Preferred Alternative, and the proposed plans to avoid, minimize, and/or mitigate these impacts. Overall, impacts to biological resources within the project area are expected to be temporary in nature.

#### **5.3.1 Vegetation**

As described in Chapter 4.4.1, much of White Oak Bayou has been channelized and the adjacent ROW has been cleared. The project area has been disturbed through past channel modifications and urban development. Commercial, industrial, and residential developments abut the HCFCD ROW throughout the project area, allowing very little native vegetation to thrive within the area. Table 5-1 identifies the potential impacts to habitat within the project area from the construction of the Recommended Plan. The habitat impacts are also broken down by Recommended Plan component in the following sections.

**Table 5-1  
Potential Habitat Impacts Within the White Oak Bayou Project Area  
from West Tidwell Road (Cole Creek) to FM 1960**

<b>Habitat Classification</b>	<b>Total Habitat Area (acres) Baseline January 1, 1998</b>	<b>Potential Impacts (acres) to Habitat Areas by the Recommended Plan</b>
Emergent Wetland-Fringe	2.30	2.30
Emergent Wetland-Depressional	7.15	3.01
Forested Wetland <sup>1</sup>	8.58	7.86
Maintained Grasses	449.97	433.85
Upland Pine-Hardwood Forest	211.05	153.13
Upland Hardwood Forest	13.63	7.06
Upland Scrub-Shrub	31.58	24.12
Remnant Prairie	0.44	0.29
Aquatic <sup>2</sup>	55	19
<b>Total</b>	<b>779.7</b>	<b>650.62</b>

<sup>1</sup> The forested wetland classification includes Chinese tallow-tree (*Sapium sebiferum*) dominated scrub-shrub wetlands.

<sup>2</sup> The aquatic habitat classification includes only the stream and no vegetation.

### 5.3.1.1 White Oak Bayou Channel

The existing HCFCF ROW along the top of banks on both sides of the White Oak Bayou channel consists of maintained grasses. Trees along the bayou are either adjacent to the fence lines of adjacent property owners and do not appear to be within HCFCF ROW, or are within undeveloped tracts outside of HCFCF ROW; therefore, there would be no impacts to trees with at least an 8-inch diameter at breast height ("dbh") within the White Oak Bayou channel component. Vegetation impacts along most of the White Oak Bayou channel would be temporary in nature. Once construction is complete, the top banks and side slopes would be replanted with a seed mix similar to that of the existing ROW in order to reduce erosion and establish ground cover.

Approximately 4,810 trees and 4,810 shrubs/plantings are to be planted along the bayou. These numbers are based on four trees and four shrubs/plantings to be planted for every 100-linear feet of bayou, on each bank of the bayou. Therefore, the combined rate for both banks of the bayou would be eight trees and eight shrubs/story per 100-linear feet of bayou. However, these figures are only to determine the average rate of revegetation plantings. The plantings would be in natural configurations or groupings, rather than in rows or lines.

In areas where the existing aesthetic value is low or the surrounding land uses do not lend themselves to recreational use of the bayou, the number of plantings would be lower than average. In areas with a high aesthetic value, existing habitat, and/or the adjacent land uses encourage use of the bayou for recreation purposes, the number of plants would be greater than the average of four trees and four shrubs per 100-linear feet.



It should be noted that the TPWD identified to HCFCFCD four forested areas of concern within the study area during the screening process. Although one area has been developed by others and is now a commercial development, avoidance of the remaining areas minimized potential impacts to mature stands of trees and wildlife habitat within the study area.

### **5.3.1.2 Jersey Village Channel**

The existing Jersey Village channel is a combination of two man-made HCFCFCD drainage channels. The vegetation within these drainage channels is maintained grasses and herbaceous wetland vegetation. Once deepening and widening of the Jersey Village channel is complete, the banks would be reseeded and the fringe and emergent wetland vegetation is expected to reestablish within the channel. No additional tree or shrub plantings are being considered along the Jersey Village channel.

### **5.3.1.3 Detention Basins**

Trees and shrubs would be planted within the detention basin's perimeter located as environmental design features within the Recommended Plan. In order to screen the detention basins from the surrounding land uses, approximate 150-foot vegetative buffers would surround the Fairbanks-North Houston Road (north and south) and Hollister Road (eastern perimeter) detention basin complexes. A minimum 50-foot vegetative buffer would surround the Hollister Road (western perimeter), Gessner/ 8, and Jones Road detention basin complexes. Site lines into the detention basins would be cut for the safety of the potential users and surrounding neighbors. The detention basin complexes plantings would be based on an equivalent of one tree and shrub per 25 feet. This equates to revegetation with approximately 5,600 trees and shrubs planted in clusters, giving the sites a naturally-wooded feel. The side slopes and perimeter would be seeded with grass after construction is completed to establish ground cover and reduce erosion. To date, approximately 7,000 trees have been planted in the Fairbanks-North Houston (south) detention basin and 375 trees have been planted in the Hollister Road detention basin. Additionally, a total of approximately 28,000 trees have been planted within the study area at various other HCFCFCD owned properties.

Based on field investigations, the remnant prairie community, including the 0.44-acre subject site, predominantly contained non-native herbaceous and woody scrub-shrub species. Emergent herbaceous species included Gulf cordgrass (*Spartina spartinae*), grass-leaf groundsel (*Senecio glabellus*), small-fruit spikerush (*Eleocharis microcarpa*), and Alabama supplejack (*Berchemia scandens*). Several herbaceous non-natives, such as coastal Bermuda (*Cynodon dactylon*), King Ranch bluestem (*Bothriochloa ischaemum*) and Paraguayan windmill grass (*Chloris canterai*), were also present. The upland scrub-shrub community contained a dominance of approximately 30 percent woody vegetation. Species within this area included eastern false-willow (*Baccharis halimifolia*), yaupon (*Ilex vomitoria*), sugar hackberry (*Celtis laevigata*) and other woody species, which are transforming the site from prairie to scrub-shrub habitat.

Based on a review of historic-aerial photography, from 1930 to present day, it appears that the subject site transformed from native prairie to a mixed non-native herbaceous and woody scrub-shrub community. From 1930 to the mid-1970s, the site in question and adjacent lands appeared as prairie grassland used as pasture that was trending toward "improved." (It was over this period that grasses like coastal Bermuda and King Ranch bluestem probably were introduced, either by intentional over seeding to improve forage yields or through seeds that had been in transit in the guts of cattle who had been moved from elsewhere to this site). Between 1972 and 1984, the site was clearly undergoing a transition manifested in the appearance of many woody plants (scrub/shrub), most likely due to the cessation of grazing in anticipation of development during that time of oil-induced boom. From 1989 until 2002, the site had become young mixed woods with a handful of small patches of herbaceous-dominated, degraded and isolated grasses.

The history of the site reveals a continued transformation from native prairie to mixed non-native herbaceous and woody scrub-shrub communities that began in the late 1970s with the cessation of heavy cattle grazing. Due to its small size, isolation within an urbanized area, and continuing degradation of function and values as prairie, this remnant is not considered a significant resource.

#### **5.3.1.4 Soil Disposal**

The proposed soil disposal sites are developed properties located within the urban environment. Since the soil disposal sites are already developed, no impacts to vegetation would occur.

The No Action Alternative would not involve impacts to any vegetation types within the project area. However, future development by others is likely to occur, causing impacts to the vegetation.

### **5.3.2 Wildlife**

#### **5.3.2.1 Terrestrial Species**

##### **5.3.2.1.1 White Oak Bayou and Jersey Village Channel**

Wildlife within the project area is limited to species adapted to an urban setting. Impacts to wildlife resulting from channel modifications are expected to be minimal and temporary in nature. Species that currently occupy these channels are limited to small- and medium-sized mammals, birds, reptiles, and amphibians that are adapted to the type of habitat and urban environment that currently exists within and adjacent to the existing ROW. Impacts along the channels would primarily be short-term with the temporary displacement of wildlife during construction activities. Environmental quality features include planting approximately 4,810 trees and 4,810 shrubs along the bayou. The trees would be planted in clusters as described in Section 5.3.1.1 to provide wildlife habitat value.

##### **5.3.2.1.2 Detention Basins**

The wildlife habitat value within the potential detention basins is marginal and fragmented due to the invasive nature of the plant communities on these sites, as well as the surrounding urban development. The wildlife in these areas consists of species adapted to an urban setting.

The loss of marginal habitat in these areas from excavation would result in the displacement of some wildlife. Many of these species that are adapted to human disturbance would vacate the habitat during construction, populating similar habitat in the area, and would likely return after habitat has been reestablished.

Although the proposed detention basins are cleared and graded during construction, most of these areas would be planted with grasses following construction. A variety of tree and shrub plantings in parts of the basins are included in the design features of the detention basins, as well as the likely creation of wetland areas in parts of the basins. Approximately 5,600 trees and shrubs would be planted in parts of the basins as part of the proposed action.

Following construction, the change in habitat may result in a change in types of wildlife species, with some of the wildlife returning to the project area and some wildlife reestablishing in the surrounding areas. The proposed construction of the detention basins, with the planting of trees and shrubs and creation of wetlands, would provide different proportions of habitat types than what currently exist at detention sites. This new habitat may attract species of wildlife different from those species currently inhabiting the area, thereby potentially increasing wildlife diversity in the overall area.

Construction would be accomplished in compliance with guidance concerning migratory birds that is in effect at the time construction begins. Measures would be taken to avoid impacts to migratory birds, their eggs, and their young.

### **5.3.2.2 Aquatic Species**

Impacts to aquatic species are anticipated to be minor and temporary given the condition of the existing water quality and the nature of the proposed activities. While short-term disruption of sediments and elevated turbidity levels may occur, elevated turbidity levels are not expected to last after construction activities are finished. Under the TPDES stormwater program, the HCFCFCD would ensure that appropriate steps are taken to control water pollution during construction to reduce impacts to fish species. Fish species that presently occupy the channel are expected to leave the construction area during construction and would return after construction is complete. The aquatic species found within the channel are well adapted to the urban environment and therefore would not be adversely impacted by the proposed activities.

The No Action Alternative would not involve impacts to any wildlife within the project area. However, future development by others may occur, causing impacts to wildlife and their habitats.

## **5.4 THREATENED AND ENDANGERED SPECIES IMPACTS**

The USFWS (federal) and TPWD (state) were notified of the proposed action on October 13, 1998, February 4, 1999, October 19, 2000, October 16, 2001, May 17, 2002, and March 23, 2005. One response letter from USFWS dated November 8, 2000, and one response letter from TPWD, dated December 13, 2001 was received. Follow-up coordination was sent to the USFWS on May 17, 2002, with regard to the endangered plant species, Texas prairie dawn-flower and on March 23, 2005, regarding changes to the previous project design. USFWS responded on May 9, 2005, requesting that if potential habitat for the Texas prairie dawn-flower exists in the project area, a survey by a qualified individual is required. To date, surveys by Dr. Larry Brown have been conducted and existing Texas prairie dawn-flower populations were monitored. However, since 2006, monitoring visits did not identify Texas prairie dawn-flower species or suitable habitat. The above-mentioned coordination letters are located in Appendix C.

A draft BA was prepared to fulfill the USACE obligations under Section 7(c) of the Endangered Species Act ("ESA") of 1973, as amended. The draft BA is the USACE's evaluation of the proposed action following the applicable policies and guidelines of the 1990 WRDA, Public Law 101-640, as part of the comprehensive flood damage reduction plan for Buffalo Bayou and Tributaries, Texas project. The draft BA has been prepared (Appendix B) and submitted to the USFWS for review and concurrence. HCFCFCD received the standard USFWS form letter (June 2011) for "no effect" determinations. No further coordination with USFWS is required.

Field investigations for threatened and endangered species and SOC were conducted for the proposed action from 1998 to present. In 1998 and 2002, one potential habitat area and one population area of the federally and state listed endangered Texas prairie dawn-flower were identified within the Hollister Road and Fairbanks-North Houston Road (south) basins, respectively.

Direct effects are immediate effects on the species or its habitat. A potential habitat area was identified on the Hollister Road detention basin (HOL.3B), although no Texas prairie dawn-flower plants have been identified on-site. The detention basin was designed to avoid direct impacts to this habitat area. Short-term impacts occurred within the area during implementation of local project construction. However, construction is complete and the area was confirmed to persist. Therefore, the temporary disturbances were determined to be insignificant. The area is currently flagged and remains within an approximate 50-foot buffer zone. The area would be fenced off for future construction of the basin to avoid this potential habitat area.

The Fairbanks-North Houston Road detention basin (FNH.3) was designed to avoid direct impacts to the Texas prairie dawn-flower site identified in 2002. The population area was flagged and protected during local construction of the basin and remains within an approximate 50-foot buffer zone. However, as noted, the site became too overgrown to sustain Texas prairie dawn-flower species as of 2006. Therefore, the suitable habitat at this basin no longer exists.

In conclusion, no threatened or endangered species (other than the above-mentioned Texas prairie dawn-flower) were observed during field investigations of the project area. According to the draft BA, there would be no effect to any threatened or endangered species or their preferred habitat.

The No Action Alternative would not involve impacts to any threatened or endangered species within the project area. However, future development by others may occur, causing impacts to threatened and endangered species.

## **5.5 FLOODPLAINS, DRAINAGE, AND WATER QUALITY IMPACTS**

### **5.5.1 Floodplains**

Implementation of the Recommended Plan is designed to reduce damages resulting from flooding within the project area. Implementing the Recommended Plan would result in reductions in flood depths and damages throughout the study reach. No increase in flood levels for the project area is predicted. Upon implementation of the proposed action, approximately 22 percent of the homes that currently exist within the 100-year (1 percent) floodplain would then be located outside the 100-year floodplain due to a reduction in size of the floodplain. Similarly, approximately 52 percent of the structures within the current 25-year (4 percent) floodplain and 96 percent of the structures within the current 10-year (10 percent) floodplain would then be located outside of their respective floodplains through the implementation of the

Recommended Plan. Additionally, reduction of the size of the 100-year floodplain is not expected to impact wetlands currently located in this floodplain due to the percentage of the floodplain that is currently developed. There would be no adverse impacts on floodplain areas within the project area as a result of implementation of structural or non-structural measures.

The No Action Alternative would not involve any impacts to floodplains within the project area. Future development would continue to be regulated by local ordinances.

### **5.5.2 Drainage**

The purpose of the proposed action is to reduce damages resulting from flooding to structures within the White Oak Bayou watershed. Impacts to drainage by implementation of the Recommended Plan would be reduced by what would be considered "improved" drainage, a positive impact to the White Oak Bayou watershed.

The No Action Alternative would not involve any impacts to drainage within the project area. However, future development by others could potentially impact existing drainage patterns.

### **5.5.3 Water Quality**

Because of the current poor water quality of White Oak Bayou, the temporary nature of construction activity, and the fact that the bayou is not being converted to some other use, no long-term effect on the water quality of White Oak Bayou and its tributaries is anticipated. Temporary impacts would be associated with localized increases in turbidity levels caused by suspension of sediments excavated or otherwise disturbed during construction activities associated with channel modifications and detention basin construction. These intermittent effects would dissipate shortly after completion of construction activities.

Water quality is expected to improve within White Oak Bayou from the filtration created by the wet bottom marshes located on the northern and southern portions of the Fairbanks-North Houston detention basin and the proposed forested wetland within the Hollister Road detention basin. In addition, the forested buffer zones surrounding the detention basins and less sedimentation build-up as a result of the proposed low-flow channel are expected to help improve the water quality within the project area. Since the Recommended Plan does not involve the need for subsurface water, no effect on groundwater or the water table is anticipated.

The Recommended Plan would disturb over 5 acres during construction; therefore, a Texas Pollution Discharge Elimination System ("TPDES") permit is required prior to construction. A Notice of Intent ("NOI") stating that a Storm Water Pollution Prevention Plan ("SW3P") has been developed would be filed with the TCEQ prior to the beginning of construction. The HCFCD and its contractor(s) are required to review the SW3P with the City of Houston and are responsible for implementing, maintaining, and inspecting SW3P control measures. The HCFCD and its contractor(s) are also responsible for filing the

NOI. The HCFCDD would ensure that appropriate steps are taken to control water pollution during construction.

The HCFCDD and its contractor(s) are also responsible for complying with the local Storm Water Quality permitting requirements for new development and redevelopment within the City of Houston and the unincorporated areas of Harris County. This permitting program is required for the municipal separate storm sewer system ("MS4") permit that has been implemented as mandated by EPA regulations. The MS4 permit includes temporary construction stormwater quality control.

As required by the Clean Water Act ("CWA"), Section 402(p), Storm Water Construction Program, implementation of a sediment and erosion control plan would minimize damage. In accordance with ER 1105-2-100, a Section 404(b)(1) evaluation was completed and the proposed action was found to be in compliance with Section 404 (b) guidelines (Appendix D). The results of the finding of compliance for the proposed action are as follows:

1. No substantial adaptation of the guidelines was made relative to this evaluation.
2. The planned disposal of fill material would not violate any applicable state water quality standards, with the exception of minor turbidity excursions during substantial rain events. This temporary effect is unavoidable in construction areas. The excavation and disposal operation would not violate the Toxic Effluent Standards of Section 307 of the CWA.
3. Use of USACE-approved, fully-functioning, licensed vendors to dispose of excavated material would not harm any endangered species or their critical habitat.
4. The proposed excavation, fill, and soil disposal activities would not result in substantial adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic life and other wildlife would not be adversely affected. Substantial adverse effects on the aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values would not occur.
5. Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems include incremental construction along White Oak Bayou, construction controls, revegetation after completion of construction, avoidance of impacts to wetlands and endangered species, and implementation of the environmental quality measures included in the proposed action at the various detention basins.
6. On the basis of the guidelines, the proposed excavation and fill sites for discharge of material are specified as complying with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects to the affected aquatic ecosystem.

As required by Section 401 of the CWA, a water quality certification would be obtained from the TCEQ prior to construction of this proposed action. The water quality certification is located in Appendix D. The certification was received from the TCEQ on May 24, 2013.

As discussed previously in Section 1.1, construction of some components of the Recommended Plan has already occurred. All required permits, certifications, and Best Management Practices have been in place for the construction.

The No Action Alternative would not involve any impacts to water quality within the project area and no permits would be required. However, future development by others may occur, causing impacts to water quality.

## **5.6 AQUATIC ENVIRONMENT IMPACTS**

### **5.6.1 Streams**

No impacts would occur to Little White Oak Bayou, Cole Creek, Vogel Creek, or Rolling Fork Creek, as these are not a part of the Recommended Plan and only intersect with White Oak Bayou.

Implementation of the Recommended Plan would result in impacts to White Oak Bayou, including 19 acre-feet of fill placed below the OHWM. This amount of fill is required in order to add stability around bridges and utility lines. In addition, a total of 379 linear feet of a natural stream channel located in the Jones Road detention basin and 0.07 acre of the Jersey Village channel (containing flows from White Oak Bayou below the OHWM) would be impacted by the proposed action as well.

The White Oak Bayou channel is proposed to be an earthen, low-flow channel and not concrete lined, thereby allowing habitat functions and values to return to the channel. Since the Recommended Plan would deepen and widen the channel and maintain an earthen channel, a greater area of stream habitat would be created. The aquatic environment that exists within the stream would be able to reestablish once construction is complete. In addition to the low-flow channel, an SW3P would be implemented and followed during construction activities to avoid unnecessary pollution impacts and to minimize unavoidable pollution impacts to the bayou and the 0.07 acre of the Jersey Village channel.

The following BMP's would be implemented in order to avoid unnecessary impacts and to minimize unavoidable impacts to the bayou: seeding and sodding the channel would be implemented in a timely fashion and silt fencing would be used during construction and restoration. Reintroduction of riffle and pool complexes and preservation of forested buffer zones surrounding the detention basins would be implemented as design practices. Based on a field survey conducted in April 2008, there are currently 39 riffle and pool complexes within the project area. A similar amount would be established once the Recommended Plan is implemented. These BMP's and design practices would assist in the replication of the existing bayou once construction is complete.

Construction of a low-flow channel in the center of the Jones Road detention basin would replace the existing stream channel being impacted. BMP's would be implemented during and after construction of the basin, including seeding and/or sodding, silt fencing, and preservation and enhancement of the forested buffer zone.

As discussed previously in Section 1.1, construction of some components of the Recommended Plan has already occurred. All required permits, certifications, and Best Management Practices have been in place for the construction.

The No Action Alternative would not involve any impacts to White Oak Bayou or other streams within the project area.

## **5.6.2 Wetlands**

Wetland impacts would be avoided to the maximum extent practical. Of the approximate 780 acres required for channel modifications, and detention basin construction, a total of 18.03 acres are considered wetlands. A total of 13.17 acres of wetlands would be impacted during construction of the project, avoiding impacts to 4.86 acres of wetlands. As discussed previously in Section 1.1, construction of some components of the Recommended Plan has already occurred. All required permits, certifications, and Best Management Practices have been in place for the construction, and the construction has been consistent with the wetlands impacts and mitigation discussed in this section. The plan is considered to be the Environmentally Preferred Alternative

The project impact analysis projects future habitat conditions over the period of analysis (61 years) in terms of average annual habitat units ("AAHU's") and determines the net impact of the proposed project. AAHU's were calculated for the habitat conditions within the detention complexes with the proposed project constructed ("with project") and the habitat conditions within the detention complexes without the proposed project constructed ("without project"). Habitat units are annualized by summing the HU's for all years in the period of analysis and dividing the total by the number of years in the period of analysis, resulting in AAHU's. The net average annual impact of the proposed project is equal to the difference between the "without project" AAHU's and the "with project" AAHU's.

Table 5-2 identifies the wetland habitat and impacts within the project area. The wetland habitat impacts are also broken down by Recommended Plan component below.



**Table 5-2  
Wetland Habitat, Quality, and Impacts Within the White Oak Bayou  
Project Area from Cole Creek (South of West Tidwell Road) to FM 1960**

Habitat Classification	Evaluation Species	Total Wetlands (Acres)	Total Wetlands Impacted (Acres)	Wetland Habitat Quality in January 1998 (Habitat Units)	Wetland Habitat Quality "With Project" (Average Annual Habitat Units)	Future Wetland Habitat Quality "Without Project" (Average Annual Habitat Units)	Net Impact (Average Annual Habitat Units)
<b>Emergent Wetland-Fringe</b> Located within the White Oak Bayou Channel Modifications E100-00-00	<b>Great Egret</b>	<b>2.30</b>	<b>2.30</b>	<b>0.64</b>	<b>0.59</b>	<b>0.64</b>	<b>0.05</b>
<b>Emergent Wetland-Depressional</b> Located within Detention Basins:	<b>Swamp Rabbit</b>						
Fairbanks-North Houston Road-North FNH.3/E500-01-00		1.70	1.20				
Fairbanks-North Houston Road-South FNH.3/E500-02-00		4.70	1.06				
Gessner/Beltway 8-South GBW.3/E500-10-00		0.75	0.75				
<b>Total Emergent Wetland-Depressional</b>		<b>7.15</b>	<b>3.01</b>	<b>5.36</b>	<b>2.06</b>	<b>2.42</b>	<b>0.36</b>
<b>Forested Wetland (FW), including Scrub-Shrub (SSW)</b> Located within Detention Basins:	<b>Forested:</b> Eastern Gray Squirrel Downy Woodpecker Barred Owl <b>Scrub-Shrub:</b> Yellow Warbler American Woodcock						
Hollister Road HOL.3B/E500-04-00		2.76	2.76				
Fairbanks-North Houston Road-North FNH.3/E500-01-00		0.50	0.00				
Fairbanks-North Houston Road-South FNH.3/E500-02-00		3.00	2.78				
Gessner/Beltway 8-North GBW.3/E500-10-00		2.25	2.25				
Jones Road-East JR.4/E500-11-00		0.07	0.07				
<b>Total Forested Wetland including Scrub Shrub</b>		<b>8.58</b>	<b>7.86</b>	<b>7.51</b>	<b>0.80</b>	<b>3.72</b>	<b>2.92</b>
<b>Total Wetlands</b>		<b>18.03</b>	<b>13.17</b>	<b>13.51</b>	<b>3.45</b>	<b>6.78</b>	<b>3.33</b>

### **5.6.2.1 White Oak Bayou Channel**

A total of 2.30 acres of fringe wetlands are located within and along both banks of White Oak Bayou within the project area. Channel modification construction would impact the 2.30 acres of wetlands. The wetland habitat quality for fringe wetlands for the project area totals 0.64 HU's. The period of the HEP analysis was determined to be 61 years, which includes the pre-start date from 1997 to 2008 and the life of the project date from 2008 to 2058. Over the period of the HEP analysis (61 years), the fringe wetlands within the project area would provide 0.64 AAHU of habitat (in terms of species selected for the HEP modeling for fringe wetlands) if the proposed action were not constructed (without project) and 0.59 AAHU of habitat if the proposed action were constructed (with project). An average of 0.05 fewer HU's would be available every year during the period of analysis if the proposed action was constructed. Future fringe wetland characteristics were assumed to remain the same as baseline conditions, and the average future area of available habitat was assumed to be equal to the baseline area. However, the 2.30 acres of fringe wetlands would be impacted in 2014, resulting in essentially no available habitat for that year. Although the 2.30 acres of wetlands impacted are anticipated to revegetate within one year, the loss of 2.30 acres of habitat in 2014 (anticipated start of construction) results in a net impact of 0.05 AAHU or 3.05 HU's over the period of analysis. Discussion of the mitigation alternatives for the fringe wetland habitat and a mitigation plan is in Section 5.17.2.

### **5.6.2.2 Jersey Village Channel**

As discussed in Chapter 4, wetland determinations resulted in no additional assessment of wetlands within the Jersey Village channel due to the channel being a man-made drainage channel excavated from uplands between 1989 and 1994; the E200-00-00 portion of the Jersey Village channel has no normal flow from White Oak Bayou; and the channels that drain into the E200-00-00 portion of the Jersey Village channel are also man-made. The E141-00-00 portion of the Jersey Village channel does contain an OHWM and backflow from White Oak Bayou; however, there are no wetlands located within this portion of the Jersey Village channel.

### **5.6.2.3 Detention Basins**

A total of 15.73 acres of emergent and forested (including scrub-shrub) wetlands are located within the four detention basin complexes associated with the Recommended Plan. The emergent wetlands total 7.15 acres and the forested wetlands total 8.58 acres. Detention basin construction would impact 3.01 acres of the emergent wetlands and 7.86 acres of the forested wetlands for a total of 10.87 acres of emergent and forested wetlands impacted. The wetland habitat quality for emergent wetlands within the detention basins totals 5.36 HU's and the wetland habitat quality for forested wetlands within the detention basins totals 7.51 HU's.

Over the period of the HEP analysis (61 years), the emergent wetlands within the detention basins would provide 2.42 AAHU's of habitat (based on the species selected for the HEP modeling for emergent wetlands) without the proposed action and 2.06 AAHU's of habitat with the proposed action. An average of 0.36 fewer HU's would be available every year during the period of analysis if the proposed action was constructed. The proposed action would impact 3.01 acres (42 percent) of the emergent wetlands within the detention basin complexes. Although the Habitat Suitability Index/("HSI") scores were relatively high over the period of analysis, ranging from 0.71 to 0.95, the loss of 3.01 acres of emergent wetland habitat over the period of analysis results in a net loss of 0.37 AAHU or 22.57 HU's over the period of analysis.

Over the period of the HEP analysis (61 years), the scrub-shrub wetlands within the project area would provide 0.33 AAHU of habitat (based on the species selected for the HEP modeling for scrub-shrub wetlands) without the proposed action and 0.20 AAHU of habitat with the proposed action. An average of 0.13 fewer HU's would be available for every year during the period of analysis if the proposed action was constructed. The proposed action would impact 5.54 acres (88 percent) of the scrub-shrub wetlands within the detention basin complexes. Although the predicted HSI scores were relatively high over the period of analysis, ranging from 0.70 to 0.79, the loss of 5.54 acres of scrub-shrub wetland habitat over the period of analysis results in a net loss of 0.13 AAHU or 7.93 HU's over the period of analysis.

Over the period of the HEP analysis (61 years), the forested wetlands within the project area would provide 3.39 AAHU's of habitat (based on the species selected for the HEP modeling for forested wetlands) without the proposed action and 0.60 AAHU of habitat with the proposed action. An average of 2.79 fewer HU's would be available for every year during the period of analysis if the proposed action was constructed. The proposed action would impact 2.32 acres (100 percent) of the forested wetlands within the detention basin complexes. Although the existing forested wetlands were anticipated to develop and provide increasingly more peak habitat conditions, resulting in an increase in HSI scores over the period of analysis, the loss of 2.32 acres of forested wetland habitat over the period of analysis results in a net loss of 2.79 AAHU's or 170.19 HU's over the period of analysis.

Discussion of the mitigation alternatives for the forested (including scrub-shrub) and emergent wetland habitats and a mitigation plan is in Section 5.16.2 and on Exhibit 5-1.

#### **5.6.2.4 Soil Disposal**

Excavated soil from the proposed action would not be disposed of in a wetland or other significant resource; therefore, no wetlands would be impacted by the soil disposal associated with implementation of the Recommended Plan.

The No Action Alternative would not involve any impacts to wetlands within the project area. However, future development by others may occur, causing impacts to wetlands.

### **5.6.3 Navigable Waters Impacts**

Bridge modifications are not proposed as part of the Recommended Plan; therefore, no impacts to navigable waters would occur within the project area.

The No Action Alternative would not involve any impacts to navigable waters within the project area.

### **5.6.4 Wild and Scenic Rivers Impacts**

There are no rivers or river segments listed on the U.S. Department of Interior's National Inventory of River Segments in the National Wild and Scenic River System in the vicinity of the Recommended Plan; therefore, no impacts would occur.

The No Action Alternative would not involve any impacts to wild and scenic rivers within the project area.

### **5.6.5 Coastal Consistency Impacts**

The Recommended Plan is not located within the Coastal Zone Management Plan boundaries; therefore coordination with the Coastal Coordination Council is not required and no impacts would occur.

The No Action Alternative would not involve any impacts to the coastal management plan boundaries within the project area.

### **5.6.6 Coastal Barriers Impacts**

The Recommended Plan would not affect any coastal barriers along the Texas Gulf Coast; therefore, no impacts would occur.

The No Action Alternative would not involve any impacts to coastal barriers within the project area.

## **5.7 CULTURAL RESOURCES IMPACTS**

### **5.7.1 Archeological Resources**

The White Oak Bayou Federal Flood Control Project is not anticipated to impact any historic properties, buildings, structures, objects, sites, and districts included in or eligible for inclusion in the NRHP. Moreover, no impacts are anticipated to any cultural resources. However, surveys are still pending for the Gessner Drive detention basin and would be completed once right-of-entry is obtained. As previously noted, a PA has been prepared and signed between USACE, HCFCD, and the SHPO. The PA addresses archeological and historical resources to ensure that the most recent guidance, policies and interpretation are utilized.

### **5.7.1.1 White Oak Bayou Channel**

Although no archeological resources impacts would occur along the White Oak Bayou channel, archeological investigations resulted in the determination that a qualified archeologist should monitor all bank excavation deeper than 75 centimeters (30 inches) between Cole Creek and West Road, including the areas encompassing the 10.81 acres of additional ROW. Although a dart fragment was found between West Road and FM 1960, the dart fragment was considered an isolated object of no significance. The THC concurred with the recommendations that no further cultural resources investigations are necessary prior to construction from West Road to FM 1960 (Appendix G).

### **5.7.1.2 Jersey Village Channel**

No impacts to archeological resources are anticipated along the Jersey Village channel. Archeological investigations resulted in THC concurrence on July 25, 2007, that no further archeological work would be required for the proposed Jersey Village channel modifications (Appendix G).

### **5.7.1.3 Detention Basins**

No archeological resources impacts would occur within the Hollister Road detention basin complex. Two previously-recorded prehistoric sites were avoided during local project construction by allowing the sites to remain within the forested buffer zone. The proposed design to deepen and widen this detention basin complex would continue to protect the two prehistoric sites from impacts by allowing the sites to remain in the forested buffer zone.

No archeological resources impacts would occur to the Fairbanks-North Houston detention basin complex. The THC concurred with the findings on July 25, 2007 (Appendix G).

No archeological resources impacts would occur to the portion of the Gessner/ 8 detention basin complex located north of Brookriver Drive; however, once right-of-entry has been obtained, additional work is recommended in the portion south of Brookriver Drive. This work would be in accordance with the PA. The deep nature of the soils, the proximity to the bayou and the wooded aspect of the property all fall within the factors making it possible that intact archeological deposits may exist within the remaining segments of the proposed detention basin. Furthermore, the extreme limitations on access and the densely wooded nature of the tract made an accurate visual assessment difficult and inaccurate. The footprint of the business noted in the northwest corner is exempt from additional work.

The No Action Alternative would not involve any impacts to archeological resources within the project area. However, future development by others may occur, causing impacts to archeological resources.

#### **5.7.1.4 Soil Disposal**

As noted in the REC process in Section 3.3.5, excavated soil from the proposed action would not be disposed of in a location that would impact archeological resources; therefore, no impacts to archeological resources would occur due to soil disposal from implementation of the Recommended Plan. All work would be in accordance with the PA.

The No Action Alternative would not involve any impacts to archeological resources within the project area. However, future development by others may occur, causing impacts to archeological resources.

#### **5.7.2 Historical Resources**

Based on historic structures surveys completed in 2005 and 2006, no historical impacts would occur to buildings or structures 50 years or older within the existing ROW of the White Oak Bayou channel from Cole Creek to FM 1960, the 10.81 acres of additional ROW required from Cole Creek to Gessner Drive, and the four detention basin complexes. The THC concurred with these findings on August 16, 2006. Agency coordination is located in Appendix G.

The No Action Alternative would not involve any impacts to historical resources within the project area. However, future development by others may occur, causing impacts to historical resources.

### **5.8 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE IMPACTS**

Based on the Hazardous, Toxic and Radioactive Waste (HTRW) investigations, three leaking underground storage tank (LUST) sites and one voluntary cleanup program (VCP) site were identified as potential concerns. The LUST sites include a Shell Fuel Facility, a Citgo gas station, and a Diamond Shamrock-Little Buddy gas station. The VCP is a Pilgrim Cleaners. These sites are identified on Exhibit 4-1. A copy of the HTRW report is on file at the HCFCD office.

A file review of the LUST sites concluded the following:

1. Shell Fuel Facility - does not appear to present a significant environmental concern based on the regulatory status, lack of contaminants of concern in the monitoring well located closest to the project area, direction of groundwater flow, and distance from the project area.
2. Citgo - does not appear to present a significant environmental concern based on the regulatory status and lack of contaminants of concern in the monitoring well located closest to the project area.
3. Diamond Shamrock-Little Buddy - does not appear to present a significant environmental concern based on its regulatory status, direction of groundwater flow, and distance from the project area.

A file review of the VCP site was conducted to determine the extent of soil contamination, depth to groundwater, groundwater gradient, and plume size. The file review concluded that a Limited Phase II

investigation would be necessary to determine if any subsurface impacts from the VCP site are present. A Limited Phase II investigation was conducted on July 20, 2006, and a subsequent investigation was conducted in August 2006. The investigations concluded that the excavation depths planned at the Jones Road west detention basin are located above the impacted groundwater. Based on the analytical results of the soil samples collected, the soils above the impacted groundwater have not been impacted by the chlorinated solvent groundwater plume and could be excavated and taken off-site to be used as fill for other projects without further testing. The chlorinated solvent-impacted groundwater in the southeastern portion of the Jones Road west detention basin should not adversely affect basin construction so long as the groundwater-bearing unit is not intercepted in this area. In the event that the groundwater-bearing unit is encountered in the southeast portion during excavation, these commingled soils should be tested to determine if they could be reused as fill.

A letter was sent to the TCEQ on August 23, 2006, requesting concurrence with the findings of the above-referenced Limited Phase II investigation. The TCEQ responded in a letter dated September 20, 2006, that they concur with the findings of the report. Specifically, in the event that soils encountered at depth in the southeast portion of the site have been impacted by chlorinated solvents from the Pilgrim facility, they should be tested to determine the possible reuse of the soil as fill material.

The No Action Alternative would not involve any impacts to HTRW within the project area. However, future development by others may occur, causing impacts to HTRW.

## **5.9 IMPACTS ON AIR QUALITY**

An air emissions inventory was developed to represent both direct and indirect emissions for the 10 primary construction tasks of the Recommended Plan. In order to calculate annual nitrous oxides ("NOx") and volatile organic compound ("VOC") emissions for the proposed action, assumptions were made regarding types of equipment and estimated durations of equipment usage. Results of the NOx and VOC emissions are summarized in Tables 5-3 and 5-4.

**Table 5-3  
VOC Emissions Summary (tpy)**

Year	TG.2A1	JR.4	HOL.3B	GBW.3	FNH.2	E200H.2A	GE200.7A WOB Channel	GE200.7A JV Channel	TOTAL	De Minimis
1989								0.18	0.18	25
1990								0.19	0.19	25
1991								0.19	0.19	25
1992								0.19	0.19	25
1993								0.19	0.19	25
1994					1.29			0.19	1.47	25
1995					1.29				1.29	25
1998			0.61						0.60	25
1999			0.60						0.60	25
2000					1.24				1.20	25
2001					1.22				1.20	25
2002				0.27					0.30	25
2003				0.26					0.30	25
2004			0.55	0.26					0.80	25
2005			0.54	0.25					0.80	25
2006		0.52							0.50	100
2007		0.51							0.50	100
2008	0.34	0.50	0.52	0.24	1.11	0.09	0.07	0.17	3.00	100
2009			0.51					0.16	0.67	100
2010			0.49					0.16	0.65	100
2011									0.00	100
2012						0.09	0.04		0.13	100
2013						0.09	0.06		0.155	100
2014	0.17			0.23			0.04		0.44	100
2015	0.32			0.22					0.54	100
2016	0.17			0.11					0.28	100



**Table 5-4  
NOx Emissions Summary (tpy)**

Year	TG.2A1	JR.4	HOL.3B	GBW.3	FNH.2	E200H.2A	GE200.7A WOB Channel	GE200.7A JV Channel	TOTAL	De Minimis
1989								1.00	1.00	25
1990								0.99	0.99	25
1991								0.99	0.99	25
1992								0.98	0.98	25
1993								0.97	0.97	25
1994					6.86			0.96	7.82	25
1995					6.81				6.81	25
1998			3.20						3.20	25
1999			3.04						3.00	25
2000					6.53				6.50	25
2001					6.48				6.50	25
2002				1.44					1.40	25
2003				1.43					1.40	25
2004			3.01	1.41					4.40	25
2005			2.97	1.38					4.40	25
2006		2.60							2.60	100
2007		2.57							2.60	100
2008	1.76	2.51	2.87	1.32	6.06	0.48	0.34	0.86	16.20	100
2009			2.83					0.85	3.68	100
2010			2.79					0.85	3.64	100
2011									0.00	100
2012						0.47	0.17		0.63	100
2013						0.46	0.33		0.79	100
2014	0.87			1.30			0.17		2.34	100
2015	1.69			1.28					2.97	100
2016	0.87			0.65					1.52	100

The proposed action, the Recommended Plan, is considered a federal action that would produce construction equipment related emissions in the HGB moderate non-attainment area. Due to the activity type and location of the Recommended Plan, NO<sub>x</sub> and VOC emissions were assessed for General Conformity with the HGB State Implementation Plan ("SIP") per federal and state regulations. As shown previously in Chapter 4, NO<sub>x</sub> and VOC emissions do not exceed the current *de minimis* threshold of 100 tons per year ("TPY") for the duration of the proposed action. Effective June 15, 2004, EPA issued new nonattainment classifications under the eight-hour ozone standard. Tables 5-3 and 5-4 show the *de minimis* value changing from 25 to 100 starting in year 2006. As a result, project emissions from the Recommended Plan are deemed to be in General Conformity with the HGB SIP and no further analysis is required. A copy of these findings was submitted to TCEQ for review and concurrence, and the TCEQ has concurred with these findings (see Appendix C).

The No Action Alternative would not involve any impacts to air quality within the project area. However, future development by others may occur, causing impacts to air quality.

### **5.10 IMPACTS ON NOISE**

Noise levels are expected to increase slightly during construction from equipment operation, work crew activities, etc. General construction noise impacts, such as temporary speech interference for passersby and those individuals living or working near the project, can be expected. The increase in noise levels would occur only during daylight hours and would not interfere with the lifestyles of local residents. Considering the relatively short-term nature of construction noise, these impacts are not expected to be substantial. Contractors would be required to make every reasonable effort to reduce construction noise through reasonable abatement measures in order to reduce noise impacts. Abatement measures include monitoring and maintenance of exhaust systems to ensure mufflers are functioning properly; shut-down of heavy equipment when not in use beyond five minutes, and adherence to daylight working hours.

The No Action Alternative would not involve any impacts to noise within the project area. However, future development by others may occur, causing impacts to noise.

### **5.11 SOCIAL AND ECONOMIC IMPACTS**

Assuming completion of the Recommended Plan, the average annual damages would be reduced by approximately 58 percent, from \$61 million to \$26 million, with an estimated Recommended Plan first construction cost totaling approximately \$106 million. Upon completion of all components of this alternative, the size of the 100-year floodplain would be reduced. Therefore, 22 percent of the homes that are currently in the 100-year (1 percent) floodplain, 52 percent of the homes that are currently within the 25-year (4 percent) floodplain, and 96 percent of the homes with are currently within the 10-year (10 percent) floodplain would all be located outside of their respective floodplains. This would improve the life, health, and safety conditions of the surrounding communities. Furthermore, it is conceivable that the perceived property values of the area surrounding the four detention basin complexes would increase because the probability of flooding is decreased, and the detention basin complexes would be removed

from potential future development, thereby increasing the aesthetic value of the surrounding area. While there would be minor financial losses via tax revenues and temporary disruption to community cohesion due to acquisition of 29 residences, the proposed project would provide significant benefits in terms of flood control, recreational opportunities, and increase the overall aesthetic value of the area. For the commercial and residential structures that are located within the proposed ROW, relocation is not expected to be a constraint as there is an adequate supply of decent, safe, and sanitary “DSS” replacement housing in the study area. Additionally, the number of residents in the project area that would benefit from the proposed project greatly exceeds the impact of relocating 29 residents.

### **5.11.1 Acquisitions and Displacements**

White Oak Bayou channel modifications would require a combination of 10.8 acres of additional easements or right-of-way, which remains to be acquired. Acquisition of property would occur along the White Oak Bayou channel but not the Jersey Village Channel. Structures were identified using Harris County Appraisal District maps. The right-of-way acquisitions would result in 18 residential displacements. These acquisitions are structural measures of the Recommended Plan and not for buyout purposes to remove the structures from the floodplain.

The four detention basin complexes total approximately 353 acres of land, of which 10.6 remains to be acquired. The 10.6 acres would be acquired from the Gessner/ 8 (south of Brookriver Drive) detention basin complex. The ROW acquisitions would result in two commercial displacements. These acquisitions are structural measures of the Recommended Plan and not for buyout purposes to remove the structures from the floodplain. The four detention basin complexes are located within the project area and would provide 2,938 acre-feet of storage. Although the proposed detention basins would essentially remain "green," use of these sites for detention removes these areas from potential future development.

For the commercial and residential structures that are located within the proposed ROW, relocation is not expected to be a constraint as there is an adequate supply of decent, safe, and sanitary ("DSS") replacement housing in the study area. Additionally, the number of residents that would benefit from the proposed project greatly exceeds the impact of relocating 18 residents.

The HCFCD relocation policy would accommodate relocation of all displacements through fair and equitable market value appraisals of the residential and commercial properties. Relocates would be compensated according to the HCFCD policy. Public involvement was conducted to inform local residents about the proposed action and the relocation policy. For further information regarding public involvement, refer to Section 6.2.

The No Action Alternative would not require any acquisitions or displacements.

## **5.12 ENVIRONMENTAL JUSTICE IMPACTS**

### **5.12.1 Minority and Low-Income Populations**

The EO 12898 requires that minority and low-income populations not receive disproportionately high adverse human health or environmental impacts and that representatives of any minority or low-income population that could be affected by the proposed action be involved in the community participation and public involvement process. Disproportionate environmental impacts from the exposure to an environmental hazard occur when the risk to a minority population or low-income population exceeds the risk to the general population.

For this analysis, census tracts within the project area were compared to census tracts within the study area and watershed. As stated in Section 4.13.1 the population living within the project area is primarily comprised of White persons (47.2 percent), followed by Hispanic or Latino persons (25.7 percent), Black or African American persons (18.4 percent), and other ethnicities (8.7 percent). The population living within the study area is primarily comprised of White persons (46.5 percent), followed by Hispanic or Latino persons (32.6 percent), Black or African American persons (14.5 percent), and other ethnicities (6.4 percent). The percent minorities within the project area (52.8 percent) are greater than 50 percent, but are not greater than the minority population of the census tracts within the study area (53.5 percent) or watershed (66.0 percent). The displacement of 32 structures would be required, which includes 29 residences, one out-building, and two commercial properties located in census tracts 5328 and 5342. The population within census tract 5328 consists primarily of White persons (44.2 percent), followed by Hispanic or Latino persons (27.9 percent), Black or African American persons (25.8 percent), and other ethnicities (2.1 percent). The population within census tract 5342 consists primarily of White persons (61.9 percent), followed by Hispanic or Latino persons (21.0 percent), Asian persons (9.9 percent), Black or African American persons (5.1 percent), and other ethnicities (2.1 percent). The percent of minorities (55.8 percent) within buyout census tract 5328 is slightly greater than the minority populations within the project area (52.8 percent) and study area (53.5 percent) but less than the watershed (66.0 percent). The percent minorities (38.1 percent) within census tract 5342 are less than the minority population within all focal areas. Therefore, minority populations are not being disproportionately impacted as compared to other census tracts in the project area.

The median household income for the buyout census tracts are \$55,417 for tract 5328 and \$61,069 for tract 5342. The median household income is significantly above poverty levels within the two buyout census tracts; therefore, low-income populations are not being disproportionately impacted from the proposed project.

In comparison to the project area and watershed population, the specific targeting of minorities or low income residences by buyout is not apparent. Therefore, impacts anticipated from the proposed action

would not disproportionately impact minority or low-income populations and the proposed action is in compliance with EO 12898.

### **5.12.2 Limited English Proficiency**

Approximately 7 percent of the population age of five years and above within the census tracts along the project area speaks English "Not Well" or "Not at All." Other languages spoken by LEP populations include Spanish (86 percent), Asian and Pacific Island languages (14 percent), and Indo-European languages (3 percent). HCFCD would continue to publish all future notices in English and Spanish newspapers and would provide means of communication to LEP individuals at future public involvement activities. The requirements of EO 13166 appear to be satisfied.

### **5.13 RECREATIONAL RESOURCES IMPACTS**

No temporary construction easements and no additional ROW are required from the six parks located within the project area; therefore, no impacts to these areas would occur.

Impacts would occur to 3.5 miles of the 9.81-mile West White Oak Bayou Trail Extension. However, the City has use of the HCFCD ROW for the trail with the agreement that HCFCD projects would take priority over City projects. Should any impacts occur to existing trails from implementation of the proposed action, HCFCD would restore the trails to pre-impact conditions. The cost of potential trail restoration associated with the trail from the confluence of White Oak Bayou and Cole Creek upstream to Hollister is included in the Recommended Plan costs. Coordination has begun with the City in order to coordinate efforts in this area. Coordination letters are located in Appendix C.

Recreational opportunities within the project area would increase based on the recreation plan components. The 12-mile hike and bikeway extension from Hollister Road to north of West Road would create a continuous parkway corridor from downtown to north of West Road. Adding recreational components within the detention basins adds four recreational park areas throughout the upper reach of White Oak Bayou.

The No Action Alternative could result in temporary impacts to pedestrian and bicycle facilities located along the bayou due to flooding.

### **5.14 TRAFFIC CONTROL AND SAFETY IMPACTS**

No substantial impacts on existing traffic patterns or safety are expected during construction of the Recommended Plan. Temporary impacts to traffic patterns may occur during construction of the project; however, coordination with the city, state, and railroad officials would ensure continuous operations for the traveling public.

## **5.15 CUMULATIVE IMPACTS**

### **5.15.1 Introduction**

Identifying major cumulative effects involves defining the direct and indirect effects of the proposed action on the resources, ecosystems, and human communities affected and determining which of these effects are important from a cumulative effect perspective. In assessing cumulative effect, consideration is given to (1) the degree to which the proposed action affects public health or safety; (2) the unique characteristics of the geographic area; (3) the degree to which the effects on the quality of the human environment are likely to be highly controversial; (4) the degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks; and (5) whether the action is related to other actions with individually insignificant but cumulatively significant impacts on the environment.

Cumulative effects can result from many different activities, including the addition of materials to the environment from multiple sources, repeated removal of materials or organisms from the environment, and repeated environmental changes over large areas or long periods. More complicated cumulative effects occur when stressors of different types combine to produce a single effect or suite of effects. Cumulative effects may also occur when the timing of perturbations are so close that the effects of one have not dissipated before the next occurs or when the timing of perturbations are so close in space that their effects overlap.

Since no standard approach or methodology is available to quantify cumulative effects or to define the geographic scope of the area that would be impacted by the proposed action, it is necessary to evaluate each project on an individual basis, define its area of influence, and understand the current social and economic conditions and transportation infrastructure of the area.

### **5.15.2 Area of Influence**

The area of influence ("AOI") identified for the White Oak Bayou Federal Flood Control project generally includes Harris County. Buffalo Bayou is included in the AOI and there are no flood control projects currently being constructed in that watershed. For the air analysis, the eight-county area identified by the H-GAC as the HGB area was used. The Recommended Plan components are located within the AOI.

Assessing potential cumulative effects related to the proposed action involves a summary and assessment of other projects occurring within the AOI. A number of actions that have been (or are likely to be) undertaken by federal and non-federal agencies within the AOI are discussed in this Cumulative Impacts section. All of the listed projects would have some degree of direct or indirect impact on the environment.

The potential impacts of general trends in population growth, economic development, habitat resources, etc., plus all of the projects described below, as well as the proposed action, combine and interact to result in cumulative effects upon the AOI. These cumulative effects are discussed in the following sections. Beneficial effects include new economic opportunities, housing alternatives, employment opportunities and recreational resources. As development occurs, the need for additional infrastructure and services (schools, transportation, utilities, fire, police, and emergency medical services) would increase. Potentially adverse cumulative effects associated with the continued development of the AOI include loss of habitat, water quality impacts, and the conversion of land uses.

### **5.15.3 Land Use**

According to the City of Houston Planning Department, between 2000 and 2010, Houston experienced a 7.5 percent change (increase) in population, exceeding the growth rates of New York, Los Angeles, and Chicago. Residential development slowed in the AOI between 2007 and 2011 compared to previous years, though not as much as other parts of the U.S. According to the 2008-2012 Consolidated Plan for Harris County, the housing market in the county is still experiencing growth despite the nationally felt housing correction. Additional housing, infrastructure, and commercial and public land uses required to serve the population growth projections for the area would result in continued development and land use changes in the region.

Virtually all of the surrounding areas are currently undergoing residential construction or are planning for development within the next five years and would require the associated infrastructure. With the slowdown in home building there has been a trend to improve existing facilities including streets, sidewalks, highways, wastewater systems and storm drainage.

Each of the municipal areas in the general study area has plans for commercial development. Restaurants, retail shops, office complexes, business parks, and convenience stores are among the commercial developments currently being designed or constructed.

Development impacts associated with normal growth in the region are expected to result in conversion of wetland and riparian habitat and agricultural lands into commercial, residential or industrial expansion, as well as additional infrastructure and services as people continue to move into the area. The four detention basin complexes would potentially create open areas that may create fringe wetland habitat around the edge of some of the basins. Conversely, these sites would no longer be available for residential and/or commercial development. Land use impacts from the proposed action would reduce flood damages to the surrounding areas.

#### **5.15.4 Transportation**

Transportation improvement projects in the region include highway, road, bridge, or overpass construction, reconstruction, widening, or upgrades to accommodate current and projected traffic in the area. The cumulative effects of development on transportation facilities and traffic volumes in the region depend largely on the origin and destination points associated with traffic-generating developments. The Recommended Plan is not a traffic-generating development and thus is not expected to have a cumulative effect upon transportation in the AOI.

#### **5.15.5 Social and Economic Impacts**

Residential, commercial, office and industrial development are accompanied by increased economic opportunity and area employment. The degree and type of employment hinges on the economy and area demand. In Harris County, major employment sectors are retail trade, manufacturing, administrative and support, waste management, and remediation services.

According to the Greater Houston Partnership and the Texas Workforce Commission as of September 2007, Houston's unemployment rate dropped below the national average in late 1989 and generally remained marginally below it well into 1992. Over the past 15 years, the two rates have crisscrossed, but only rarely have differed significantly from each other.

December 2000 saw Houston's unemployment rate plunge to 3.5 percent, the lowest unemployment rate recorded in Houston since early 1981. From that point, both the Houston and the national rates moved upward through mid-2003, and then trended downward through the first quarter of 2008. The influx of southern Louisiana residents fleeing Hurricane Katrina in September 2005 abruptly expanded Houston's labor force, interrupting this trend and producing an atypical upward shift in Houston's unemployment rate through late 2005. By February 2006, however, the Houston and U.S. unemployment rates again were essentially equal (No rates are seasonally adjusted). According to the Texas Workforce Commission in May 2010, the unemployment rate in Texas remained steady at 8 percent. This is slightly down from 2009 and below the national average of 9.1 percent. The Houston/ Sugar Land/ Baytown area had an unemployment rate of 8.2 in May 2011. More than 205,000 jobs have been gained in Texas since May 2010.

Labor availability remains better in Harris County than in many other metropolitan areas. Because Houston's labor force is large, its May 2011 unemployment rate of 8.2 percent translates into 240,600 unemployed workers seeking jobs.

The proposed action is not expected to have a cumulative effect on the economy or employment of the AOI.



### **5.15.6 Terrestrial Habitat (Including Wetlands)**

There have been significant losses to wetlands and other significant habitats and in turn wildlife habitat diversity since the 1950s and the continued urbanization and industrialization of the Houston-Galveston area would cause continued pressure on these habitats and the ecosystem. To a large extent, impacts to wetlands and protected species within the AOI would be avoided, minimized, or mitigated by compliance with existing federal statutes that apply to private and government interests. The USACE (under Section 404 of the CWA) and the USFWS (under the Endangered Species Act) has legislative mandates and program implementation policies to reduce or avoid significant, adverse impacts to resources on an individual as well as a cumulative basis. These regulations should minimize adverse effects on resources as a cumulative consequence of continuing historic development patterns. Regardless, the obvious trend is continued development in the region and complete avoidance of impacts is not practical.

### **5.15.7 Water Quality and Hydrology**

Various existing and planned developments in the area have a cumulative water quality impact on the receiving water bodies due to wastewater discharges and urban runoff. Surface water quality impacts of new development include point source and non-point source discharges. Point source discharges are regulated by the TPDES, which is administered by the TCEQ to protect the quality of the receiving waterbodies. Runoff from developed sites is a major contributor of non-point source discharges. These discharges are regulated under the TPDES stormwater program for construction, industrial multi-sector, and MS4 activities. In accordance with stormwater regulations, the water quality impacts of runoff are generally mitigated by BMP's utilized to the extent practicable.

Impervious cover increases as a result of development and, in turn, leads to higher runoff volume as well as higher peak runoff rates, and as a result, the residences and businesses along the bayous are frequently inundated by floodwaters. Flood control projects, such as the proposed action, are being constructed to improve the hydraulics of the major waterways in an attempt to prevent future flood damage to residences and businesses without worsening existing flood conditions in other areas.

While impacts on water quality and benthic habitat can be anticipated during implementation of the Recommended Plan, these impacts tend to be temporary and localized. Similar activities for other projects in the region can be expected to have similar temporary and localized effects on water quality and habitat. Based on the historic data available regarding effects of channel modifications, the Recommended Plan is not expected to make a major contribution to cumulative water quality impacts.

### **5.15.8 Air Quality**

The study area for assessing cumulative effects is generally located within the HGB Air Quality Control Region, also referred to as the HGB. This area includes Harris County and the seven surrounding counties of Montgomery, Liberty, Chambers, Galveston, Brazoria, Fort Bend, and Waller.

Ozone is the only criteria pollutant for which the HGB fails to meet the NAAQS. The HGB is categorized as a moderate non-attainment area for ozone.

The TCEQ has the responsibility for developing a plan for attaining the air quality standard in the HGB. This plan, which was submitted to and approved by the EPA, is termed the SIP. The SIP describes how the area would reach attainment of the air quality standard for ozone. The SIP sets emissions budgets for point sources such as power plants and manufacturers, area wide sources such as dry cleaners and paint shops, off-road mobile sources such as boats and lawn mowers, and on-road sources such as cars, trucks, and motorcycles.

The HGB is expected to experience growth in the regional population and economy, resulting in increased traffic and industrial capacity. The network of future roadways and subdivision streets resulting from cumulative effects, in addition to existing and planned industrial facilities within the AOI, would be expected to contribute to additional and varying amounts of air pollution emissions.

Even with increased growth in the area, historical ambient air monitoring data for the HGB indicates a long-term downward trend in ozone. This is generally the result of efforts made to reduce emissions from various sources of VOCs. Since being classified as non-attainment with the ozone standard, the HGB has implemented many new controls on emissions since 1990, which have significantly reduced emissions of VOCs and would further reduce emissions of NO<sub>x</sub> in the area.

Possible cumulative impacts of reasonably foreseeable actions may result from projects related to transportation improvement, industrial facilities, and navigation improvements. Specific factors inherent to these actions impacting air quality include emissions from construction activities, operations, and transportation. Construction activities, such as those included in the Recommended Plan, would result in exhaust emissions from the combustion of fuel in construction equipment and emissions of dust from land disturbance. Emissions from industrial activities result from the operation of the facilities, including combustion emissions from fuel-burning equipment and fugitive emissions of particulate matter ("PM") and VOCs. Navigation related activities would result in emissions from the combustion of fuel in dredge and support vessels and the placement of dredged material.

Air quality impacts associated with the construction of planned transportation and industrial projects would result in a temporary impact on air quality. Emissions from these activities would be intermittent and of relatively short duration, generally ending when the construction activity ends. Although

somewhat localized, emissions from the construction of transportation projects would be spread throughout the HGB as different project segments are completed. Emissions from the construction of industrial projects would be more localized, resulting from on-site construction equipment and worker vehicles. As it is likely that the construction activities related to reasonably foreseeable actions and the Recommended Plan are spatially separated by considerable distances, the potential short-term cumulative air quality impacts due to construction activities associated with the foreseeable and proposed actions would be limited and would not result in the deterioration of air quality to exceed applicable standards. Potential long-term cumulative air quality impacts due to reasonably foreseeable actions would be limited and would not result in deterioration that would exceed applicable ambient air quality standards.

### **5.15.9 Hazardous Materials**

The risk of contamination of soils, surface water, and groundwater as a result of construction of the Recommended Plan is relatively small. Several factors contribute to this conclusion, including the type of proposed activities, the nature of the proposed action, and the SW3P and spill control measures to be implemented during construction. As a result, construction of the proposed action is not expected to make a substantial contribution to cumulative effects of the use of hazardous materials on the environment in the region.

### **5.15.10 Present and Future Actions**

Specific actions that may contribute to overall cumulative effects in the area are described in the following sections. Potential impacts of these actions include improving access to these areas and increasing the potential for development.

### **5.15.11 Transportation**

#### **TxDOT**

Several planned roadway and highway projects and studies would impact the AOI. These include improvements along US 59, US 290, IH 45, IH 10, and West Loop IH 610. The TxDOT is the local state agency on these projects with the FHWA as the federal lead agency. Other public transportation projects that are currently under construction include Beltway 8 (the Sam Houston Toll Road), which is sponsored by the Harris County Toll Road Authority, with TxDOT as the local state agency and the FHWA as the federal lead agency.

#### **Grand Parkway**

The Grand Parkway (SH 99) is a proposed four-lane, 170-mile circumferential scenic highway that would eventually traverse seven counties and encircle the greater Houston area. Factors evaluated during the continuing development of the various segments of the proposed facility include existing and future traffic demands, land acquisition, construction funding, and environmental impacts. This partially

completed facility has no immediate effect on the AOI. The Grand Parkway is sponsored by the Grand Parkway Association, with TxDOT as the local state agency, and the FHWA as the lead federal agency.

### **Transportation Improvement Plan**

The Transportation Improvement Plan ("TIP") is a staged, three- to five-year prioritized program of transportation projects in the metropolitan planning area. It is designed to be consistent with the Metropolitan Transportation Plan ("MTP"). This program is required for a locality to receive federal transit and highway grants. The TIP also contains an annual or biennial element that lists all transportation project activities that would receive federal funding for a given one- or two-year period. The Metropolitan Planning Organization ("MPO") and state and transit operators are required to cooperatively develop the TIP. The MPO for Harris County is the Houston-Galveston Area Council.

### **George W. Bush International Airport**

Improvements to the George W. Bush International Airport are currently underway. Houston Airport Systems, in conjunction with the Federal Aviation Administration and the City of Houston, is currently constructing additional commercial runways and terminals. This expansion project is a direct response to the ever-increasing socioeconomic growth and development in the Houston Metropolitan Statistical Area.

## **5.15.11.1 Channel Modifications**

### **Houston Navigation Channels Project**

A cumulative effect assessment was performed in 1995 to assess the combined effects of several authorized and planned federal development projects in the Galveston Bay area. An Interagency Coordination Team ("ICT") joined to identify and resolve concerns. A subcommittee of the ICT, including the GBNEP, National Marine Fisheries Service ("NMFS"), TPWD, USACE, and USFWS was created as the Cumulative Impact Subcommittee. The findings and recommendations were incorporated into the Supplemental EIS for the Houston Ship Channel project.

A scope of work was agreed upon and included parameters to address 10 past, present, and reasonably foreseeable future federal projects viewed as pertinent to the bay's condition. Parameters that were included in the assessment included biological, physical, chemical, socioeconomic, and cultural attributes. The assessment addressed three scenarios that included: (1) continued maintenance dredging of the Houston Ship Channel as the WITHOUT PROJECT; (2) open-bay unconfined disposal (OPEN BAY) where new work and maintenance dredged material from the widening and deepening would be placed in subaqueous unconfined disposal cells and in upland confined and semi-confined disposal cells; and (3) a Beneficial Uses Group plan ("BUG") in which new work and maintenance material from dredging would be used for construction of marshes, a bird island and shoreline stabilization, and upland confined disposal.

The WITHOUT PROJECT scenario resulted in a net negative impact baywide. The OPEN BAY scenario was assessed as resulting in a greater negative impact in Galveston Bay when compared with the WITHOUT PROJECT scenario. The BUG scenario, including associated construction of Beneficial Use sites, resulted in a net negative impact bay-wide in comparison with the two other options; however, the positive net benefit of marsh creation would reduce the negative impact of this scenario.

In summary, the results of the cumulative impact assessment conducted by TCB and the Galveston Bay Association (1995) indicated "continued maintenance dredging of the Houston and Galveston Channels in combination with other proposed projects reviewed would result in a negative impact to the Galveston Bay ecosystem." The study also indicated the BUG scenario would have more positive effects than either the OPEN BAY or WITHOUT PROJECT scenarios.

#### **5.15.11.2 Federal Flood Control Projects**

In addition to the navigation channel projects, several Federal Flood Control projects, such as the White Oak Bayou Recommended Plan, are under consideration or have been constructed by HCFC and the USACE. These projects include modifying existing channels as well as excavating detention basins to reduce flood damage to residences and businesses within those watersheds. Accounts of past and present Federal Flood Control projects are provided below:

The following seven Federal Flood Control projects have been completed (year completed):

1. Addicks and Barker Reservoirs (1948)
2. Brays Bayou (1968)
3. White Oak Bayou (1976)
4. Vince Bayou (1980)
5. Little Vince Bayou (1988)
6. Cypress Creek (2001)
7. Clear Creek, second outlet (1997)

The following two Federal Flood Control projects are currently under construction (year started):

1. Sims Bayou (1994)
2. Brays Bayou, Section 211(f), Detention Element (1994)

The following Federal Flood Control project studies have been completed, but construction has not yet begun:

1. Greens Bayou, Section 211(f)
2. Brays Bayou, Alternative to Diversion Element, Section 211(f)

The following five Federal Flood Control projects are currently being studied:

1. Hunting Bayou, Section 211(f)
2. White Oak Bayou, Section 211(f) (the proposed action)
3. Halls Bayou, Section 211(f)
4. Buffalo Bayou and Lower White Oak, Section 211(f)
5. Clear Creek Flood Damage Reduction and Ecosystem Restoration Study

All the previously constructed or permitted flood control projects would help alleviate flooding and damages in the surrounding areas, as well increase the potential for development in these areas. The proposed action would have the same effects. The aforementioned projects and the proposed actions would also potentially reduce habitat for some species, while increase habitat for others. The proposed action would provide better habitat for fish, potentially increase water quality within the bayou, and provide food for other species.

The No Action Alternative would be least likely to induce cumulative impacts.

## **5.16 MITIGATION**

This proposed action, the Recommended Plan, has been designed to avoid, minimize, and compensate, respectively, for unavoidable impacts to regulated resources, and is considered to be the Environmentally Preferred Plan. Unavoidable impacts have been minimized to the extent possible and compensation would be provided for those adverse impacts, which are unavoidable. Table 5-5 below describes the potential impacts, proposed mitigation, and construction practices. The cost of the mitigation measures in the Recommended Plan that exceed the cost of the least cost-mitigation determined in the analysis described in EA Appendix E would be paid for by the Local Sponsor. No mitigation is being provided for the remnant prairie because it is not a significant resource.

**Table 5-5  
Summary of Potential Adverse Impacts and Proposed Compensatory Mitigation**

<b>Category</b>	<b>Potential Adverse Impacts</b>	<b>Mitigation</b>	<b>Construction Practices</b>
Upland vegetation, not including maintained grasses	184.31 acres	Not Applicable	Tree and shrub plantings along the bayou and within the detention basin complexes.
Remnant Prairie	0.44 acres	Not Applicable	All areas of remnant prairie would be impacted by construction. The history of the remnant prairie subject site reveals a continued transformation from native prairie to mixed non-native herbaceous and woody scrub-shrub communities that began in the late 1970s with the cessation of heavy cattle grazing. Due to its small size, isolation within an urbanized area, and continuing degradation of function and values as prairie, this remnant is not considered a significant resource.
Wildlife	Shift from forest and scrub-shrub species to grass species in some areas.	Not Applicable	Tree and shrub plantings along the bayou and within the detention basin complexes would create wildlife habitat areas.
Threatened & Endangered Species	None	Not Applicable	The potential habitat area located within the Hollister Road detention basin would be flagged and avoided. A management plan for the Fairbanks-North Houston detention basin site would be followed. Cease construction if T&E are observed. Coordinate with USFWS and TPWD.
Floodplains	None	Not Applicable	Not Applicable

<b>Category</b>	<b>Potential Adverse Impacts</b>	<b>Mitigation</b>	<b>Construction Practices</b>
Water Quality	Temporary water quality impacts (i.e. suspended sediments).	Not Applicable	Improve water quality through the earthen and low-flow channel, detention basins, and vegetative buffer zones. TPDES, MS4 permit, SW3P, and Water Quality Certification.
Aquatic Environment (including streams and wetlands)	18.03 acres and 379 linear feet of stream impacts at White Oak Bayou channel, Jersey Village channel, and Jones Road east detention basin and 13.17 acres of wetland impacts.	Off-site through purchase of 4.99 acres of wetlands at the GBWMB and 7.0 acres onsite. Avoidance of 4.86 acres of wetland impacts.	BMP's would be implemented to avoid impacts to White Oak Bayou and streams including: riffle and pool complexes, seeding and sodding the channel, silt fencing, and forested buffer zones surrounding the detention basins.
Navigable Waters	None	Not Applicable	Not Applicable
Wild and Scenic Rivers	None	Not Applicable	Not Applicable
Coastal Management Plan	None	Not Applicable	Not Applicable
Cultural Resources	Two previously-recorded sites on the Hollister Road detention basin.	None; however, need to perform future investigations in areas once additional ROW is acquired.	Avoid future impacts to the forested buffer zone area containing the two previously-recorded sites. A qualified archeologist should monitor all bank excavation deeper than 30 inches between Cole Creek and West Road.
HTRW	One Voluntary Cleanup Program site located within the Jones Road west detention basin.	Not Applicable	In the event that soils encountered at depth in the southeast portion of the Jones Road west detention basin have been impacted by chlorinated solvents from the Pilgrim facility (the VCP facility), they should be tested to determine the possible reuse of the soil as fill material.
Air Quality	None	Not Applicable	Use of emission control devices-inspectors oversee construction and enforce pollution control measures.



<b>Category</b>	<b>Potential Adverse Impacts</b>	<b>Mitigation</b>	<b>Construction Practices</b>
Noise	Temporary noise impacts due to construction.	Not Applicable	Contractor must make every reasonable effort to minimize construction noise through abatement measures such as work-hour controls and proper maintenance of muffler systems.
Land Use	780 acres of land, of which 21.8 acres are remaining to be acquired.	Not Applicable	REC on alternative disposal sites.
Recreational Resources	3.5 miles of 9.81-mile West White Oak Bayou Trail. Impacted trails would be restored to pre-impacted conditions, if impacted.	Recreation Plan cost included for trail from the confluence of White Oak Bayou and Cole Creek upstream to Hollister.	Coordination with the City of Houston and Recreation Plan requirements.
Socio-Economic Analysis	Displacement of 21 structures.	Just compensation and relocation assistance, if applicable, for the displacement of 21 residential and commercial structures per HCFC policy.	Not Applicable

## **5.16.1 Wetland Mitigation Alternatives and Plan**

### **5.16.1.1 Wetland Mitigation Alternatives**

Wetlands were identified as the only significant resource warranting compensatory mitigation. Of the approximate 780 acres required for channel modifications and detention basin construction, a total of 18.03 acres are considered wetlands. A total of 13.17 acres of wetlands would be impacted during construction of the project, avoiding impacts to 4.86 acres of wetlands.

As discussed in Sections 4.7.2 and 5.6.2, HEP modeling was conducted to determine the habitat quality of the wetlands within the project area. The habitat quality is expressed in AAHU's. HU is an abbreviation for a "habitat unit", a measure of the area of habitat suitable for a series of selected wildlife species. AAHU's are the average annual habitat units. The impacted area of 13.17 acres contains 3.33 AAHU of

wetlands. The 3.33 AAHU's includes 0.41 AAHU of emergent wetlands, 2.79 AAHU's of forested wetlands, and 0.13 AAHU's of scrub-shrub wetlands.

The acreage required for mitigation is based on the HSI scores for each alternative mitigation area and the AAHU's needed. The AAHU's were divided by the HSI scores to determine the mitigation acreage requirements for each habitat type (AAHU/ = acres). The HEP Analysis Project Impact and Mitigation Alternatives Analysis (March 2008) report is on file at the HCFCFCD office.

Compensatory wetland mitigation would be provided for all or part of the 13.17 (3.33 AAHU's) of wetlands that are impacted. There are eight alternatives for compensatory mitigation for the excavation or filling of the wetlands within the Recommended Plan, as discussed below. A CE/ICA was completed using the USACE's IWR Planning Suite software for each mitigation alternative for the purposes of evaluating the cost in terms of AAHU's.

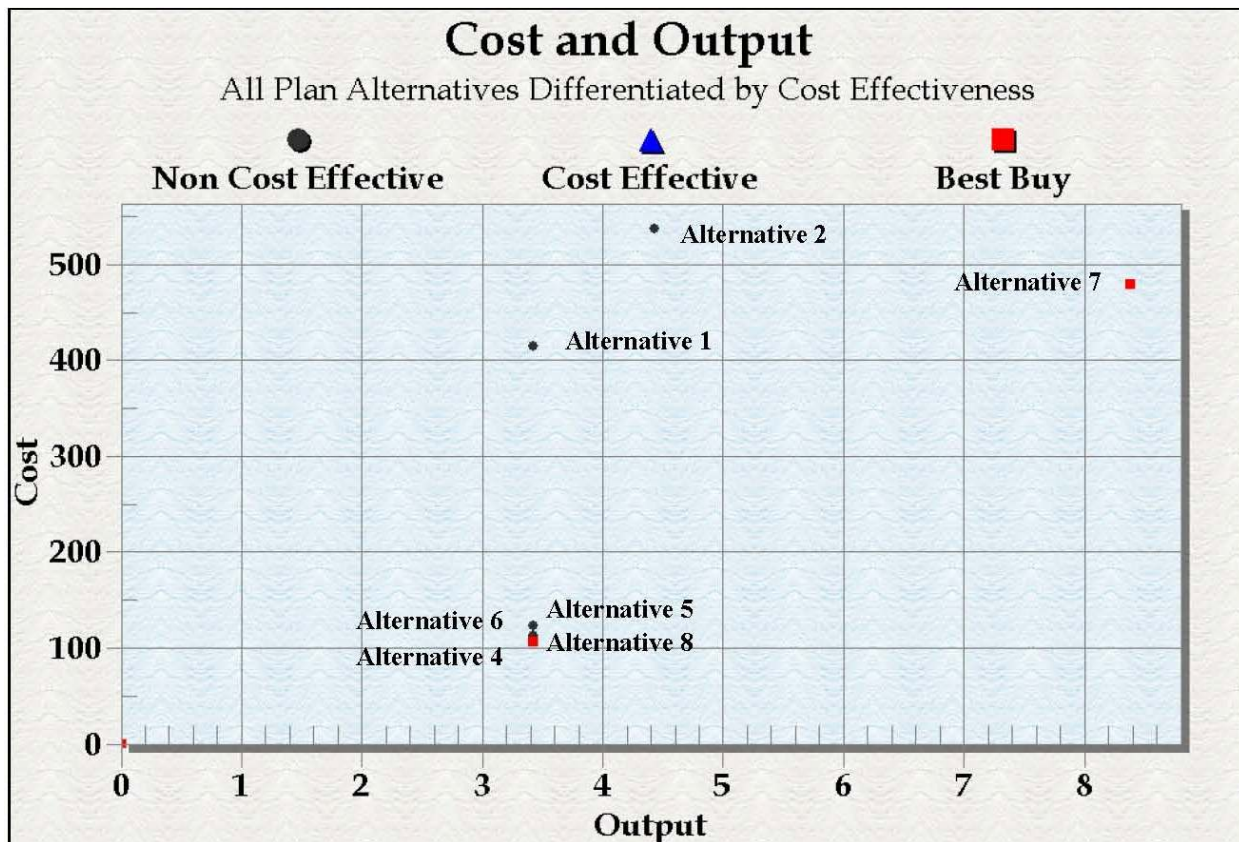
The eight alternatives include:

1. Creation of wetlands and other habitat quality features on-site within the Hollister Road detention basin complex (HCFCFCD Unit No. E500 03 00) equal to 3.33 AAHU's.
2. Creation of wetlands and other habitat quality features on-site within the Hollister Road detention basin complex (HCFCFCD Unit No. E500 03 00) equal to 13.24 acres, or 3.33 AAHU's.
3. Acreage in the GBWMB Subdivision A consisting of emergent, forested, and scrub-shrub wetlands equal to 3.33 AAHU's.
4. Acreage in the GBWMB Subdivision B equal to 3.33 AAHU's .
5. Combination of acreage in the GBWMB Subdivision A equal to 2.92 AAHU's and the on-site creation of wetlands equal to 0.41 AAHU within the Hollister Road detention basin complex.
6. Combination of acreage in the GBWMB Subdivision B equal to 2.92 AAHU's and the on-site creation of wetlands equal to 0.41 AAHU within the Hollister Road detention basin complex.
7. Combination of acreage in the GBWMB Subdivision A equal to 6.41 AAHU's and the on-site creation of wetlands equal to 7 acres, or 2.17 AAHU's, within the Hollister Road detention basin complex.
8. Acreage in the GBWMB Subdivision A consisting of emergent and forested wetlands equal to 3.33 AAHU's.

Alternative 3 is not feasible because this mitigation scenario would require 11.17 acres of mitigation. For the purpose of this analysis, HCFCFCD is considered to own 9.04 acres in the GBWMB Subdivision A. The remaining 2.13 acres would need to be purchased. However, acreage in Subdivision A is no longer available for purchase. Therefore, this alternative is not feasible and was not analyzed further.

Based on the results of the CE/ICA, only two of the seven remaining alternatives are Best Buy alternatives— Alternative 4: acreage in the GBWMB Subdivision B equal to 3.33 AAHU's and Alternative 7: combination of acreage in the GBWMB Subdivision A equal to 6.41 AAHU's and the on-site creation of wetlands equal to 7 acres, or 2.17 AAHU's. See Figure 1 for the cost and output of the

mitigation alternatives. (Plotting points for Alternatives 5, 6 and 8 are very close to each other and therefore cannot be distinguished separately on the figure.)



**Figure 1**  
**Cost and Output for Mitigation Alternatives**

Alternative 4 provides the lowest average cost per AAHU and the lowest incremental cost per unit of output (AAHU) while providing the 3.33 AAHU's required to mitigate for wetland impacts associated with the Recommended Plan. Alternative 7 provides 5.05 additional AAHU's above those provided by Alternative 4 and increases the cost by \$376,008. Although Alternative 4 is less expensive, providing 3.33 AAHU's at Subdivision B, Alternative 7 is the selected Mitigation Plan. Alternative 7 proposes to use a combination of the previously purchased acreage HCFCFCD already owns at Subdivision A, 9.04 acres or 6.41 AAHUs, and the on-site creation of wetlands, 7 acres or 2.17 AAHUs. Therefore, Alternative 7 provides 5.25 additional AAHU's  $([6.41-3.33]) + 2.17$  above those provided by Alternative 4 which will increase the cost by \$376,008.

The federal cost of the selected Mitigation Plan will equal the least cost-mitigation measure, Alternative 4 or \$103,148. The portion of the Mitigation Plan that exceeds the cost of the least cost-mitigation measure, \$376,008, would be paid for by the Local Sponsor. This plan was coordinated with agencies locally and is the preferred plan. The CE/ICA is provided in Appendix E.

#### **5.16.1.2 Wetland Mitigation Plan**

The project will impact 13.17 acres of wetlands with an AAHU of 3.33. Cost-shared mitigation for this impact is proposed as construction of 4.99 acres of wetlands at GBWMB Subdivision A, resulting in 6.41 AAHUs and a cost \$103,148. In addition, at the request of resource agencies, the Local Sponsor proposes to construct non cost-shared mitigation at the Hollister Road detention basin complex consisting of the creation of seven acres of forested wetlands with a value of 2.17 AAHUs and a cost of \$376,008. The cost will be paid solely by the Local Sponsor and was not considered in the costs and economic results of the project.

Impacts to wetlands would be mitigated at the GBWMB Subdivision A. The total amount of acreage purchased within the GBWMB Subdivision A to be used for mitigation of the Recommended Plan equates to 4.99 acres (6.41 AAHU's). Although Alternative 4, purchasing acreage at Subdivision B, is less expensive, HCFCD proposes to use the previously purchased acreage they already own at Subdivision A.

The GBWMB is currently a USACE approved mitigation bank (USACE permit number SWG-1993-01638). According to mitigation rule 33 CFR 332.3(b)(2), the District Engineer of the USACE should give preference to the use of mitigation banks when permitted impacts are located within the service area of the mitigation bank and the bank has the appropriate number and resource types available. The GBWMB is owned and operated by HCFCD and is approximately 18 miles east of the project area within the Greens Bayou watershed. The project impacts occur within the White Oak Bayou watershed and Harris County. Flows from both White Oak Bayou and Greens Bayou ultimately discharge to the San Jacinto River watershed. The GBWMB includes all of Harris County in its service area, and service area descriptions read as follows: "Harris County excluding riparian corridors under saline influence and all brackish or saline wetlands." The project impacted wetlands are not brackish or saline; therefore, the GBWMB service area can accommodate the project impacts. The proposed mitigation plan is in accordance with WRDA 2007 Section 2036 (c), Wetlands Mitigation, dated 6 November 2008. No Federal funds were used for Subdivision A of the GBWMB. Per 33 CFR Part 325 and 332 all 12 components for the GBWMB are discussed in the mitigation plan, which can be accessed online (<http://geo.usace.army.mil/ribits/index.html>).

Coordination with various resource agencies was initiated to obtain input during the development of the wetland mitigation plan. In particular, input from the USFWS was obtained via a PAL. Following are recommendations from the PAL and HCFCD's responses.

**Summary of USFWS PAL dated November 11, 2011, and  
HCFCD Responses dated January 4, 2012**

<b>PAL Recommendation</b>	<b>HCFCD Response</b>
Plant the wet-bottom basins with preferred wetland plant species.	Wetland plant species will be planted around the perimeter of the wet-bottom basins. Plant lists were sent to USFWS for review. The design of the basins includes "no maintenance zones" to allow wetland plants to grow.
The plants lists were reviewed. Plant a diverse seed bank of native grasses to promote growth during the winter and summer seasons.	A diversity of tree and grass species will be planted based on availability.
Locate all known Texas prairie dawn-flower (TPDF) sites in the project area and develop and implement a long-term plan to control the woody and exotic invasive herbaceous plants and perform annual quantitative surveys for the species.	Investigations to locate all known sites of TPDF in the project area have occurred and are documented in the EA. A TPDF management plan has been developed for both areas and is included in the Biological Assessment. Annual monitoring of the two sites will occur for five years.
Spot treat scattered individual plants and small infestations of deep-rooted sedge at Texas prairie dawn-flower sites	Deep-rooted sedge was not identified at either site. Annual monitoring will include survey for deep-rooted sedge; if species is identified within the area, it will be treated.
Basal stem or "hack and squirt" treatments should be applied to as many woody plants in close proximity to TPDF sites as possible. In less densely infested areas, individual trees should be felled (provided the stumps do not pose a hazard) and the stumps treated with the appropriate herbicide.	At the Fairbanks-North Houston detention basin site, HCFCD will remove woody species within 50 feet of the previous Texas prairie dawn-flower site to allow for necessary sunlight. HCFCD will follow USFWS recommendations for removal.
If feasible, prescribed fire should be considered as a management tool in the remaining stands of coastal prairie. Alternately, periodic mowing and haying could provide the disturbance necessary to prevent reestablishment of woody plants to benefit the Texas prairie dawn-flower and other prairie plants and plant communities of conservation concern.	HCFCD does not include the use of prescribed fire in its management plans. Mowing will occur within the detention basins, with the exception of in "no maintenance zone" areas located in wetland planting areas Mowing will occur once in October to allow prairie plants to advance through an entire lifecycle.
Identify and place 2 acres of coastal prairie in a conservation easement to offset the impacts to this rare habitat.	Prairie mitigation specifically for the White Oak Bayou Federal Flood Reduction project is not proposed. However, HCFCD values prairie habitat and will continue to seek feasible opportunities to add rescued prairie habitat.
Immediate restoration of TPDF habitat within all of the District's properties and right-of-ways.	Comment is not applicable to the White Oak Bayou Federal Flood Reduction project. Management plans for the project area are included in the Biological Assessment for the project.
Use of rock Straight and V weirs, and placement of instream boulder dissipaters to create instream fishery enhancements.	Creation of in stream fishery enhancements is not proposed as part of this project.
Develop a fisheries enhancement plan for White Oak Bayou that identifies suitable riffle, pool, and weir placement areas.	HCFCD does not propose to develop or incorporate a fisheries enhancement plan as part of this project.
Plant the fringe areas along White Oak Bayou with native grass species to create a "no-mow" buffer of not less than three feet from the bank's edge to provide cover for aquatic and terrestrial species.	Native herbaceous wetland species will be planted along the perimeter of the wet-bottom detention basins. "No maintenance zones" will be located within the detention basins to protect the planted wetland species.

<b>PAL Recommendation</b>	<b>HCFCD Response</b>
The use of off-road/all terrain vehicles (ATVs) should be discouraged in the detention basins.	HCFCD is aware of the impacts created by recreational ATV use within the detention basins and does discourage ATV use.
Develop an invasive flora and fauna management plan that encompasses all detention basin sites. Invasive species should not comprise more than two percent of the vegetation at a site.	HCFCD plans to plant native herbaceous wetland species and a diversity of tree and grass species. During mitigation monitoring efforts, any invasive species would be noted and dealt with in accordance with the Term Contract for Wetland Creation, Enhancement and Planting for Harris County Flood Control District throughout Harris County. This plan incorporates measures including but not limited to quarterly inspections of plants during first year of growth, replanting of zones that exceed 100 square feet of contiguous noxious species and replacement of desirable plants damaged by any weed or noxious plant control measures, and additional watering services for the woody plants during the first year after planting in the event extremely dry weather conditions.
Wetlands and trees should be monitored for a minimum of 10 years.	Monitoring will be conducted for a minimum of five years or until success criteria are met, whichever is longer. Survival survey of forested wetland plantings will be conducted at 60 days and 120 days with a second planting effort if survival within a 30-foot radius is less than 50 percent. Continued replanting will occur if survival rates are not met. Forested wetland , would be considered successful when at least 70 percent aerial coverage by desirable forested wetland plants is achieved within five years.
Plant native hardwood species to form dense motts in wetland features within islands. Sites with less than 70% tree survivability should be replanted and watered appropriately.	HCFCD has plans to plant trees on the island within the Hollister detention basin (E500-03-00) and will consider planting a dense matt of native hardwood species during the development of the planting plan. HCFCD will contract out the tree planting, mulching, and maintenance for the Hollister detention basin and will anticipate that the contractor maintain the care of these trees for two years. HCFCD has already planted a dense cluster of trees on the island within the Fairbanks-North Houston detention basin (E500-12).

As part of a local initiative to comply with resource agency requests, HCFCD would additionally create seven acres (2.17 AAHU's) of forested wetlands within the Hollister Road detention basin complex, referred to herein as Local Sponsor Volunteer Mitigation. This would bring the total acres and AAHU's of wetland mitigation to approximately 12 acres and 8.58 AAHU's, respectively.

The wetland creation as part of the local initiative would adhere to the following concepts.

Seven acres (2.17 AAHU's) of forested wetlands would be created within the Hollister Road detention basin complex. Native species of forested wetland vegetation would be planted at the Hollister Road

detention basin. The created forested wetland mitigation on the Hollister Road detention basin complex would be monitored for a minimum period of five years or until success criteria are achieved. In addition, native emergent wetland species would be planted among the trees and shrub species to create a forested wetland that consists of a shrub and tree stratum as well as an herbaceous vegetation stratum. This would create a balanced wetland area and reduce the potential for invasive species. Exhibit 5-1 presents a conceptual view of the wetland mitigation plan at the Hollister Road detention basin complex.

As previously described in Section 5.3.1.3, trees and shrubs would be planted in clusters in the Hollister Road detention basin complex to facilitate animal movements between the forested wetland area and other habitat features. The number of trees and shrubs would depend upon the availability of space between the wetland creation and tree preservation in the forested buffer zone. Table 5-6 identifies the forested wetland species, including wetland scrub-shrub species that would be used as appropriate based on the availability at the time of planting.

**Table 5-6  
Hollister Road Detention Basin Forested Wetland Species List**

Scientific Name	Common Name	USFWS Region 6 Indicator Status
<b>Large Trees</b>		
<i>Acer rubrum</i> var. <i>drummondii</i>	swamp red maple	FACW
<i>Betula nigra</i>	river birch	FACW
<i>Carya illinoensis</i>	pecan	FAC+
<i>Celtis laevigata</i>	sugarberry	FAC
<i>Fraxinus pennsylvanica</i>	green ash	FACW-
<i>Liquidambar styraciflua</i>	sweetgum	FAC
<i>Magnolia grandiflora</i>	southern magnolia	FAC-
<i>Magnolia virginiana</i>	sweetbay magnolia	OBL
<i>Nyssa aquatica</i>	water tupelo	OBL
<i>Nyssa sylvatica</i> var. <i>biflora</i>	black gum	FAC
<i>Pinus taeda</i>	loblolly pine	FAC-
<i>Platanus occidentalis</i>	eastern sycamore	FAC+
<i>Quercus alba</i>	white oak	FACU+
<i>Quercus falcata</i>	southern red oak	FACU
<i>Quercus laurifolia</i>	laurel oak	FACW
<i>Quercus lyrata</i>	overcup oak	OBL
<i>Quercus macrocarpa</i>	bur oak	FAC-
<i>Quercus michauxii</i>	swamp chestnut oak	FACW
<i>Quercus muehlenbergii</i>	chinquapin oak	FAC+
<i>Quercus nigra</i>	water oak	FAC+

Scientific Name	Common Name	USFWS Region 6 Indicator Status
<i>Quercus nuttallii</i>	Nuttall oak	FACW
<i>Quercus phellos</i>	willow oak	FACW
<i>Quercus shumardii</i>	Shumard oak	FAC
<i>Quercus virginiana</i>	live oak	FACU+
<i>Taxodium distichum</i>	bald cypress	OBL
<i>Ulmus americana</i>	American elm	FAC
<i>Ulmus crassifolia</i>	cedar elm	FAC
<b>Small Trees/Shrubs</b>		
<i>Cephalanthus occidentalis</i>	buttonbush	OBL
<i>Cercis canadensis</i>	redbud	Not Listed
<i>Craetageus marshallii</i>	parsley hawthorne	FAC
<i>Ilex decidua</i>	deciduous holly	FACW-
<i>Ilex vomitoria</i>	yaupon	FAC-
<i>Malvaviscus drummondii</i>	Turk's cap	Not Listed
<i>Myrica cerifera</i>	southern wax myrtle	FAC
<i>Prunus caroliniana</i>	cherry laurel	Not Listed
<i>Viburnum dentatum</i>	Arrowwood	FAC

Table 5-7 identifies the emergent wetland species that would be used at the Hollister Road detention basin as appropriate based on the availability at the time of planting.

**Table 5-7**  
**Detention Basin Emergent Wetland Species List**

Water Depth (inches)	Scientific Name	Common Name	USFWS Region 6 Indicator Status
<b>Marsh Margins</b>			
0-4	<i>Asclepeias incarnata</i>	swamp milkweed	FACW+
0-4	<i>Asclepeias rubra</i>	red milkweed	OBL
0-4	<i>Bacopa</i> spp.	water hyssop	OBL
0-4	<i>Canna glauca</i>	maraca amarilla	OBL
0-4	<i>Carex cherokeensis</i>	Cherokee sedge	FACW-
0-4	<i>Carex flaccosperma</i>	thinfruit sedge	FACW
0-4	<i>Carex lurida</i>	shallow sedge	OBL
0-4	<i>Crinum americanum</i>	swamp lily	OBL
0-4	<i>Cyperus drummondii</i>	Drummond's sedge	Not Listed
0-4	<i>Cyperus cuspidatus</i>	coastal plain flatsedge	NO
0-4	<i>Eleocharis microcarpa</i>	smallseed spikerush	OBL



Water Depth (inches)	Scientific Name	Common Name	USFWS Region 6 Indicator Status
0-4	<i>Eleocharis montevidensis</i>	sand spikerush	FACW+
0-4	<i>Erianthus giganteus</i>	sugarcane plumegrass	FACW+
0-4	<i>Erianthus strictus</i>	narrow plumegrass	FACW+
0-4	<i>Gratiola brevifolia</i>	hedge hyssop	FACW+
0-4	<i>Helianthus angustifolius</i>	sunflower	FAC
0-4	<i>Heteranthera dubia</i>	grassleaf mudplantain	OBL
0-4	<i>Heteranthera mexicana</i>	Mexican mudplantain	OBL
0-4	<i>Heteranthera reniformis</i>	kidneyleaf mudplantain	OBL
0-4	<i>Hibiscus militaris</i>	scarlet rosemallow	Not Listed
0-4	<i>Hibiscus moscheutos</i>	swamp rosemallow	OBL
0-4	<i>Hibiscus</i> spp.	marsh-mallow	Primarily OBL on List
0-4	<i>Hydrolea ovata</i>	water-leaf	OBL
0-4	<i>Hymenocallis</i> sp.	spider-lily	Primarily OBL
0-4	<i>Iris brevicaulis</i>	zig-zagiris	OBL
0-4	<i>Iris virginica</i>	blue flag (iris)	OBL
0-4	<i>Juncus effusus</i>	soft rush	OBL
0-4	<i>Lobelia cardinalis</i>	cardinal-flower	FACW+
0-4	<i>Ludwigia palustris</i>	american seedbox	OBL
0-4	<i>Panicum hemitomon</i>	maidencane	OBL
0-4	<i>Physostegia intermedia</i>	false dragon-head	OBL
0-4	<i>Polygonum hydropiperoides</i>	smartweed	OBL
0-4	<i>Polygonum pennsylvanicum</i>	Pennsylvania smartweed	FACW-
0-4	<i>Rhexia mariana</i>	Md. meadow-beauty	FACW+
0-4	<i>Rhexia virginiana</i>	common meadow-beauty	OBL
0-4	<i>Rhynchospora glomerata</i>	beak-rush	OBL
0-4	<i>Rudbeckia nitida</i>	cone-flower	FACU-
0-4	<i>Sabatia gentianoides</i>	pinewoods rose-gentian	FACW+
0-4	<i>Saururus cernuus</i>	lizard's tail	OBL
0-4	<i>Spartina patens</i>	marsh-hay cordgrass	FACW
0-4	<i>Spartina pectinata</i>	prairie cordgrass	FACW+
0-4	<i>Tripsacum dactyloides</i>	eastern gama grass	FAC+
<b>Shallow Emergent Marsh</b>			
2-6	<i>Eleocharis equisetoides</i>	spikerush	OBL
2-6	<i>Eleocharis montana</i>	mountain spikerush	OBL
2-6	<i>Eleocharis quadrangulata</i>	squarestem spikerush	OBL
2-6	<i>Orontium aquaticum</i>	goldenclub	OBL
2-6	<i>Pontederia cordata</i>	pickerelweed	OBL
2-6	<i>Proserpinaca palustris</i>	mermaid weed	OBL

Water Depth (inches)	Scientific Name	Common Name	USFWS Region 6 Indicator Status
2-6	<i>Sagittaria graminea</i>	grassy arrowhead	OBL
2-6	<i>Sagittaria lancifolia</i>	duck potato	OBL
2-6	<i>Sagittaria papillosa</i>	nipplebract arrowhead	OBL
2-6	<i>Sagittaria platyphylla</i>	delta arrowhead	OBL
<b>Tall Emergent Marsh</b>			
2-6	<i>Scirpus americanus</i>	olney bulrush	OBL
2-6	<i>Scirpus cyperinus</i>	woolgrass	OBL
4-8	<i>Scirpus californicus</i>	california bulrush	OBL
4-8	<i>Scirpus validus</i>	softstem bulrush	OBL
4-8	<i>Thalia dealbata</i>	fire flag	OBL
4-8	<i>Zizaniopsis miliacea</i>	giant cutgrass	OBL
<b>Floating Submerged Plants</b>			
4-8	<i>Ludwigia peploides</i>	smooth water primrose	OBL
4-8	<i>Ruppia maritima</i>	widgeon grass	OBL
> 1 ft	<i>Brasenia schreberi</i>	water-shield	OBL
> 1 ft	<i>Cabomba caroliniana</i>	fanwort	OBL
> 1 ft	<i>Ceratophyllum demersum</i>	coontail	OBL
> 1 ft	<i>Najas guadalupensis</i>	naids	OBL
> 1 ft	<i>Nuphar intera</i>	spatterdock	Not Listed
> 1 ft	<i>Nymphaea elegans</i>	blue water-lily	OBL
> 1 ft	<i>Nymphaea mexicana</i>	yellow water-lily	OBL
> 1 ft	<i>Nymphaea odorata</i>	fragrant white water-lily	OBL
> 1 ft	<i>Nymphoides aquatica</i>	floating-hearts	OBL
> 1 ft	<i>Potamogeton pusillus</i>	small pondweed	OBL
> 1 ft	<i>Potamogeton foliosus</i>	leafy pondweed	OBL
> 1 ft	<i>Potamogeton bicupulatus</i>	snailseed pondweed	NI

The wetland mitigation monitoring and success criteria have been coordinated with USFWS through the agency's Planning Aid Letter (PAL). These criteria include the following:

Wetland Mitigation Monitoring and Success Criteria

- Monitoring for a minimum of five years or until success criteria are met, whichever is longer
- Establishment of "no maintenance zones" to allow wetland plants to grow
- Survival survey of forested wetland plantings at 60 days and 120 days with a second planting effort if survival within a 30-foot radius is less than 50 percent
- Continued replanting if survival rates are not met

- Forested wetland mitigation would be considered successful when at least 70 percent aerial coverage by desirable forested wetland plants is achieved within five years

#### Texas Prairie-Dawn Flower

- Management to restore and maintain previous habitat at two sites known to historically contain Texas prairie-dawn flower
- Annual monitoring of these two sites for five years

Invasive exotics would be managed within the basin. Control technologies include flooding, mowing, herbicide, and mechanical removals, or some combination thereof. Mowing would be conducted approximately three times per year in grassy areas. Removal of Chinese tallow-trees and other exotics from tree clusters where mowing may be inaccessible would occur annually. Should species such as cattail develop, management would occur on an annual basis.

After initial forested wetland mitigation planting occurs in the basin, the contractor would conduct a survival survey of the area at 60 days and 120 days. If at least 50 percent survival within a 30-foot radius is not achieved, a second planting effort would be conducted. Monitoring of the wetland mitigation area would occur yearly during the peak growing season. Monitoring would occur for a minimum five-year period or until success criteria are met, whichever is longer. Replantings would continue to occur if survival rates are not met. Written reports detailing aerial coverage would be submitted yearly by HCFCFCD at the end of each growing season. The forested wetland mitigation area would be considered successful when at least 70 percent aerial coverage by desirable forested wetland plants is achieved within five years. The creation of seven acres of forested wetlands would create 2.17 AAHU's of forested wetlands and 0.13 AAHU's of scrub-shrub wetlands and is estimated to cost \$285,700, exclusive of any replanting costs. The cost of the seven acres would be paid entirely by the Local Sponsor.

## **6.0 COORDINATION WITH OTHERS**

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This chapter describes the coordination with others that was conducted during the development of this EA, including coordination during the initial Environmental Screening, which began in October 1998.

### **6.1 AGENCY COORDINATION**

The following is coordination that was initiated with federal, state, and local agencies in order to identify the major environmental concerns associated with the proposed action.

1. United States Army Corps of Engineers (USACE)
2. United States Coast Guard (USCG)
3. United States Fish and Wildlife Service (USFWS)
4. National Marine Fisheries Service (NMFS)
5. United States Environmental Protection Agency (EPA)
6. General Land Office (GLO)-Coastal Division
7. General Land Office (GLO)-Texas Coastal Management Program
8. Houston-Galveston Area Council (H-GAC)
9. Texas A&M University-State Data Center (TAMU-SDC)
10. Texas Parks and Wildlife Department (TPWD)
11. Texas Historical Commission (THC)
12. Harris County Historical Commission (HCHC)
13. Houston Archeological Society (HAS)
14. Texas Archeological Research Laboratory (TARL)
15. Texas Commission on Environmental Quality (TCEQ)
16. Texas Department of Transportation (TxDOT)
17. City of Houston (COH)-Bikeway Network Coordinator
18. City of Houston (COH)-Public Works and Engineering Department
19. City of Houston (COH)-Planning and Development Department
20. City of Houston (COH)-Parks and Recreation Department

Copies of all agency correspondence are located in Appendix C.

In addition to written correspondence, HCFCD also conducted several meetings to discuss the proposed action and potential impacts. Table 6-1 summarizes the dates and attendees of these meetings.

**Table 6-1  
Summary of Meetings and Field Trips**

<b>Date</b>	<b>Location</b>	<b>Attendees</b>	<b>Purpose</b>
<b>Meetings</b>			
July 16, 1998	HCFCO Office	HCFCO, Carter & Burgess, Citizens Advisory Committee (CAC)	CAC Meeting
September 17, 1998	Eisenhower High School	HCFCO, USACE, Carter & Burgess, Lentz Group, Residents	Public Meeting
November 11, 1998	HCFCO Office	HCFCO, Carter & Burgess, CAC	CAC Meeting
November 18, 1999	USACE-Galveston District Office	HCFCO, USACE, Carter & Burgess	Feasibility Scoping Meeting
March 25, 1999	HCFCO Office	HCFCO, Carter & Burgess, CAC	CAC Meeting
October 12, 2000	HCFCO Office	HCFCO, Carter & Burgess, CAC	CAC Meeting
November 29, 2000	St. Matthew Catholic Church	HCFCO, USACE, Carter & Burgess, Lentz Group, Residents	Public Meeting
November 30, 2000	Scarborough High School	HCFCO, USACE, Carter & Burgess, Lentz Group, Residents	Public Meeting
February 22, 2001	HCFCO Office	HCFCO, Carter & Burgess, CAC	CAC Meeting
July 26, 2001	HCFCO Office	HCFCO, Carter & Burgess, CAC	CAC Meeting
October 30, 2001	USACE-Galveston District Office	USACE, HCFCO, Carter & Burgess	Status Meeting
January 8, 2002	HCFCO Office	USACE, HCFCO, Carter & Burgess	Environmental Resource Meeting
January 22, 2002	HCFCO Office	HCFCO, City of Houston, Harris County, Carter & Burgess	Recreation Plan Workshop
October 15, 2002	HCFCO Office	HCFCO, Carter & Burgess, CAC	CAC Meeting
January 17, 2003	USACE Galveston District Office	HCFCO, Carter & Burgess, Charles Yoe	Status Meeting- New Optimization Process
October 9, 2003	San Luis Hotel, Galveston	HCFCO, Carter & Burgess, LJA, Civil Tech	Status Meeting
June 10, 2004	USACE Galveston District Office	HCFCO, Carter & Burgess, LJA, Civil Tech	Status Meeting- Without Project Conditions

<b>Date</b>	<b>Location</b>	<b>Attendees</b>	<b>Purpose</b>
August 5, 2004	HCFCFCD	HCFCFCD, Carter & Burgess, LJA, Charles Yoe, Civil Tech	Status Meeting-Plan Formulation
October 7, 2004	HCFCFCD	HCFCFCD, CAC	CAC Meeting
May 8, 2007	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
September 21, 2007	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
December 11, 2007	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
March 4, 2008	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
May 5, 2008	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
January 29, 2009	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
June 22, 2009	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
September 29, 2009	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
April 28, 2010	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
August 24, 2010	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
April 6, 2011	USFWS	HCFCFCD, USFWS, TPWD, EPA, TCEQ	Status Meeting
<b>Field Trips</b>			
April 27, 2005	White Oak Bayou	HCFCFCD, EPA	Field Trip to Project Area
May 31, 2005	White Oak Bayou	HCFCFCD, USACE, TCEQ	Field Trip to Project Area
October 24, 2006	White Oak Bayou	HCFCFCD, USACE, TCEQ	Field Trip to Project Area
September 7, 2007	White Oak Bayou	HCFCFCD, USFWS	Field Trip to Project Area
August 17, 2011	E500-02-00 and E500-03-00	HCFCFCD, USFWS	Field Trip to Project Area
April 5, 2012	E500-02-00 and E500-03-00	HCFCFCD, USFWS, Dr. Larry Brown	Field Trip to Project Area

Copies of all correspondence, including sign-in sheets from the above-listed meetings, are on file at HCFCFCD. Relevant information pertaining to the environmental issues obtained from the resource

agencies is included and discussed in the appropriate subsections of this chapter and in Chapters 4.0 and 5.0.

For the primary purpose of showing the resource agencies the project area of the White Oak Bayou federal study, six resource agency field trips were conducted: April 27, 2005, May 31, 2005, October 24, 2006, September 7, 2007, August 17, 2011, and April 5, 2012. Invitations were sent to the USFWS, NMFS, EPA, TPWD, THC, TCEQ, and GLO for one or more of the field trips. Representatives from USACE and TCEQ attended the May 31, 2005 and October 24, 2006 field trip, the EPA attended the April 27, 2005 field trip, and the USFWS attended the September 7, 2007, August 17, 2011 and April 5, 2012 field trip.

During the April 27, 2005 field trip, the EPA expressed a desire to see White Oak Bayou as a self sustainable, stable system (use of fluvial geomorphological design).

During the May 31, 2005 field trip, the TCEQ raised concerns about the option to concrete line the channel. The TCEQ also expressed that both isolated and jurisdictional wetlands should be mitigated for in the federal project.

During the October 24, 2006 field trip, TCEQ asked if the stream would continue to meander. The HCFCD stated that meanders would be considered where appropriate. There were discussions concerning no loss of aquatic habitat, where HEP data would be collected, that the existing pools were positive environmental features, that having a permanent low-flow channel would be positive, observation of erosion/in the Jersey Village area, discussion of impacts to vegetation along the channel and adjacent detention basins and discussion of how water outfalls from the basin to the bayou.

Field trips with the USFWS in 2007, 2011, and 2012 discussed potential remnant prairie and Texas prairie dawn-flower habitat.

In addition, meetings with USFWS and TPWD were held on August 2, 2006, October 10, 2006, November 13, 2006, and September 21, 2007 to obtain comments regarding the HEP modeling, including input data, field data collection, and resources to be mitigated. Since 2007, the Local Sponsor has continued to meet two to four times a year with the resource agencies to review and coordinate this project.

For the Draft EA, a public notice was published and distributed to interested federal, state, and local agencies, Native American Tribes, private organizations, and individuals regarding its completion. The public notice provided a description of the proposed project, how to comment on the project, and how to request a public hearing. In addition to the public notice, a copy of the Draft EA was sent to interested agencies along with a 30-day public comment period. Specifically, a copy of the Draft EA was sent to the following agencies:

USFWS  
EPA  
TCEQ  
TPWD  
THC

Appendix I describes in more detail all the comments received as part of the public and agency review of the draft EA and the responses.

## **6.2 PUBLIC INVOLVEMENT**

Public involvement in the planning process and the development of the Recommended Plan was achieved primarily through public meetings, through the Citizens Advisory Committee ("CAC") established for the project, and through other public involvement activities conducted by the Local Sponsor. The following paragraphs describe each.

### **6.2.1 Public Meetings**

Two public meetings were scheduled at key times during the planning process.

The first meeting was held on September 17, 1998, at the start of the study with the purpose of introducing the public to the project and the project team. The public was presented background information on previous improvement projects and studies within the watershed and was provided an overall description and schedule of the project planning process. Flooding problems were confirmed and additional flooding problems were identified. A public notice was mailed to all residents, agencies, organizations, media, and individuals known to be interested in the project. The notice was made to solicit additional information on the problems in the watershed. Approximately 500 persons attended the meeting. A larger-than-expected audience attended the meeting because of the heightened public awareness of flooding experienced during the September 11, 1998, Tropical Storm Frances event that affected many of the residents in the watershed. In addition to introducing the public to the feasibility study, a general overview of the recent flooding from Tropical Storm Frances was presented. The general tone of the meeting was that of anger and frustration due to residents dealing with flood damaged homes and property from Tropical Storm Frances, which occurred six days before the meeting. No alternatives were presented at this meeting.

A second series of meetings was held on November 29 and 30, 2000. Two identical meetings were held at two different locations along the White Oak Bayou watershed to present the status of the federal planning study along with some of the alternatives under consideration. On November 8, 2000, postcards were mailed to property owners within the White Oak Bayou watershed.

The first meeting on November 29, 2000, provided a convenient location to citizens in the upstream section of the watershed. The second meeting on November 30, 2000, provided a location convenient to



those in the downstream section of the watershed. The formal presentation described the background information on the project, completed and ongoing work, current status of the GRR including goals, objectives, and constraints, and the alternatives being considered. Meeting attendees were provided handouts of an agenda for the meeting, a copy of the slide presentation, a comment form, a Fall 2000 issue of a newsletter published by HCFCD, and an index card to write in any questions and/or comments. A total of 452 persons signed attendance sheets at the two meetings. In general, the public responded favorably to the material presented

### **6.2.2 Citizens Advisory Committee**

The HCFCD establishes CAC's for its important planning studies, and one was established for this project. The purpose of the CAC is as follows:

1. Provide a broad cross-section of the groups of citizens that have a vested interest in the watershed. Groups represented include homeowners, businesses in the watershed, development interests, environmental groups, and users of the watercourse and surrounding area.
2. Act as a sounding board for ideas developed by the consultant and HCFCD, and also to provide their own ideas about what should be considered in the planning process.

Eight meetings of the advisory committee were held at selected milestones during the project. Meetings were held at HCFCD offices or at Harris County TranStar. The CAC provided input and guidance throughout the planning process and supports the Recommended Plan. The meetings were held on July 16, 1998; November 11, 1998; March 25, 1999; October 12, 2000; February 22, 2001; and July 26, 2001.

### **6.2.3 Other Activities**

The following is a list of other activities conducted to insure public involvement and communication for the project.

1. The White Oak Bayou Association (WOBA) is a citizen's organization that has participated in the public involvement process. HCFCD attended numerous meetings of the WOBA.
2. HCFCD has held and continues to hold coordination meetings with the affected municipalities, the City of Jersey Village and the City of Houston.
3. Newspaper articles have been published regarding the project and the status of construction activities.
4. In areas where individual residents and landowners are impacted by the project, the HCFCD has communicated directly with the affected persons.
5. The HCFCD maintains a website where information on its projects is available. A specific page is dedicated to the White Oak Bayou Flood Damage Reduction Plan. This page describes the project history and the ongoing project activities and provides a map of the project area. Over the last two and one half years, the page has averaged approximately 220 unique visitors per month.

6. This draft Environmental Assessment as well as the draft Final Report for the project would be distributed to public libraries within the project area and placed on the HCFCFCD website for review and receipt of public comment, when these documents have been approved for publication by the USACE-HQ.

#### **6.2.4 Draft EA**

The Tentatively Recommended Plan developed during the Plan Formulation process was presented in the February 2013 draft of the GRR and the EA . This version of the GRR and EA was distributed to required agencies, interested parties and to the public for review and comment as part of the NEPA process. Significant public comment was received in opposition to the acquisition of the area identified as the west cell of the Fairbanks - North Houston detention basin for construction of additional detention storage. Concerns were raised regarding the historical, social, and environmental significance of the area to be acquired. Based on these concerns the Local Sponsor reviewed the performance of the flood protection plan resulting from the removal of this area from the plan. It was decided to adopt the resulting plan which contains all the features of the Tentatively Recommended Plan except the west cell as the Recommended Plan. This plan meets the planning objectives and provides similar flood protection benefits in comparison to the Tentatively Recommended Plan and avoids the social, historical, and environmental impacts of relocating 11 residences in a sensitive area.

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## **7.0 REGULATORY COMPLIANCE**

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This chapter of the EA summarizes the applicable regulatory requirements and required coordination for the proposed action. Construction carried out to date by HCFCD (within the federal project) was done in a manner that satisfies NEPA requirements in the interest of receiving federal reimbursement upon project approval, in addition to all Federal, State, and local laws and regulations. Future project construction would also be carried out in accordance with these same requirements, laws, and regulations. The proposed action is considered to be the Environmentally Preferred Alternative.

### **7.1 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT**

This EO requires agencies to take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains.

To increase capacity of the existing channel within the middle and upper reaches of White Oak Bayou and thereby reduce flooding and flood damages within the watershed, the proposed action would require deepening and widening the channel and excavation of detention facilities within or adjacent to the floodplains of White Oak Bayou. The end result of implementing the Recommended Plan, RF-31, which would be the creation of additional storage and conveyance in or adjacent to the floodplain, would have a beneficial effect on the existing floodplain. The objectives and requirements of this Recommended Plan mirror the mandates of the EO.

### **7.2 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS**

This EO requires agencies to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.

Based on environmental investigations, the Recommended Plan, RF-31, would impact wetlands (see Section 5.6.2 for discussion of potential wetland impacts). Mitigation is proposed for the unavoidable destruction, loss, or degradation of wetlands (as discussed in Section 5.16.2). Approximately 4.99 acres of wetlands would be purchased at the GBWMB Subdivision A to mitigate for the approximately 13 acres of impacts. Additionally, as a local effort, seven acres of wetlands would be created within the Hollister detention basin.

### **7.3 COAST GUARD AUTHORIZATION ACT OF 1982**

This Act authorizes the USCG to regulate the construction of bridges across navigable waters of the U.S.

Implementation of the Recommended Plan, RF-31, would not require replacement or modification of any bridges; therefore, coordination with the USCG is not required under the Recommended Plan.

## **7.4 CLEAN WATER ACT OF 1977**

This Act is an amendment to the Federal Water Pollution Control Act of 1972 and it sets the basic structure for regulating discharges of pollutants into waters of the U.S. The Act makes it unlawful to discharge stormwater from construction sites into a water of the U.S. without a permit.

Greater than 3 acres of wetlands would be impacted by the Recommended Plan. Under TCEQ guidance, the Recommended Plan qualifies as a Tier II project. Tier II projects require completion of a 401 Certification Questionnaire form and an Alternatives Analysis checklist. These completed forms are included in Appendix D. Water quality certification would be obtained from TCEQ prior to issuance of a FONSI by the USACE. Findings of this Section 404(b)(1) evaluation demonstrate that the Recommended Plan would be in compliance with this Act (see Appendix D).

Because this project would disturb more than 5 acres of land, HCFCFCD is required to comply with the TCEQ TPDES General Permit for Construction Storm Water Runoff. A NOI, stating that a SW3P has been developed, would be filed with the TCEQ prior to the beginning of construction. Implementation of the SW3P would minimize damage as required by Section 402 (p) of this Act.

At least one control from each of the three categories (erosion, sedimentation, and post-construction total suspended solids) must be implemented. The controls, known as BMP's, (Best Management Practices) are utilized to comply with the Recommended Plan. Sod would be used to deal with erosion control. Silt fences would be set up to control sedimentation. Vegetative filter strips would be used to control total suspended solids. Other control techniques may be employed as conditions warrant on the construction site(s).

### **7.4.1 Clean Water Act Section 404(b)(1) Evaluation Summary**

No significant adaptation of the 404(b)(1) guidelines was made for this project. The planned disposal of fill material would not violate any applicable state water quality standards with the exception of minor turbidity excursions during significant rain events. This temporary effect is unavoidable in construction areas. The excavation and disposal operation would not violate the Toxic Effluent Standards of Section 307 of the CWA.

Use of the selected disposal sites would not harm any endangered species or their critical habitat.

The proposed excavation, fill and soil placement disposal activities would not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. The life stages of aquatic

life and other wildlife would not be adversely affected. Significant adverse effects on aquatic ecosystem diversity, productivity and stability, and recreational, aesthetic and economic values would not occur.

Appropriate steps to minimize potential adverse impacts of the discharge on aquatic systems include incremental construction along White Oak Bayou, construction controls, revegetation after completion of construction, avoidance of impacts to wetlands and endangered species locations, and implementation of the environmental quality measures included at the detention basin complexes.

On the basis of the guidelines, the proposed excavation and fill sites for discharge of material include appropriate and practical conditions to minimize pollution or adverse effects to the aquatic ecosystem.

For the complete Section 404(b)(1) Evaluation see Appendix D.

## **7.5 NATIONAL HISTORIC PRESERVATION ACT OF 1966, AS AMENDED**

This Act establishes as federal policy the protection of historic properties or places and their values in cooperation with other nations and with state and local governments. It establishes a program of grants-in-aid to state governments for historic preservation activities. Subsequent amendments designated the SHPO or the Tribal Historic Preservation Officer as the individual responsible for administering programs in the state or reservations. The Act also creates the ACHP. Section 106 of the Act requires federal agencies to take into account the effects of their undertaking on historic properties, and afford the ACHP a reasonable opportunity to comment.

The Recommended Plan, RF-31, would not adversely affect any cultural resources based on archival research, field investigations, and agency coordination (see Section 5.7). There are however, two sites that would need to be assessed upon acquisition of the properties, as right-of-entry has been denied at this time. A PA has been prepared to more fully address the consultation requirements of Section 106 and is included in Appendix G. For the Recommended Plan, the PA supersedes the 1980 Memorandum of Agreement ("MOA"). These sites would be investigated per PA requirements. Copies of correspondence with the THC are included in Appendix G. As the project moves forward, the Local Sponsor would execute the proposed action in accordance with the PA and apprise the USACE and SHPO of results and resolution of cultural resource issues.

## **7.6 ENDANGERED SPECIES ACT OF 1973**

The Act provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found. Section 7 (a)(2) of this Act requires each federal agency to ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species.

Since the Recommended Plan, is a federally authorized and funded project, consultation with the USFWS is required to determine the effects of the proposed action on threatened or endangered species. This consultation process, referred to as a Section 7 consultation, was initiated during the EA process. The HCFCD prepared a Fish and Wildlife CAR and a subsequent PAL was prepared with authorization from the USFWS and under the guidelines of the Fish and Wildlife Coordination Act, dated July 6, 2001. The PAL was sent to USACE on November 9, 2011. A copy of the CAR and PAL are located in Appendix A. A summary of the PAL recommendations and responses is also included in Section 5.16 Mitigation. A draft BA has been prepared and submitted to the USFWS.

As discussed in Section 5.4, the Recommended Plan would not adversely affect any threatened or endangered species or their preferred habitat. The BA mentioned above has been submitted to the USFWS for review to seek their written concurrence that avoidance and management measures are sufficient to justify authorization of the Recommended Plan. Copies of correspondence with the USFWS are included in Appendix C.

## **7.7 NATIONAL ENVIRONMENTAL POLICY ACT OF 1969**

The National Environmental Policy Act of 1969, as amended (Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, §4(b), September 13, 1982) establishes a national policy for the environment and provides for the establishment of a Council on Environmental Quality.

This document was prepared in conformance with the requirements of the NEPA 40 CFR 1500–1508. All known impacts on economic, community, terrestrial, and aquatic resources have been identified. No significant adverse impacts on these resources were identified.

## **7.8 FISH AND WILDLIFE COORDINATION ACT, AS AMENDED**

This Act authorizes the Secretaries of Agriculture and Commerce to provide assistance to and cooperate with federal and state agencies to protect, rear, stock, and increase the supply of game and fur-bearing animals, as well as to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife. This Act proposes to assure that fish and wildlife resources receive equal consideration with other values during the planning of water resources development projects.

As amended in 1946, the Act requires consultation with the USFWS and state fish and wildlife agencies where the "waters of any stream or other water body are proposed or authorized, permitted or licensed to be impounded, diverted... or otherwise controlled or modified" by any agency under a federal permit or license. Consultation is to be undertaken for the purpose of "preventing loss of and damage to wildlife resources."

The Recommended Plan was developed in cooperation with the USFWS and TPWD and is in compliance with this Act. Consultation with these agencies is discussed in Section 6.0 and copies of written correspondence are provided in Appendix C. As discussed in Section 5.3.2, the Recommended Plan would not substantially impact existing terrestrial or aquatic habitats, given the limited amount of undisturbed habitat remaining in the project area. The proposed action is expected to have temporary adverse effects to wildlife during construction activities and long-term beneficial effects resulting from the creation of new habitat and preservation of open areas within the project area. Construction activities would be fully coordinated with the appropriate federal and state resource agencies. A CAR was prepared and approved for the federal project and a subsequent PAL has been received and addressed (refer to Section 5.16 for a summary of the PAL recommendations and responses).

## **7.9 COASTAL ZONE MANAGEMENT ACT**

This Act encourages states to preserve, protect, develop, and where possible, restore or enhance valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats.

Coordination with the Coastal Coordination Council was initiated to confirm the Coastal Zone Management Plan boundary and consistency review requirements. Copies of correspondence are provided in Appendix C. It was determined that the proposed channel modifications occur outside the limits of the Coastal Zone Management Plan boundary and that the proposed modifications would not impact any wetlands within the extended wetland jurisdictional area of the Coastal Zone Management Plan boundary. A certification of consistency is not required for the Recommended Plan, RF-30 LA NSB1 (see Section 5.6.5).

## **7.10 EXECUTIVE ORDER 12898, FEDERAL ACTION TO ADDRESS ENVIRONMENTAL JUSTICE IN MINORITY POPULATIONS AND LOW-INCOME POPULATIONS**

This EO, signed by President Clinton on February 11, 1994, requires that minority and low-income populations not receive disproportionately high and adverse human health or environmental effects. This EO requires agencies to ensure that achieving environmental justice is part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

An environmental justice analysis was performed to determine the potential effects of the Recommended Plan, RF-31, on low-income and minority populations. As discussed in Section 5.13, the proposed action would not result in disproportionate impacts to minority or low-income populations.



### **7.11 EXECUTIVE ORDER 13166, IMPROVING ACCESS TO SERVICES FOR PERSONS WITH LIMITED ENGLISH PROFICIENCY**

This EO, signed by President Clinton on August 11, 2000, calls for all agencies to ensure that their federally-conducted programs and activities are meaningfully accessible to LEP individuals.

LEP populations within the project area were identified. HCFCD would publish future public meeting notices in English and Spanish newspapers and would provide means of communication to LEP individuals at future public involvement activities. The requirements of EO 13166 appear to be satisfied.

### **7.12 CLEAN AIR ACT OF 1970**

This Act is the comprehensive federal law that regulates air emissions from area, stationary, and mobile sources. This law authorizes the EPA to establish NAAQS to protect public health and the environment.

Pursuant to the General Conformity Rule, the state must make a determination and document that the total of direct and indirect emissions from the action, or portion thereof, would result in a level of emissions that, together with all other emissions in the HGB non-attainment area, would not exceed the emissions budgets specified in the SIP. Based on evaluation of the proposed action emissions, the NO<sub>x</sub> and VOC emissions do not exceed the current *de minimis* threshold of 25 TPY for the duration of the proposed action. As a result, proposed action emissions are deemed to be in general conformity with the HGB SIP and no further analysis is required.

### **7.13 EXECUTIVE MEMORANDUM-ENVIRONMENTALLY AND ECONOMICALLY BENEFICIAL PRACTICES ON FEDERAL LANDSCAPED GROUNDS**

This presidential memorandum, signed August 10, 1995, requires agencies to use, where cost-effective and to the extent practicable, beneficial landscaping practices. It states that agencies would: (1) use regionally native plants for landscaping; (2) design, use, or promote construction practices that minimize adverse effects on the natural habitat; (3) seek to prevent pollution by, among other things, reducing fertilizer and pesticide use; (4) implement water-efficient and runoff reduction practices; and (5) create demonstration projects employing these practices. Plantings included with this project would be in compliance with the Executive Memorandum and the guidelines for environmentally and economically beneficial landscape practices.

### **7.14 EXECUTIVE ORDER 13112, INVASIVE SPECIES**

This EO, issued February 3, 1999, requires federal agencies to prevent the introduction of invasive species and provide for their control and then to minimize the economic, ecological, and human health impacts that invasive species cause.

In accordance with this EO, native plant species of grasses, shrubs, or trees would be used in the landscaping and in the seed mixes where practicable. No noxious species would be used to revegetate the disturbed areas, and soil disturbance would be minimized, to the extent practical, to ensure that invasive species do not establish in the project area. Invasive species would be managed as part of the wetland mitigation plan.

#### **7.15            23 CODE OF FEDERAL REGULATIONS 771.135, SECTION 4(F)**

This regulation establishes as federal policy the protection of publicly owned parklands and recreational areas, wildlife and waterfowl refuge lands, and historic sites of national, state, or local significance as determined by the federal, state, or local officials having jurisdiction.

There are several public parks and pathways located within the project area. Implementation of the Recommended Plan, RF-31, would not require the taking of a potential Section 4(f) property. No temporary construction easements and no additional ROW are required from the six parks. Although impacts would occur to 3.5 miles of the 9.81 mile West White Oak Bayou Trail Extension, the City has use of the HCFCD ROW for the trail with the understanding that HCFCD would take priority over City projects. Any impacted trails would be restored to pre-impacted conditions. A Section 4(f) evaluation is not required.

#### **7.16            MIGRATORY BIRD TREATY ACT**

The Migratory Bird Treaty Act, originally passed in 1918, provides protection for migratory birds. Under this Act, it is unlawful to take, import, export, possess, buy, sell, purchase, or barter any migratory bird. Feathers or other parts, nests, eggs, and products made from migratory birds are also covered by the Act. Take is defined as pursuing, hunting, shooting, poisoning, wounding, killing, capturing, trapping, or collecting.

Construction would be accomplished in compliance with guidance concerning migratory birds that is in effect at the time construction begins. Measures would be taken to avoid impacts to migratory birds, their eggs, and their young.

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## **8.0 SUMMARY**

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This chapter of the EA summarizes alternative plans and the Recommended Plan (RF-31), also considered to be the Environmentally Preferred Alternative.

### **8.1 ALTERNATIVE FORMULATION AND OPTIMIZATION PROCESS**

During the initial stages of alternative formulation, flood control measures or components to reduce flood damages along White Oak Bayou were identified through hydraulic and hydrologic modeling and engineering and economic analyses. Several versions of the components were then further analyzed to determine their effectiveness and economic feasibility. An environmental screening investigation was performed to evaluate each of the components. Findings of the economic analysis identified channel modifications and storm water detention basins as the components that provided the greatest net economic benefit. A total of four alternative plans, including the No Action Alternative, TG.2 (the Earthen Channel Plan), TG.8 (the Concrete Channel Plan), and FNH.3+JR.4 (the Detention Basin Plan) were developed using a combination of the components evaluated in the environmental screening. Alternative TG.2 was optimized resulting in Alternative TG.2A1. This plan was further modified based on changes to certain plan components proposed by HCFCD and updated cost and economic data. This plan, identified as plan RF-31, maximizes net economic benefit and is considered to be the basis for the Recommended Plan. The alternatives described in this EA include the Recommended Plan and the No Action Alternative.

### **8.2 ALTERNATIVES GIVEN CONSIDERATION**

#### **8.2.1 Screened Alternatives**

Base Alternatives TG.8 and FNH.3+JR.4 were not selected because they failed to reasonably maximize the net economic benefit. The net economic benefits of these alternatives were generally in the \$15 million to \$19 million range.

#### **8.2.2 No Action**

Under the No Action Alternative, the channel would continue to contain only a 10-year (10 percent) probability flood event, and homes and businesses would continue to flood, resulting in billions of dollars in losses and an increased probability for loss of life. Average annual damages are estimated at \$61 million, based on 2012 price levels. This alternative fails to meet the purpose and need of the project and is therefore, not the recommended alternative.

## **8.3 RECOMMENDED PLAN**

The Recommended Plan (RF-31) would fulfill the stated needs for the proposed action and would satisfactorily meet the project objectives and goals. The Recommended Plan consists of the following major components:

Mid-Reach channel modifications from Cole Creek to Gessner Road.

Mid-Reach channel modifications from Gessner Road to HCFCD drainage number E200-00-00 in Jersey Village, including modification of two existing HCFCD drainage channels (E200-00-00 and E141-00-00).

Upper-Reach channel modifications from HCFCD drainage number E200-00-00 to FM 1960.

2,938 acre-feet (353 acres) of stormwater detention within four detention basin complexes.

Recreation plan including a linear park from Hollister Road to north of West Road and components within the detention basins

Wetlands mitigation consisting of 4.99 acres of wetlands at the GBWMB. Local Sponsor Volunteer Mitigation, consisting of seven acres of wetland construction at one of the detention basins, is also proposed that is to be paid for 100 percent by the HCFCD separate from the Federal-non-federal cost sharing.

(Between January 1, 1998 and 2011, HCFCD has completed or partially completed construction on the four detention basins. Channel modifications have also been constructed along White Oak Bayou from North Houston-Rosslyn Road (near channel E122-00-00) to Beltway 8. The construction was initiated by HCFCD as a local effort to alleviate future flooding along White Oak Bayou after severe damage occurred in the project area from Tropical Storm Frances in September 1998 and Tropical Storm Allison in June 2001. All construction has been compatible with the Recommended Plan.)

The Recommended Plan would substantially reduce flooding and flood damages along White Oak Bayou while maximizing net economic benefits of all the alternatives evaluated. Upon completion of all components of this alternative, 22 percent of the homes that are currently within the 100-year (1 percent) floodplain would now be located outside of the 100-year (1 percent) floodplain, 52 percent of the homes that are currently within the 25-year (4 percent) floodplain would now be located outside of the 25-year (4 percent) floodplain, and 96 percent of the homes that are currently within the 10-year (10 percent) floodplain would now be located outside of the 10-year (10 percent) floodplain. The flood control components of this alternative achieve net economic benefits of approximately \$31 million annually. Average annual damages are reduced by approximately 58 percent, from \$61 million to \$26 million, with an estimated first construction cost totaling \$106 million.

### **8.3.1 Support Rationale**

The Recommended Plan was designed to avoid potential impacts to natural and cultural resources to the greatest extent possible while minimizing and compensating for unavoidable impacts. To the greatest

possible extent the design of the project was modified to avoid and minimize impacts to known occurrences of wetlands, protected species, cultural resources and hazardous materials.

In summary, there is no significant public opposition to the proposed action. Implementation of the Recommended Plan would not result in any significant impacts on the human and natural environments and is considered to be the Environmentally Preferred Alternative. All potential significant impacts would be avoided, minimized and mitigated. Any temporary adverse impacts would be outweighed by the long-term beneficial effects of reducing flooding along the middle and upper reaches of White Oak Bayou.

HCFCFCD has agreed to the following project commitments for the Recommended Plan:

Any changes to the Recommended Plan that take place during the remaining construction phase would be coordinated with the appropriate resource agencies.

Construction contractors would be required to implement beneficial planting practices, including the use of native plant species to revegetate disturbed areas to minimize adverse impacts on the wildlife habitat and to partially ensure that invasive species do not establish in the project area as a result of the project.

Contractors would be required to construct under an SW3P and to ensure coverage under a TCEQ TPDES General Permit. An NOI would be required to be filed with the TCEQ.

The GBWMB Subdivision A would be utilized to offset the unavoidable loss of emergent, forested, and scrub-shrub wetlands. A total of 4.99 acres (6.41 AAHU's) of wetlands would remain at the GBWMB to mitigate impacts to the 3.33 AAHU's of emergent and forested wetlands AAHU's. As part of a local effort, the Hollister Road detention basin complex would be designed to incorporate the creation of a variety of forested wetland species within the basin. A total of seven acres (2.17 AAHU's) of forested wetland would be created in the Hollister Road detention basin complex.

In the unlikely event that hazardous materials are encountered during construction, appropriate measures for proper management of the contamination would be initiated with TCEQ and all applicable state and federal regulations. A Worker Health and Safety Plan would be prepared to address issues such as contamination of work areas and excavated soils.

Archaeological surveys would be performed in the areas HCFCFCD does not own once right-of-entry has been obtained. If evidence of archeological deposits is encountered during construction, work in the immediate area would cease and THC would be contacted to initiate accidental discovery procedures.

Construction would be accomplished in compliance with guidance concerning migratory birds that is in effect at the time construction begins. Appropriate measures would be taken to avoid impacts to migratory birds, their eggs, and their young.

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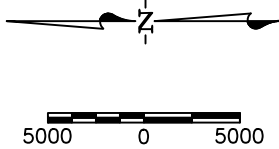
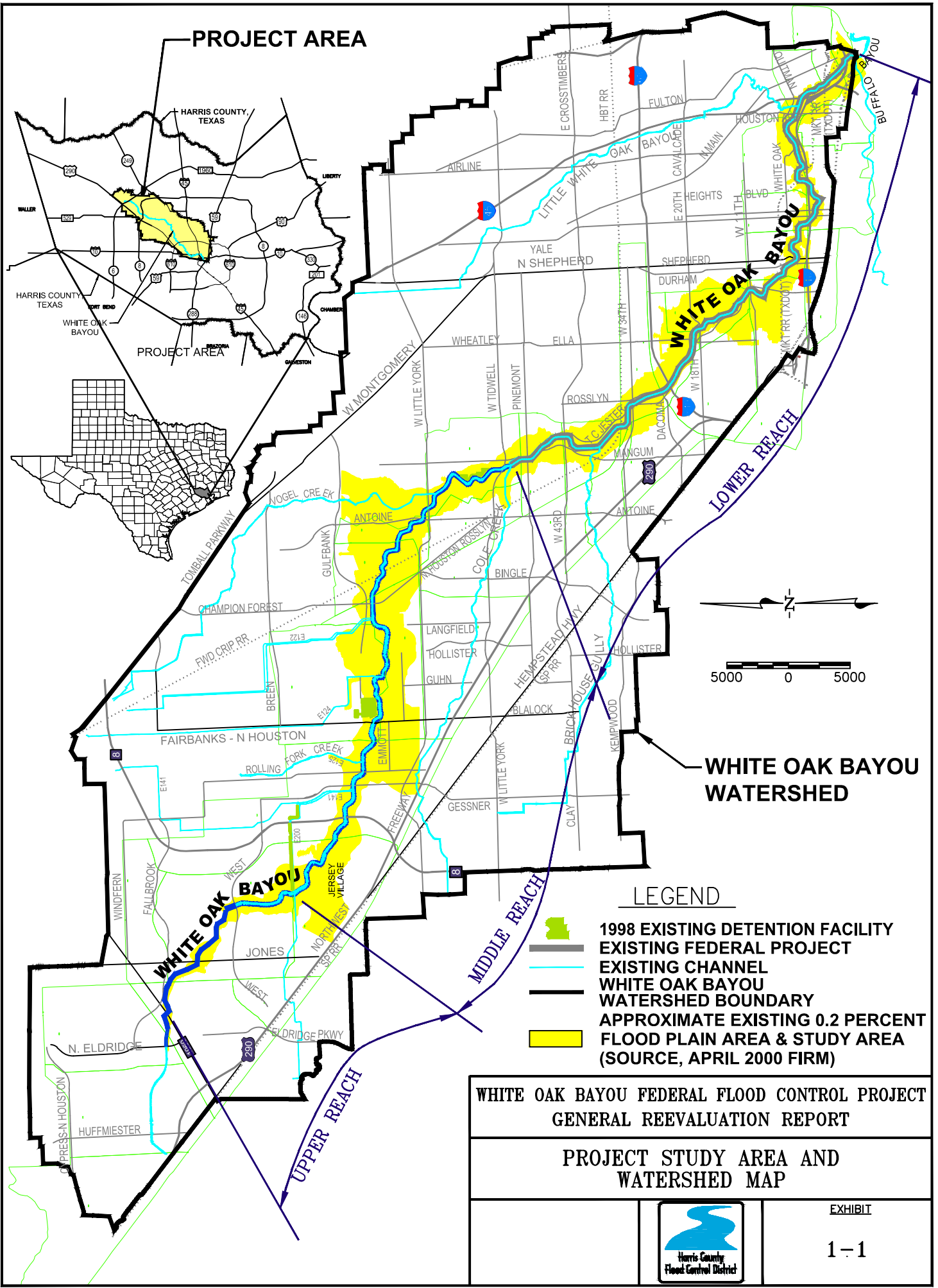
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# Exhibits

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**LEGEND**

-  1998 EXISTING DETENTION FACILITY
-  EXISTING FEDERAL PROJECT
-  EXISTING CHANNEL
-  WHITE OAK BAYOU WATERSHED BOUNDARY
-  APPROXIMATE EXISTING 0.2 PERCENT FLOOD PLAIN AREA & STUDY AREA (SOURCE, APRIL 2000 FIRM)

**WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT  
GENERAL REEVALUATION REPORT**

**PROJECT STUDY AREA AND  
WATERSHED MAP**



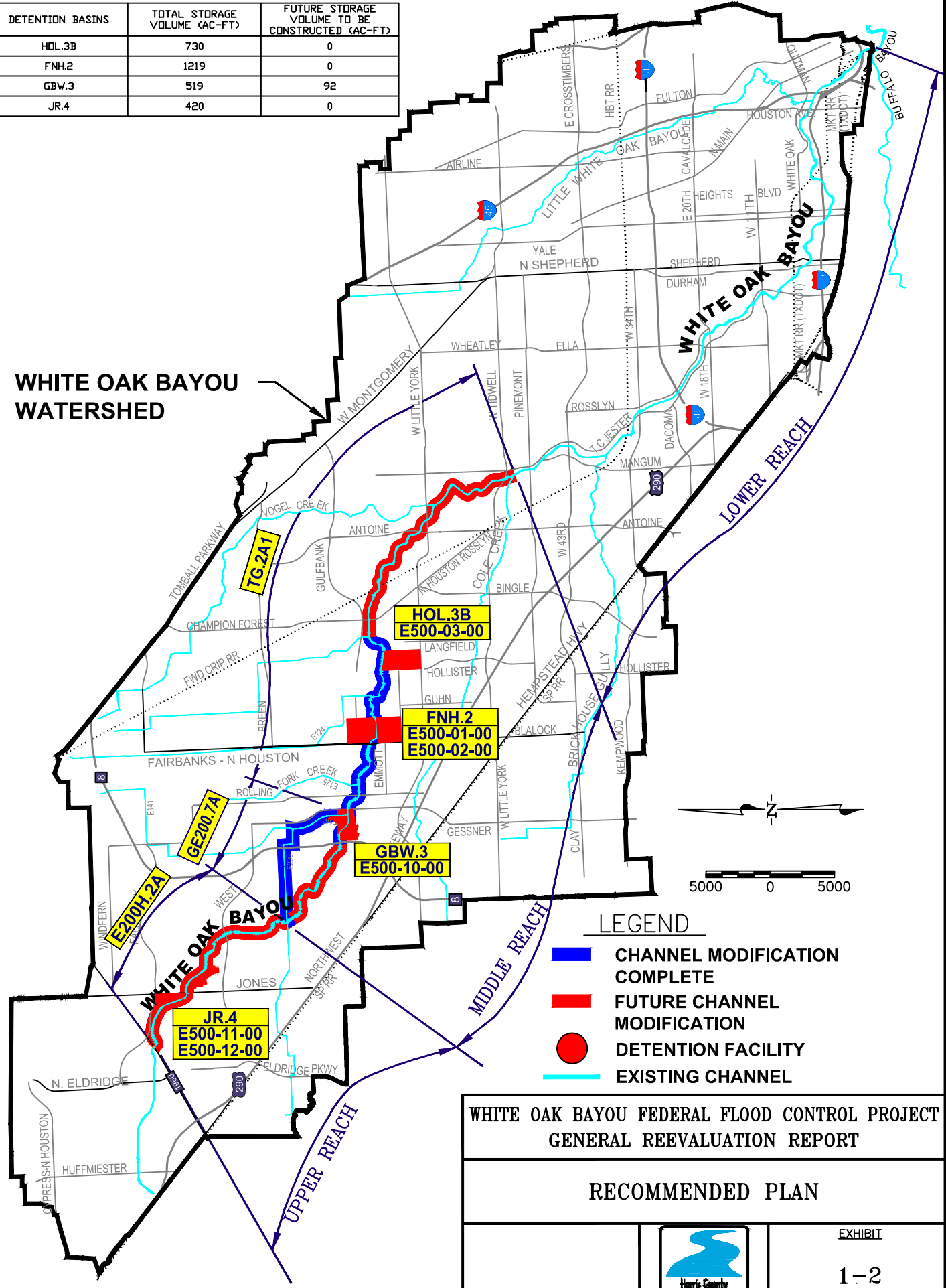
EXHIBIT

1-1

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DETENTION BASINS	TOTAL STORAGE VOLUME (AC-FT)	FUTURE STORAGE VOLUME TO BE CONSTRUCTED (AC-FT)
HDL.3B	730	0
FNH.2	1219	0
GBW.3	519	92
JR.4	420	0

# WHITE OAK BAYOU WATERSHED



## LEGEND

- █ CHANNEL MODIFICATION COMPLETE
- █ FUTURE CHANNEL MODIFICATION
- DETENTION FACILITY
- █ EXISTING CHANNEL

## WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT GENERAL REEVALUATION REPORT

### RECOMMENDED PLAN



EXHIBIT  
1-2



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**Proposed Linear Park between Hollister & Cole Creek Confluence**

- Provide hike & bike trail in coordination with City of Houston Parks Master Plan. (City of Houston is not a sponsor of this feature.)

**Existing Detention Basin HOL.3B**

- Develop detention basin as wetlands mitigation and passive use park. (Wetlands cost is not part of Recreation Plan)
- Develop urban wetlands/wildlife observation and feeding area.
- Provide trail around site.

**Existing Detention Facility FNH.2**

- Provide trail head & access to Greenbelt from neighborhood.
- 2 acres of existing wetlands currently on site. Provide urban wetland/wildlife observation/teaching facilities.
- Dry area of detention basin used as open multi-purpose fields. Provide trail around site.

**Proposed Linear Park between Hollister & West Road**

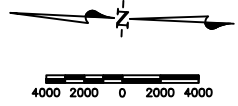
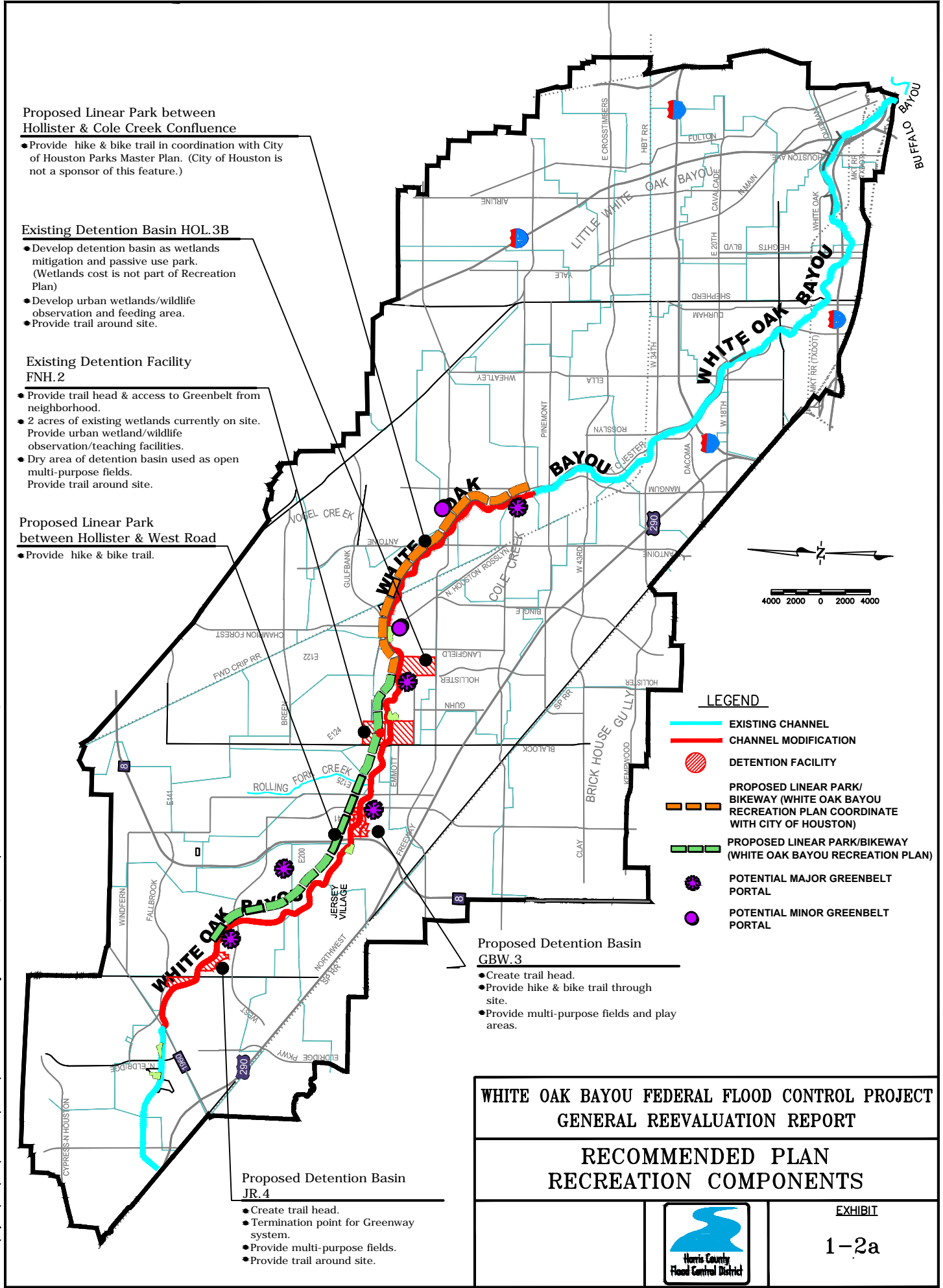
- Provide hike & bike trail.

**Proposed Detention Basin GBW.3**

- Create trail head.
- Provide hike & bike trail through site.
- Provide multi-purpose fields and play areas.

**Proposed Detention Basin JR.4**

- Create trail head.
- Termination point for Greenway system.
- Provide multi-purpose fields.
- Provide trail around site.



**LEGEND**

- EXISTING CHANNEL
- CHANNEL MODIFICATION
- DETENTION FACILITY
- PROPOSED LINEAR PARK/BIKEWAY (WHITE OAK BAYOU RECREATION PLAN COORDINATE WITH CITY OF HOUSTON)
- PROPOSED LINEAR PARK/BIKEWAY (WHITE OAK BAYOU RECREATION PLAN)
- POTENTIAL MAJOR GREENBELT PORTAL
- POTENTIAL MINOR GREENBELT PORTAL

**WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT  
GENERAL REEVALUATION REPORT**

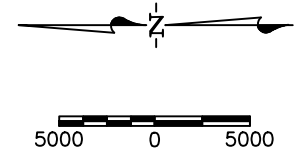
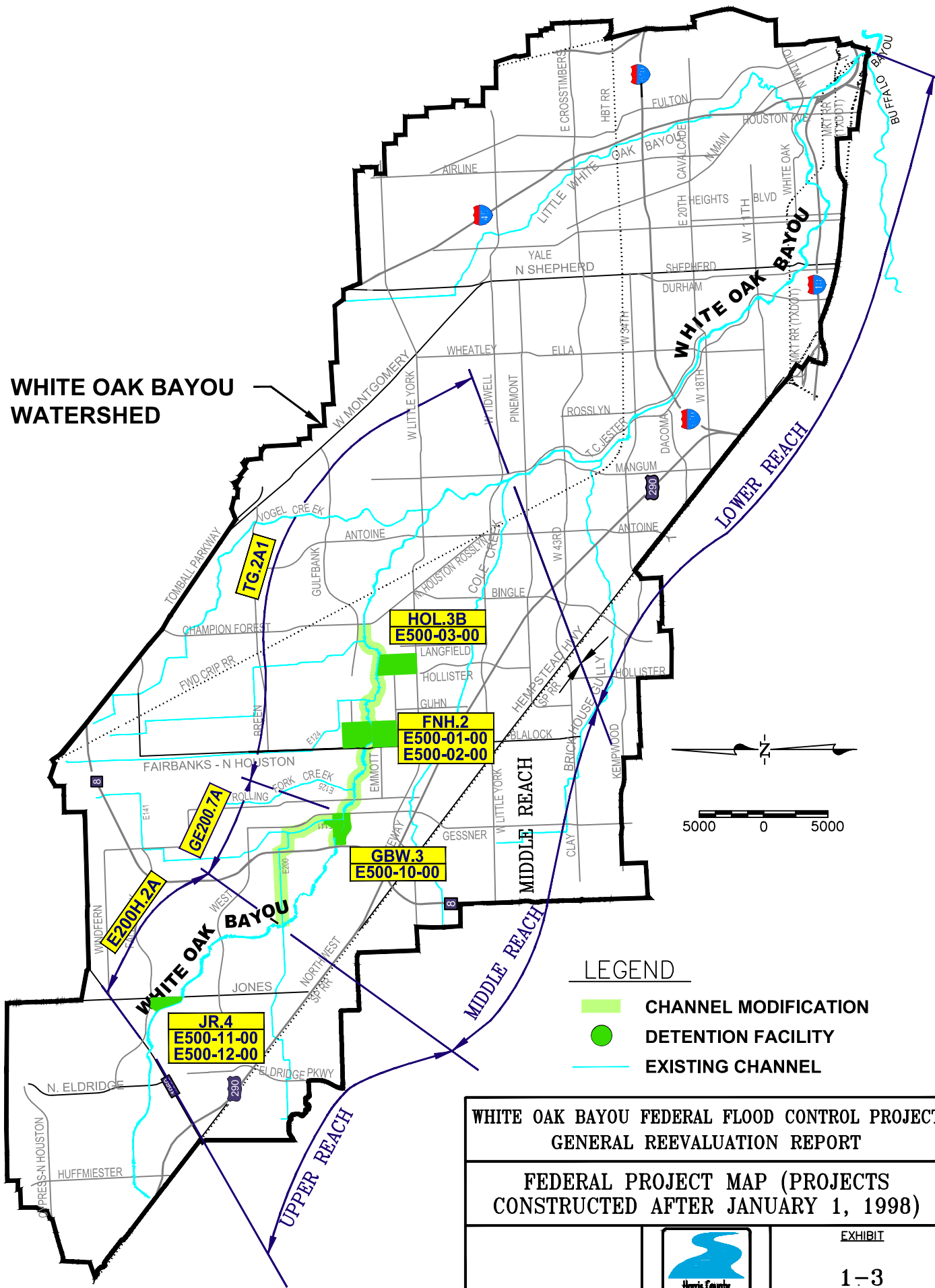
**RECOMMENDED PLAN  
RECREATION COMPONENTS**



EXHIBIT

1-2a

# WHITE OAK BAYOU WATERSHED



## LEGEND

- CHANNEL MODIFICATION
- DETENTION FACILITY
- EXISTING CHANNEL

### WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT GENERAL REEVALUATION REPORT

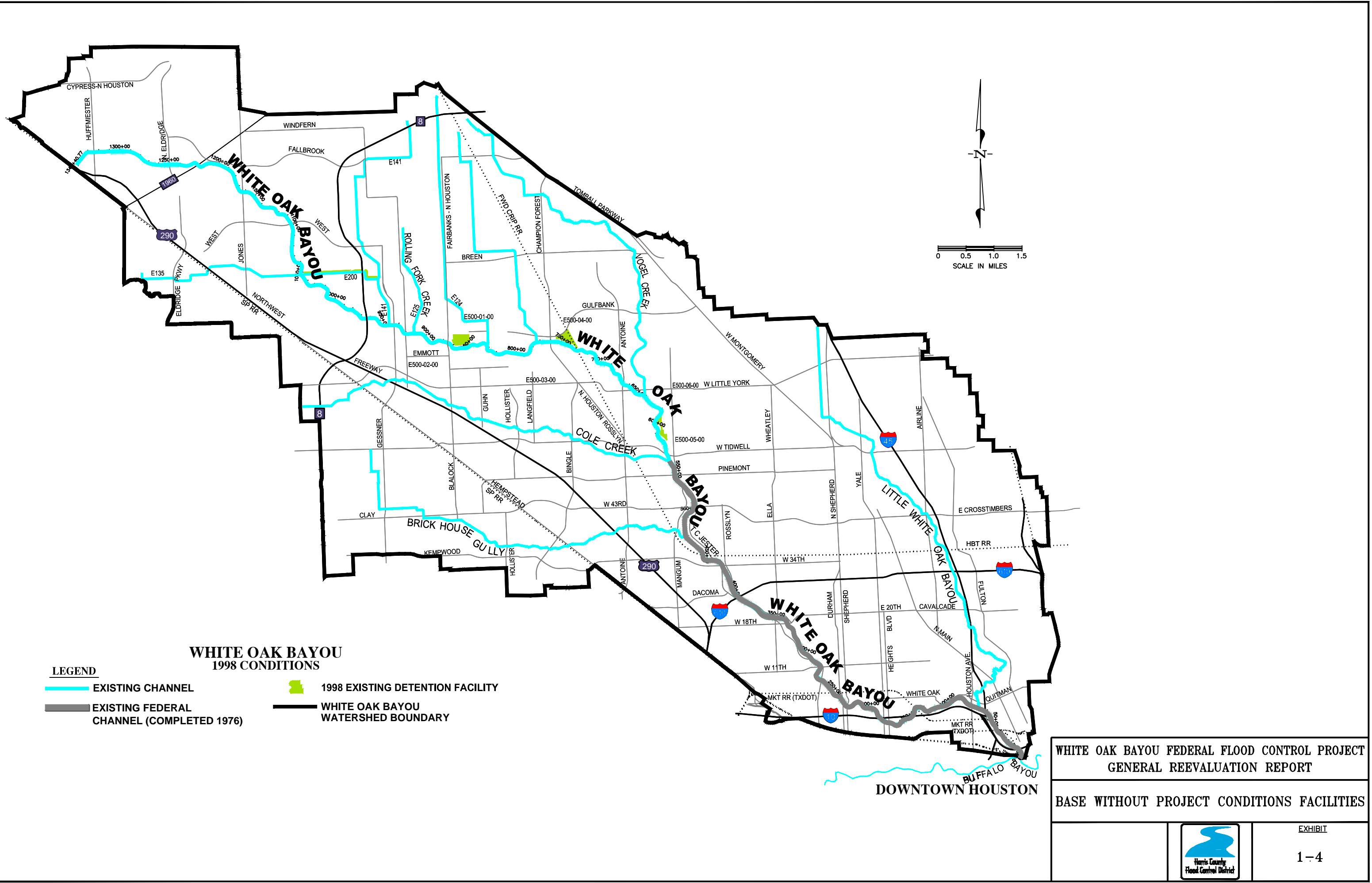
### FEDERAL PROJECT MAP (PROJECTS CONSTRUCTED AFTER JANUARY 1, 1998)



EXHIBIT

1-3

FILE INFO: I:\Projects\10344\1607\MAIN REPORT\EXHIBITS\4-1-E\_M-04-1 - Copy.dwg XREFS: STREETX; WOBTLK; WOB-CLB1; 2.2 MODIFIED: Sep 14, 2012 11:13am BY: sgonzalez PLOTTED: Sep 14, 2012 4:15pm PLOT SCALE: 1=40



**WHITE OAK BAYOU  
1998 CONDITIONS**

**LEGEND**

- EXISTING CHANNEL
- EXISTING FEDERAL CHANNEL (COMPLETED 1976)
- 1998 EXISTING DETENTION FACILITY
- WHITE OAK BAYOU WATERSHED BOUNDARY

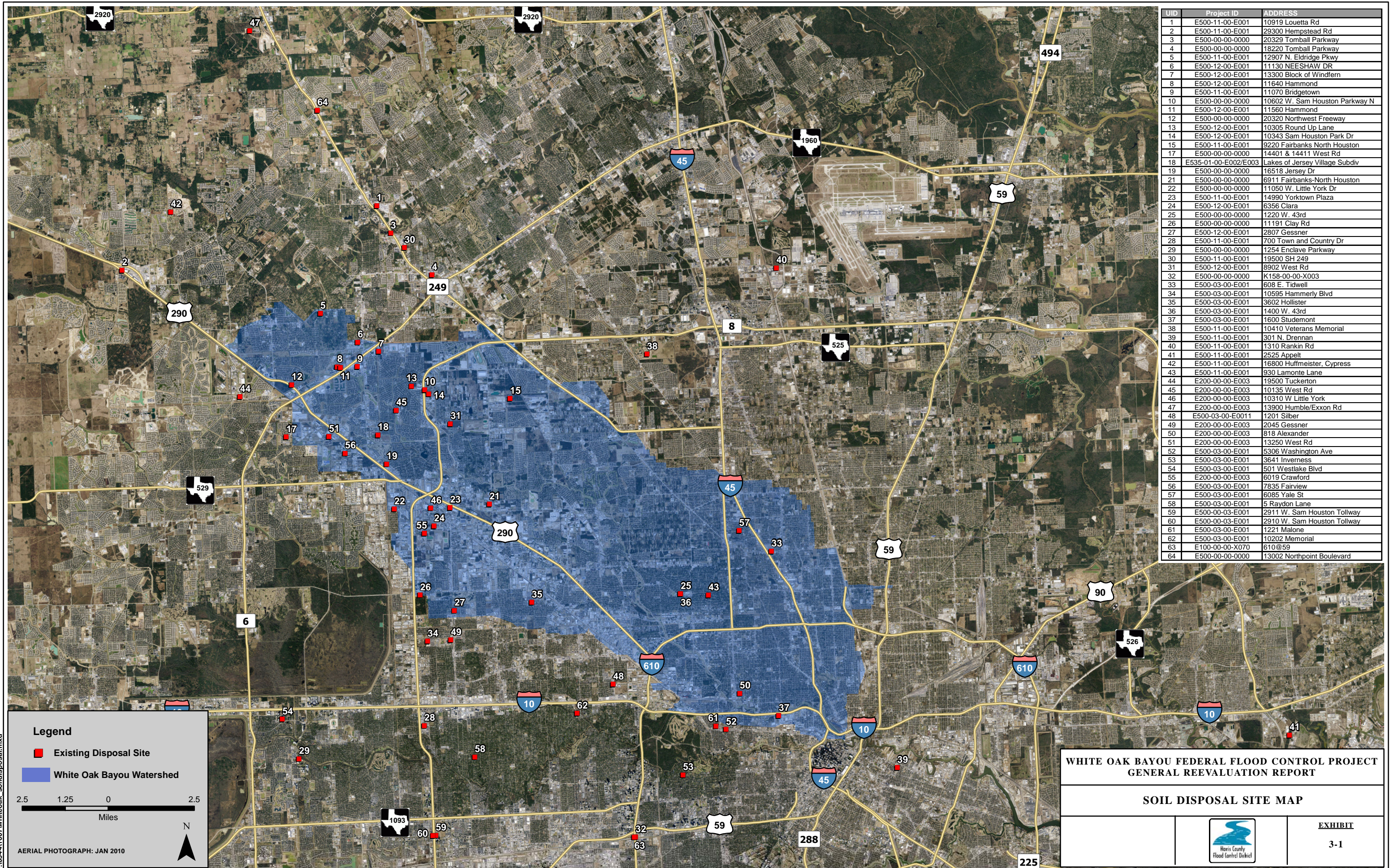
WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT  
GENERAL REEVALUATION REPORT

BASE WITHOUT PROJECT CONDITIONS FACILITIES



EXHIBIT

1-4



UID	Project ID	ADDRESS
1	E500-11-00-E001	10919 Louetta Rd
2	E500-11-00-E001	29300 Hempstead Rd
3	E500-00-00-0000	20329 Tomball Parkway
4	E500-00-00-0000	18220 Tomball Parkway
5	E500-11-00-E001	12907 N. Eldridge Pkwy
6	E500-12-00-E001	11130 NEESHAW DR
7	E500-12-00-E001	13300 Block of Windfern
8	E500-12-00-E001	11640 Hammond
9	E500-11-00-E001	11070 Bridgetown
10	E500-00-00-0000	10602 W. Sam Houston Parkway N
11	E500-12-00-E001	11560 Hammond
12	E500-00-00-0000	20320 Northwest Freeway
13	E500-12-00-E001	10305 Round Up Lane
14	E500-12-00-E001	10343 Sam Houston Park Dr
15	E500-11-00-E001	9220 Fairbanks North Houston
17	E500-00-00-0000	14401 & 14411 West Rd
18	E535-01-00-E002/E003	Lakes of Jersey Village Subdiv
19	E500-00-00-0000	16518 Jersey Dr
21	E500-00-00-0000	6911 Fairbanks-North Houston
22	E500-00-00-0000	11050 W. Little York Dr
23	E500-11-00-E001	14990 Yorktown Plaza
24	E500-12-00-E001	6356 Clara
25	E500-00-00-0000	1220 W. 43rd
26	E500-00-00-0000	11191 Clay Rd
27	E500-12-00-E001	2807 Gessner
28	E500-11-00-E001	700 Town and Country Dr
29	E500-00-00-0000	1254 Enclave Parkway
30	E500-11-00-E001	19500 SH 249
31	E500-12-00-E001	8902 West Rd
32	E500-00-00-0000	K158-00-00-X003
33	E500-03-00-E001	608 E. Tidwell
34	E500-03-00-E001	10595 Hammerly Blvd
35	E500-03-00-E001	3602 Hollister
36	E500-03-00-E001	1400 W. 43rd
37	E500-03-00-E001	1600 Studemont
38	E500-11-00-E001	10410 Veterans Memorial
39	E500-11-00-E001	301 N. Drennan
40	E500-11-00-E001	1310 Rankin Rd
41	E500-11-00-E001	2525 Appelt
42	E500-11-00-E001	16800 Huffmeister, Cypress
43	E500-11-00-E001	930 Lamonte Lane
44	E200-00-00-E003	19500 Tuckerton
45	E200-00-00-E003	10135 West Rd
46	E200-00-00-E003	10310 W Little York
47	E200-00-00-E003	13900 Humble/Exxon Rd
48	E500-03-00-E0011	1201 Silber
49	E200-00-00-E003	2045 Gessner
50	E200-00-00-E003	818 Alexander
51	E200-00-00-E003	13250 West Rd
52	E500-03-00-E001	5306 Washington Ave
53	E500-03-00-E001	3641 Inverness
54	E500-03-00-E001	501 Westlake Blvd
55	E200-00-00-E003	6019 Crawford
56	E500-03-00-E001	7835 Fairview
57	E500-03-00-E001	6085 Yale St
58	E500-03-00-E001	5 Raydon Lane
59	E500-00-03-E001	2911 W. Sam Houston Tollway
60	E500-00-03-E001	2910 W. Sam Houston Tollway
61	E500-03-00-E001	1221 Malone
62	E500-03-00-E001	10202 Memorial
63	E100-00-00-X070	610@59
64	E500-00-00-0000	13002 Northpoint Boulevard

**Legend**

- Existing Disposal Site
- White Oak Bayou Watershed

2.5 1.25 0 2.5  
Miles

AERIAL PHOTOGRAPH: JAN 2010

**WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT  
GENERAL REEVALUATION REPORT**

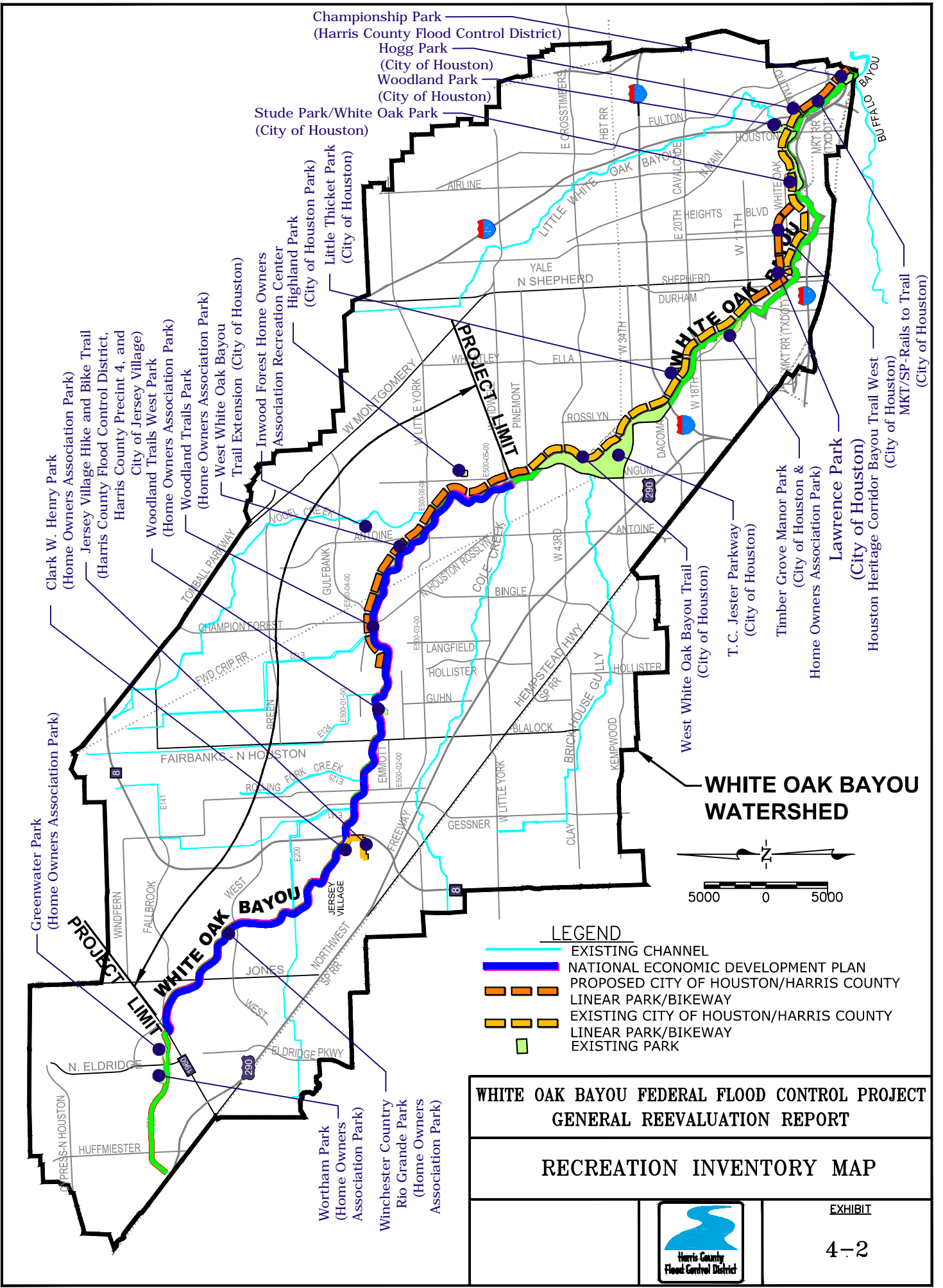
**SOIL DISPOSAL SITE MAP**

Harris County  
Flood Control District

EXHIBIT  
3-1

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Exhibit 4-1. "This Exhibit Intentionally Left Blank"



Championship Park (Harris County Flood Control District)  
 Hogg Park (City of Houston)  
 Woodland Park (City of Houston)  
 Stude Park/White Oak Park (City of Houston)  
 Little Thicket Park (City of Houston)  
 Highland Park (City of Houston)  
 Clark W. Henry Park (Home Owners Association Park)  
 Jersey Village Hike and Bike Trail (Harris County Flood Control District, Harris County Precinct 4, and City of Jersey Village)  
 Woodland Trails West Park (Home Owners Association Park)  
 Woodland Trails Park (Home Owners Association Park)  
 West White Oak Bayou Trail Extension (City of Houston)  
 Inwood Forest Home Owners Association Recreation Center (City of Houston)  
 Greenwater Park (Home Owners Association Park)  
 Jersey Village Park (Home Owners Association Park)  
 Champion Forest Park (Home Owners Association Park)  
 Fairbanks - N Houston Park (Home Owners Association Park)  
 Rolling Park Creek (Home Owners Association Park)  
 Jersey Village Park (Home Owners Association Park)  
 Wortham Park (Home Owners Association Park)  
 Winchester Country Rio Grande Park (Home Owners Association Park)  
 West White Oak Bayou Trail (City of Houston)  
 T.C. Jester Parkway (City of Houston)  
 Timber Grove Manor Park (City of Houston & Home Owners Association Park)  
 Lawrence Park (City of Houston)  
 Houston Heritage Corridor Bayou Trail West (City of Houston)  
 MKT/SP-Rails to Trail (City of Houston)


**WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT  
 GENERAL REEVALUATION REPORT  
 RECREATION INVENTORY MAP**

**LEGEND**

- EXISTING CHANNEL
- NATIONAL ECONOMIC DEVELOPMENT PLAN
- PROPOSED CITY OF HOUSTON/HARRIS COUNTY LINEAR PARK/BIKEWAY
- EXISTING CITY OF HOUSTON/HARRIS COUNTY LINEAR PARK/BIKEWAY
- EXISTING PARK

**WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT  
 GENERAL REEVALUATION REPORT  
 RECREATION INVENTORY MAP**

EXHIBIT  
 4-2



FILE INFO: H:\Projects\10344\1607\APPENDIX EA\EXHIBITS\5-1\5-1.dwg MODIFIED: Sep 13, 2012 5:23pm BY: sgonzalez PLOTTED: Sep 14, 2012 4:16pm PLOT SCALE: 1=40



WHITE OAK BAYOU FEDERAL FLOOD CONTROL PROJECT  
 GENERAL REEVALUATION REPORT  
 CONCEPTUAL WETLANDS MITIGATION  
 - HOLLISTER DETENTION BASIN



EXHIBIT

5-1