4.0 FINAL ARRAY OF ALTERNATIVES

The alternatives analysis included combining one or more optimized components to form a plan that would exhibit positive net benefits and provide FRM to the study area. Detailed studies were performed based on available lands, property acquisitions, on-site environmental field investigations, and more refined engineering and economic data. The best candidate alternatives for the NED Plan which presented various approaches to FRM were subjected to further comparison. At the conclusion of the alternatives analysis, the alternative that maximizes net economic benefits is identified as the NED Plan.

Five alternatives were analyzed which demonstrate distinctly different methods by which FRM can be accomplished within the study area.

- Alternative 1 is a full earthen channel modification, from US 59 to the mouth of Hunting Bayou and represents different scales of the 1990 Authorized Plan. These scales range from less than a 10 percent to a 50 percent FRM performance level.
- Alternative 2 is a nonstructural alternative consisting of a watershed-wide buyout of all residential and commercial properties with positive AAEV net excess benefits and represents the optimized scale for nonstructural buyouts. This alternative is a combination of stand-alone components C, F and K. This alternative provides 4 percent FRM in the upper and middle stream segment and 14 percent FRM performance in the lower stream segment.
- Alternative 3 is a nonstructural watershed-wide flood proofing of all residential and commercial properties with positive AAEV net excess benefits and represents the optimized scale of nonstructural flood proofing. This alternative is a combination of stand-alone components D, G and L. This alternative provides 4 percent FRM in the upper and middle stream segment and 11 percent FRM performance in the lower stream segment.
- Alternative 4 is the No Project Alternative.
- Alternative 5 is the same as B50-A1 which produced the greatest AAEV net excess benefits in the optimization exercise presented in Section 3.0 and represents the optimized scale for FRM among all the previous components tested and combined for economic efficiency. This alternative provides 10 percent FRM performance in the watershed's upper stream segment.

4.1 Alternative 1 – Full Earthen Channel Modification

In the 1988 USACE Feasibility Study, a full channelization plan was identified as the NED Plan for Hunting Bayou and authorized in WRDA of 1990. Thus, it was anticipated that a full channelization plan would also be a valid candidate for the NED Plan in this current study effort.

Alternative 1, a total reevaluation of the 1990 Authorized Plan, was developed using the most current hydrologic and economic information. It consisted of earthen channel modifications from US 59 to the mouth of Hunting Bayou, a distance of approximately 72,900 feet (13.8 miles). Alternative 1 was optimized by analyzing four different channel designs, with bottom widths ranging from 35 feet to 150 feet near the mouth. A3, the scale with a 110-foot bottom width channel at the mouth of Hunting Bayou replicates the 1990 Authorized Plan under current

conditions. *Table 4-1* shows the economic performance of the four bottom-width channel scales. As shown on the next page, *Exhibit 4-1* displays Alternative 1.

Table 4-1:
Economic Performance of Alternative 1

Channel Design	Total Project Cost	AAEV Project Cost	AAEV Damage Reduction Benefits	AAEV Net Excess Benefits	BCR
A1-35 BW	$210.691	$12.692	$19.801	$7.110	1.56
A2-65 BW	$236.949	$14.277	$21.875	$7.597	1.53
A3-110 BW	$341.583	$20.582	$22.401	$1.819	1.09
A4-150 BW	$421.341	$25.389	$22.414	($2.974)	0.88

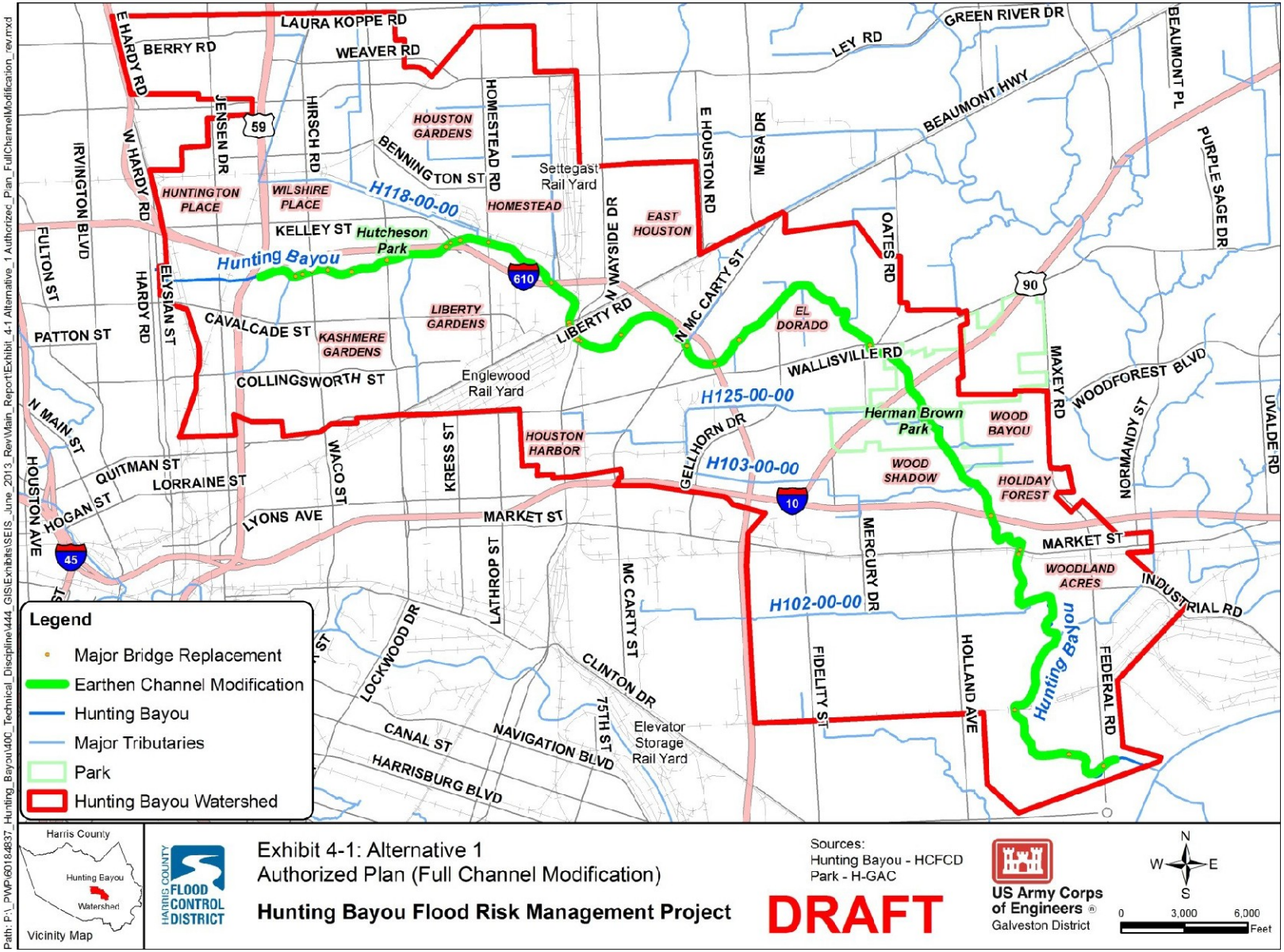
2001 price level, discount rate of 5.625; BW = bottom width
Note: All dollar values are in million

Based on the Chief's Report, the 1990 Authorized Plan's benefits would accrue from inundation damage reduction to existing and future development. At the time of the 1988 analysis there were 9,823 structures in the 100-year (1percent AEP) floodplain that were cumulatively valued at $677 M. The value of a structure averaged $69,000 in 1988. A benefit was also estimated for a reduction in the administrative costs to the flood insurance program.

The inundation reduction benefits to these 4 Authorized Design scales were based on a 1998 structure inventory of 7,689 structures in the 1 percent AEP floodplain valued at $800 million including structure and contents. Structure values alone averaged $58,000. With contents added, property values averaged $104,000.

While future development and affluence benefits were developed for the 1990 Authorized Plan, no future development or affluence benefits were calculated for the updated 1990 Authorized Plan scales. By 1998, affluence benefits, which is the assumption that residential content-to-structure value ratios increase over time, was no longer considered to be a legitimate benefit category and was very difficult to ascertain as well as credibly support. Also with Harris County's adoption of a "no adverse impact" policy for future development and the expectation that future development would conform to COH's first floor elevation criterion of 1 foot above the BFE, no impacts to future development were assumed for any condition in the Hunting Bayou federal study.

Exhibit 4-1:
Alternative 1 Authorized Plan (Full Channel Modification)



4.2 Alternative 2– Nonstructural Buyout of Residences

Alternative 2, the nonstructural buyout alternative, identifies all residential and commercial structures shown to be cost-effective for buyout within the watershed. Detailed output from the HEC-FDA WOP conditions model was used to compute the net benefits resulting from purchasing each structure in the study area.

A total of 974 structures (941 residential and 33 commercial) was identified to have a positive net benefit, which equates to an approximate 24 percent (4-year) floodplain buyout. Alternative 2 has an annual $4.360 million net benefit and a 2.15 BCR. *Exhibit 4-2* displays Alternative 2.

4.3 Alternative 3 – Nonstructural Flood Proofing of Residences

Alternative 3, the nonstructural flood proofing alternative, identifies all structures shown to be cost-effective for flood proofing within the watershed. Detailed output from the HEC-FDA WOP conditions model was used to compute the net benefits resulting from raising each structure in the study area.

A total of 1,039 structures (1,010 residential, 27 commercial and 2 public) were identified to have positive AAEV net excess benefits, which equates to an approximate 25 percent (4-year) floodplain. Alternative 3 has AAEV $2.950 million net excess benefits and a 2.06 BCR. *Exhibit 4-3* displays Alternative 3.

4.4 Alternative 4 – No Action Alternative

Alternative 4 is the No Action Alternative. Without implementing a flood damage reduction project in the Hunting Bayou study area, flood damages were calculated to be $22.42 million at 2001 prices and at the FY 2004 5.625 percent federal discount rate.

4.5 Alternative 5 - Upper Reach Channel Modification with a 50-ft Bottom Width and Homestead Detention

Alternative 5 is the same as B50-A1 which is a combination of a 50 ft bottom width channel modification, bridge modifications, and a 40-acre off-line detention basin at Homestead Road. Alternative 5 is the culmination of an optimization process detailed in Section 3 and represents the combination of best economically performing FRM components within the Hunting Bayou watershed. Alternative 5 has AAEV $10.210 million net excess benefits and a 2.51 BCR. *Exhibit 4-4* displays Alternative 5.

Exhibit 4-2:
Alternative 2 Buyouts

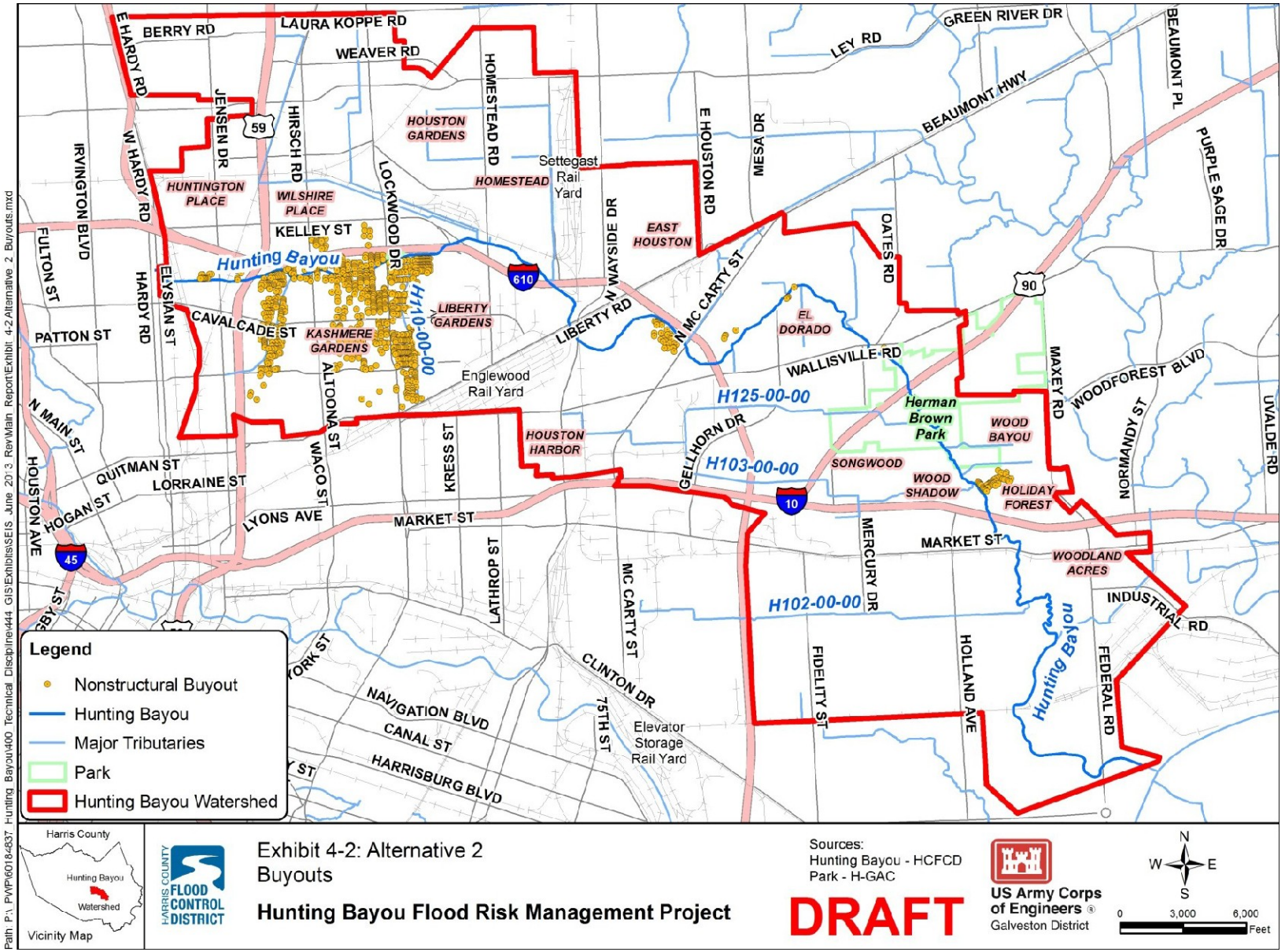


Exhibit 4-3:
Alternative 3 Flood Proofing

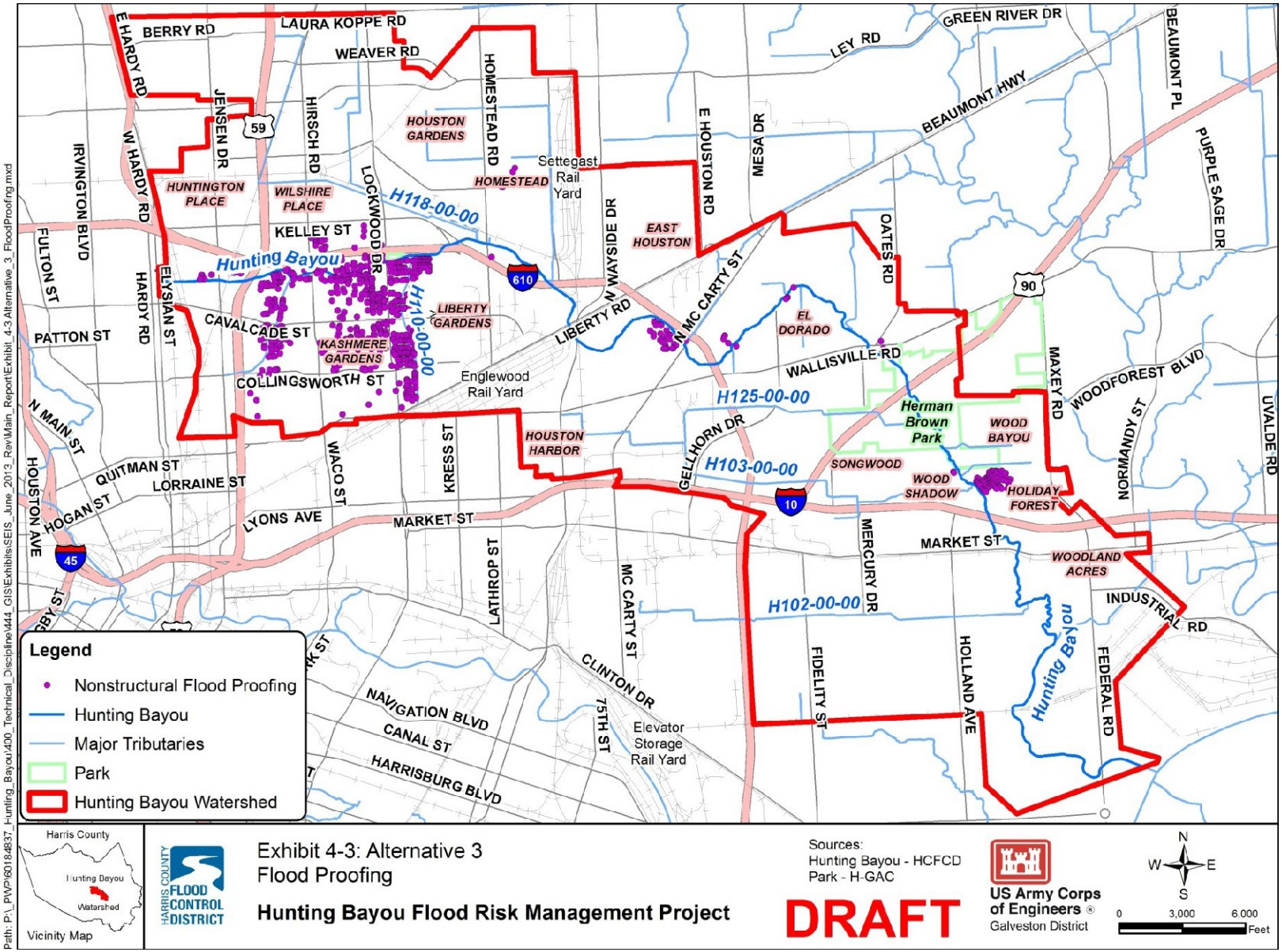
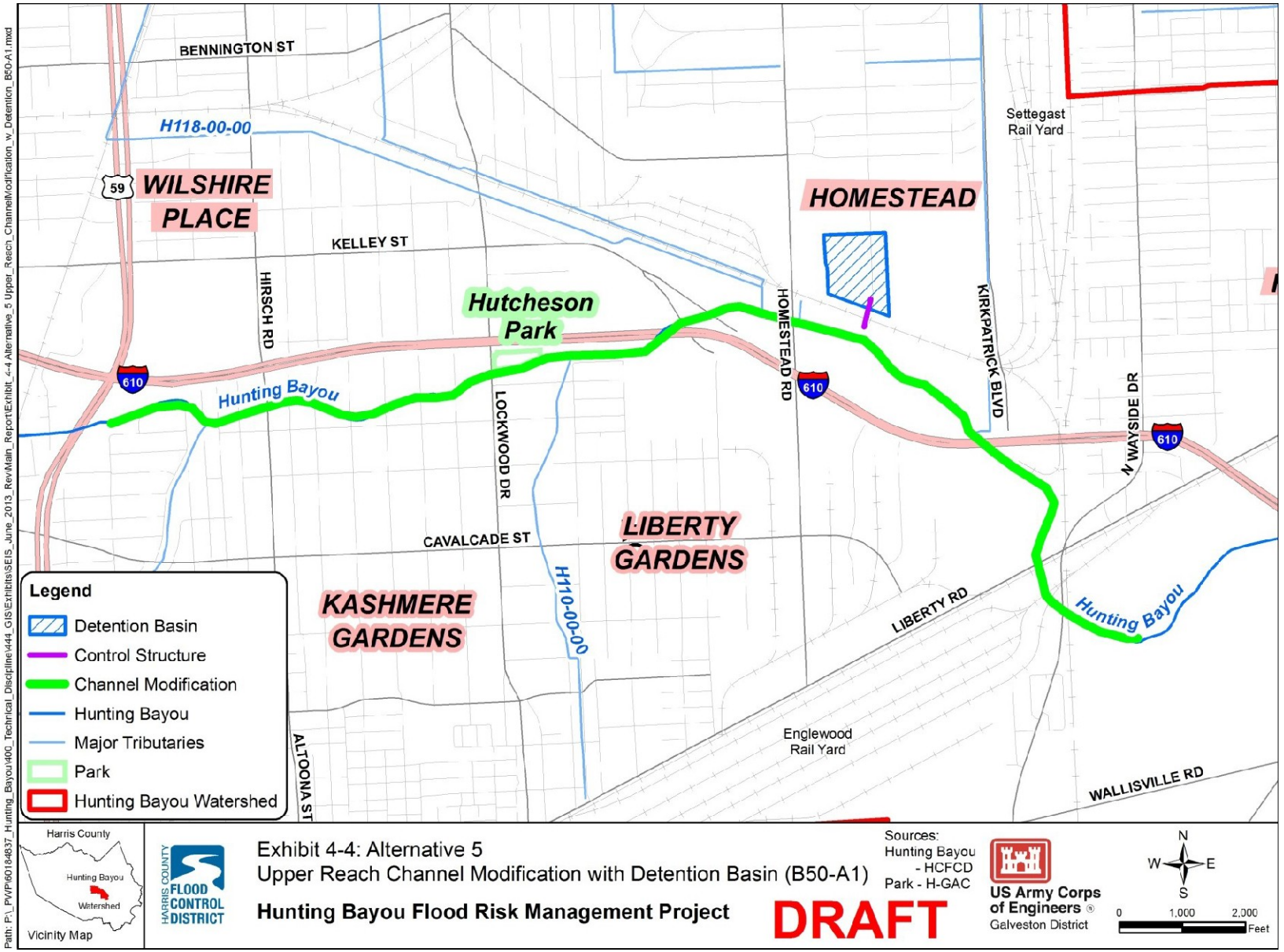


Exhibit 4-4:
Alternative 5 Upper Reach Channel Modification with Detention Basin (B50-A1)



4.6 Alternatives Analysis Summary

Table 4-2 compares the economic performance for the five alternatives.

Table 4-2:
Best Performing Alternatives

Alternative	Component Description	AAEV Project Cost	AAEV Damage Reduction Benefit	AAEV Net Excess Benefit	BCR
1	Full Earth Channel (35' BW)	$12.692	$19.801	7.110	1.56
	Full Earth Channel (10-Year) (65'BW)	$14.277	$21.875	$7.598	1.53
	Full Earth Channel (25-Year) (110' BW)	$20.582	$22.401	$1.819	1.09
	Full Earth Channel (50-Year) (150'BW)	$25.389	$22.414	($2.975)	0.88
2	Watershed-Wide Optimized Buyout (974 Structures)	$3.788	$8.148	$4.360	2.15
3	Watershed-Wide Optimized Flood Proofing (1,039 Structures)	$2.781	$5.731	$2.950	2.06
4	No Project	-	$0.000	$0.000	0.00
5	**Upper Stream Segment 50-ft BW Channel, Bridge Replacements, and Homestead Detention (B50-A1)**	**$6.780**	**$16.990**	**$10.210**	**2.51**

2001 price level, 5.625 percent discount rate.
All dollar values are in millions.
Alternative 1 – Full EarthChannel(25-year) (110'BW) represents the optimized 1990 Authorized Plan

As seen in *Table 4-2*, Alternative 5, B50-A1, maximized net excess benefits with $10.2 million in average annual equivalent values. The plan reevaluation process for the Hunting Bayou federal study identified an alternative, B50-A1, located in the watershed's upper stream segment as the best economic performer. Working in combination, the channel modification, bridge replacement and detention basin components form the NED Plan alternative. By focusing efforts to reduce flood risk in the upper stream segment, these components worked together in a systems manner to reduce damages where they occur.

From previous analysis of measures that maximize net excess benefits, the channel modification, bridge replacements and detention alternative produced higher net benefits and was chosen to advance as the NED Plan with continued refinement of scale.

4.7 Evaluating and Dismissing Alternatives

The Plan Formulation process considered a range of alternatives including the No Action Alternative. The evaluation criteria applied to the alternatives included environmental, economic and public acceptance factors. While comparing the alternatives, it became clear that two of them should not be analyzed in any further detail because they do not meet the project purposes.

This section offers those reasons why the non-structural alternatives have been eliminated from further study. The regulatory basis for this approach is that so long as all reasonable alternatives have been considered and an appropriate explanation is provided as to why an alternative was eliminated, the regulatory requirement is satisfied. The focus has been on the substance of the

alternatives versus the number of alternatives (Native Ecosystems Council vs. U.S. Forest Service, U.S. Court of Appeals for the Ninth Circuit, 428F.3d; No, 04-35274; also Curry v U.S. Forest Service 988 F. Supp541 (W.D., Pa. 1997)). The Council on Environmental Quality regulations do not impose a numerical floor on alternatives to be considered in detail.

4.7.1 Reasons for Eliminating the Non-Structural Buyout of Structures:

The nonstructural buyout alternative would displace 941 residential structures housing an estimated 2,380 persons. This magnitude of population displacement violates the study's objective for minimizing disruptions to the local community. Public sentiment gathered at local meetings did not favor displacements which could be perceived as having environmental justice implications. Therefore, with respect to the presence of an alternative that better meets the federal and study objectives, Alternative 2 is eliminated from further analysis.

4.7.2 Reasons for Eliminating the Non-Structural Flood Proofing of Structures:

The nonstructural flood proofing alternative would elevate 1,010 residential structures, impacting an estimated 2,555 persons within the watershed. While elevating out of harm's way would protect investments made to the property, the population's vulnerability to risk associated with rising flood water would remain. The affected population could mistakenly remain in their homes when flood waters threaten and not evacuate to higher ground, thereby increasing their risk to life, health and safety. The social vulnerability of the resident population with regard to age and income affects their ability to respond to flood threats. This vulnerability might be worsened by a false sense of security if residents stayed behind in their elevated homes rather than evacuated them. Therefore, with respect to the presence of an alternative that better meets the federal and study objectives, Alternative 3 is eliminated from further analysis.

4.8 Refining the Channel Modification and Detention Basin Alternative, NED Plan

The planning process focused on identifying the alternative that maximized net excess benefits, which defines the NED Plan. The combination upper stream channel modification, bridge replacements and detention basin, B50-A1, was identified as the NED Plan and was further refined.

4.8.1 Reduced Homestead Site Detention Planning Condition

In November 2004 during negotiations with UPRR, the railroad company which owns the property for the proposed Homestead Road offline detention site, the non-federal sponsor, HCFCD, learned that expansion of intermodal railroad facilities is planned for approximately one-half of the 155-acre Homestead Road site. This reduced the available land for detention to 75 acres. Therefore, obtaining more than 75 acres at the Homestead Road site would require acquisition of offsetting nearby industrial land making the optimized detention basin untenable.

4.8.2 Adapting Channelization Features

The 30-acre inline detention basin feature of the channel modification components for the upper stream segment was not previously analyzed as a stand-alone component to determine its FRM benefits attributable to this component. Therefore, it could not be determined if this feature was economically justified to be included as part of the final plan reevaluation. In addition, site investigation indicated an unregistered, unpermitted landfill is located in the area proposed for

the inline detention. Due to the uncertainties construction in such areas can pose, including increased cost estimates for the inline basin, it was decided to eliminate the inline detention site from further consideration.

4.8.3 Reevaluating Components A and B in Combination

The landfill's presence within the Component B footprint required the inline detention basin feature be abandoned and Component B be redesigned without inline detention. Losing inline detention in Component B required more storage in Component A to offset flood flows. However, Component A was constrained by limited land area for detention, which required that the cross-sectional area (channel bottom width) for channel modification be increased for Component B.

In 2009, components A and B were reanalyzed as a combined detention basin size and channel bottom width in an array of 32 scales of the NED alternative in an attempt to identify the most economically efficient scale. Channel bottom widths were modeled in a range from 40 ft. to 200 ft. Detention sizing offered less variation due to the land constraint and ranged from 25 acres to the maximum 75 acres. All scales include the optimized bridge replacements. The reevaluation results are shown in *Table 4-3* (see next page).

The analysis results produced three scales of interest for the NED Plan alternative. B90-A50, the NED Plan scale that maximized net excess benefits; B50-A25, that reasonably maximized net benefits at least cost; and B60-A75, the non-federal sponsor's, HCFCD, preferred NED Plan scale which best addresses all study objectives and reasonably maximized net excess benefits. The B90-A50 NED Plan scale best satisfied the federal objective of producing the greatest net excess benefits. However, the top 23 NED Plan scales are within 5 percent of the No. 1 ranked scale for net excess benefits. Due to the narrow range of net excess benefit outputs of the NED Plan scale array, the least cost scale which reasonably maximizes net excess benefits (within 5 percent of the maximum) is NED Plan B50-A25 for the 2009 planning iteration.

Table 4-3:
Best Performing Alternative Scales with Constrained Available Land for Detention

			AAEV Damages (x $1,000)	AAEV Damages Reduced Benefits (x $1,000)	Total Project Cost (x$1,000)	AAEV Project Cost (x$1,000)	AAEV Net Excess Benefit (x$1,000)	BCR
Net Excess Benefit Rank	NED Plan Scale	WOP AAEV Damages	$24,954.36					
1	**B90-A50**	**90-ft Channel + 50 ac**	**$5,643.70**	**$19,310.66**	**$150,966.19**	**$7,669.67**	**$11,640.99**	**2.52**
2	B100-A50	100-ft Channel + 50 ac	$5,487.27	$19,467.08	$154,159.25	$7,830.21	$11,636.87	2.49
3	B80-A50	80-ft Channel + 50 ac	$5,826.31	$19,128.05	$147,632.58	$7,502.16	$11,625.89	2.55
4	B70-A50	70-ft Channel + 50 ac	$6,023.19	$18,931.17	$143,950.34	$7,316.01	$11,615.16	2.59
5	B80-A25	80-ft Channel + 25 ac	$6,730.65	$18,223.70	$131,064.80	$6,619.17	$11,604.53	2.75
6	B90-A25	90-ft Channel + 25 ac	$6,561.39	$18,392.97	$134,462.79	$6,789.90	$11,603.07	2.71
7	B100-A25	100-ft Channel + 25 ac	$6,406.68	$18,547.68	$137,721.40	$6,953.70	$11,593.98	2.67
8	B110-A25	110-ft Channel + 25 ac	$6,220.10	$18,734.26	$141,648.46	$7,154.16	$11,580.10	2.62
9	B70-A25	70-ft Channel + 25 ac	$6,946.85	$18,007.51	$127,290.07	$6,428.42	$11,579.09	2.80
10	B60-A50	60-ft Channel + 50 ac	$6,274.23	$18,680.13	$139,701.24	$7,101.74	$11,578.39	2.63
11	B110-A50	110-ft Channel + 50 ac	$5,359.65	$19,594.71	$158,062.39	$8,029.48	$11,565.23	2.44
12	B120-A25	120-ft Channel + 25 ac	$6,107.36	$18,847.00	$144,906.85	$7,319.10	$11,527.90	2.58
13	B120-A50	120-ft Channel + 50 ac	$5,243.94	$19,710.42	$161,301.68	$8,193.47	$11,516.95	2.41
14	B140-A25	140-ft Channel + 25 ac	$5,823.87	$19,130.49	$150,784.00	$7,617.52	$11,512.97	2.51
15	B50-A50	50-ft Channel + 50 ac	$6,610.93	$18,343.43	$136,226.23	$6,898.47	$11,444.96	2.66
16	B60-A25	60-ft Channel + 25 ac	$7,301.98	$17,652.37	$122,947.23	$6,209.48	$11,442.89	2.84
17	**B50-A25**	**50-ft Channel + 25 ac**	**$7,485.88**	**$17,468.48**	**$119,406.13**	**$6,031.25**	**$11,437.23**	**2.90**
18	B140-A50	140-ft Channel + 50 ac	$5,054.28	$19,900.08	$167,249.93	$8,495.42	$11,404.66	2.34
19	B40-A50	40-ft Channel + 50 ac	$6,876.43	$18,077.93	$132,723.90	$6,749.58	$11,328.35	2.68
20	B200-A25	200-ft Channel + 25 ac	$5,146.60	$19,807.76	$169,587.39	$8,571.13	$11,236.63	2.31
21	**B60-A75**	**60-ft Channel + 75 ac**	**$5,806.12**	**$19,148.24**	**$158,295.16**	**$8,051.43**	**$11,096.81**	**2.38**
22	B70-A75	70-ft Channel + 75 ac	$5,598.37	$19,355.99	$162,643.58	$8,270.62	$11,085.37	2.34
23	B80-A75	80-ft Channel + 75 ac	$5,415.41	$19,538.95	$166,420.30	$8,461.45	$11,077.50	2.31
24	B100-A75	100-ft Channel + 75 ac	$5,109.54	$19,844.82	$173,083.82	$8,796.29	$11,048.53	2.26
25	B90-A75	90-ft Channel + 75 ac	$5,277.47	$19,676.89	$169,822.81	$8,632.38	$11,044.51	2.28
26	B50-A75	50-ft Channel + 75 ac	$6,090.92	$18,863.43	$154,750.51	$7,844.70	$11,018.73	2.40
27	B200-A50	200-ft Channel + 50 ac	$4,535.31	$20,419.05	$186,195.75	$9,456.10	$10,962.95	2.16
28	B110-A75	110-ft Channel + 75 ac	$5,008.81	$19,945.55	$177,071.49	$8,999.75	$10,945.80	2.22
29	B120-A75	120-ft Channel + 75 ac	$4,885.07	$20,069.29	$180,473.25	$9,171.82	$10,897.47	2.19
30	B40-A75	40-ft Channel + 75 ac	$6,408.48	$18,545.87	$151,147.99	$7,690.85	$10,855.02	2.41
31	B140-A75	140-ft Channel + 75 ac	$4,682.40	$20,271.96	$186,659.50	$9,485.62	$10,786.34	2.14
32	B200-A75	200-ft Channel + 75 ac	$4,173.55	$20,780.81	$206,341.95	$10,482.97	$10,297.84	1.98

2009 Price Level, Discount Rate = 4.375 percent; ac - acres
The highlighted rows illustrate the three scales of interest for the NED Plan alternative.

4.9 2013 NED Plan Scale Update and 1990 Authorized Plan Update

The NED Plan was updated as were the WOP condition and the 1990 Authorized Plan in the 2013 reiteration of the planning process. Several corrections, modifications and verifications occurred to the structure database and to hydraulic, hydrologic and flood damage estimation

programs to reflect current guidance and current conditions within the Hunting Bayou watershed. The structure inventory was verified for existence and type, was updated with 2013 RCNLD prices, and was truncated to conform to the 0.2 percent floodplain boundary. Ancillary damage categories were updated to current prices. Any new development which had occurred since 1985 was assumed to conform to COH's first floor elevation criterion of 1 foot above the BFE if the improvement lay within Hunting Bayou's 1 percent floodplain. Depth-damage curves and uncertainty estimates which are necessary components of the HEC-FDA model were reviewed and updated. The current federal discount rate was used. Also because the NED Plan's channel modification component had been optimized by length, advance bridge replacement benefits were calculated which would apply to any NED Plan scale.

4.9.1 Determining Existing Capital Investment within the Existing 0.2 Percent Annual Exceedance Probability (AEP) Floodplain

Table 4-4 shows the structure inventory and the capital investment distribution within Hunting Bayou's eight existing AEP floodplains based on first floor elevations. An estimated 90 percent of the total structures in the estimated 0.2 percent annual probability floodplain are residential, which accounts for approximately $178 million in structure value. Total structure value in the 0.2 percent floodplain is approximately $500 million.

The 2013 inventory update found the residential inventory is not increasing at the rate commercial development is. Growth in residential development averaged 0.7 percent annually while growth in commercial development exceeded 5 percent per annum between 1998 and 2013. Commercial development is taking place near multi-modal opportunities in the middle and lower stream segments closer to the rail yards and the Port of Houston and outside the project impact area. This new development is built to conform to COH first floor elevation standards.

Table 4-4:
Distribution of Capital Investment within Annual Exceedance Probability (AEP) Floodplains
Cumulative Totals based on First-Floor Elevations and Without Project (WOP) Hydrology and Hydraulic Conditions
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's

Property	Bank to 50% Floodplain "2-Year"	Bank to 20% Floodplain "5-Year"	Bank to 10% Floodplain "10-Year"	Bank to 4% Floodplain "25-Year"	Bank to 2% Floodplain "50-Year"	Bank to 1% Floodplain "100-Year"	Bank to 0.4% Floodplain "250-Year"	Bank to 0.2% Floodplain "500-Year"
Residential Property								
Number of Structures	0	203	1091	2265	3564	4614	5759	6616
Single-Family	0	154	933	2018	3226	4233	5345	6163
Multi-Family	0	49	158	247	338	380	412	450
Mobile Homes	0	0	0	0	0	1	2	3
Distribution	0.0%	2.5%	15.1%	32.7%	52.3%	68.7%	86.7%	100.0%
Structure Value	$ 0.00	$ 5,334.41	$ 28,659.54	$ 60,101.18	$ 92,472.23	$ 127,794.13	$ 156,001.36	$ 178,336.62
Content Value**	$ 0.00	$ 2,507.20	$ 13,682.06	$ 28,886.30	$ 44,842.49	$ 61,639.34	$ 75,643.88	$ 86,614.05
Total Value	$ 0.00	$ 7,841.61	$ 42,341.60	$ 88,987.48	$ 137,314.72	$ 189,433.47	$ 231,645.24	$ 264,950.67
Commercial Property								
Number of Structures	0	25	112	251	352	438	542	643
Distribution	0.0%	3.9%	17.4%	39.0%	54.7%	68.1%	84.3%	100.0%
Structure Value	$ 0.00	$ 5,876.43	$ 24,907.56	$ 46,128.99	$ 64,003.99	$ 88,835.05	$ 123,979.63	$ 172,890.13
Content Value**	$ 0.00	$ 9,521.23	$ 39,677.57	$ 73,170.55	$ 101,873.56	$ 131,901.85	$ 183,885.02	$ 244,613.38
Total Value	$ 0.00	$ 15,397.66	$ 64,585.13	$ 119,299.54	$ 165,877.55	$ 220,736.90	$ 307,864.65	$ 417,503.51
Public Property								
Number of Structures	0	2	13	33	52	57	66	69
Distribution	0.0%	2.9%	18.8%	47.8%	75.4%	82.6%	95.7%	100.0%
Structure Value	$ 0.00	$ 37.46	$ 3,537.56	$ 6,295.78	$ 9,748.17	$ 11,187.13	$ 12,776.02	$ 13,412.68
Content Value**	$ 0.00	$ 42.70	$ 4,032.82	$ 7,177.19	$ 11,112.91	$ 12,753.33	$ 14,564.66	$ 15,290.46
Total Value	$ 0.00	$ 80.16	$ 7,570.38	$ 13,472.97	$ 20,861.08	$ 23,940.46	$ 27,340.68	$ 28,703.14

Property	Bank to 50% Floodplain "2-Year"	Bank to 20% Floodplain "5-Year"	Bank to 10% Floodplain "10-Year"	Bank to 4% Floodplain "25-Year"	Bank to 2% Floodplain "50-Year"	Bank to 1% Floodplain "100-Year"	Bank to 0.4% Floodplain "250-Year"	Bank to 0.2% Floodplain "500-Year"
Hospital Property								
Number of Structures	0	0	0	0	0	1	1	1
Distribution	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%
Structure Value	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 137,000.00	$ 137,000.00	$ 137,000.00
Content Value**	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 36,990.00	$ 36,990.00	$ 36,990.00
Total Value	0	0	0	0	0	173990	173990	173990
Total Property								
Number of Structures	0	230	1216	2549	3968	5110	6368	7329
Distribution	0.0%	3.1%	16.6%	34.8%	54.1%	69.7%	86.9%	100.0%
Structure Value	$ 0.00	$ 11,248.30	$ 57,104.66	$ 112,525.95	$ 166,224.39	$ 364,816.31	$ 429,757.01	$ 501,639.43
Content Value**	$ 0.00	$ 12,071.13	$ 57,392.45	$ 109,234.04	$ 157,828.96	$ 243,284.52	$ 311,083.56	$ 383,507.89
Total Value	$ 0.00	$ 23,319.43	$ 114,497.11	$ 221,759.99	$ 324,053.35	$ 608,100.83	$ 740,840.57	$ 885,147.32
Passenger Vehicles								
Number of Vehicles	0	194	1050	2186	3477	4512	5674	6583
Distribution	0.0%	2.9%	16.0%	33.2%	52.8%	68.5%	86.2%	100.0%
Vehicle Value	$ 0.00	$ 1,495.85	$ 8,750.98	$ 18,612.32	$ 27,037.30	$ 33,345.51	$ 40,233.86	$ 45,849.47
Total Roads								
Roadway Lengths (Miles)	1	22	60	89	122	130	138	150
Distribution	0.7%	14.7%	40.0%	59.3%	81.3%	86.7%	92.0%	100.0%

**Residential Single Family Content Values displayed are based on a 50 percent content-to-structure value ratio (CSVR).*

4.9.2 Determining Flood Damages for Without Project (WOP) Condition

Flood damages were estimated for all properties within the Hunting Bayou 0.2 percent AEP floodplain for the WOP condition. Damages from inundation are based on data obtained from the previously described update of existing development. Damage estimates were computed for structures and contents for the various types of physical properties classified as residential, commercial and public. Costs were also estimated for vehicle, utility and road damages and for post-disaster recovery expenditures.

4.9.3 Single Occurrence Damages

Damages expected to accrue from the various AEP events for the WOP condition are displayed in *Table 4-5*. These values represent damages expected for individual events under the WOP hydrologic and hydraulic conditions and include structure and content values. Values are based on 2Q2013 (FY13) price levels. As an example, total flood damages expected from a 1 percent AEP event approximate $160 million. The flood damages expected from a 0.2 percent exceedance probability event approximate $271 million.

4.9.4 Average Annual Equivalent Value (AAEV) Damages

AAEV damages by reach over the 50-year period of analysis are shown in *Table 4-6*. These damages correspond to damages accruing from all damage categories earlier described and, because there is no expected change in the WSEL and to the structure inventory over time, the AAEV damages are equivalent to the expected $19.8 million annual damages.

Table 4-5:
Single Occurrence Damages by Annual Exceedance Probability (AEP) Event
Without Project (WOP) Hydrology and Hydraulic Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's

	50% "2-Year"	20% "5-Year"	10% "10-Year"	4% "25-Year"	2% "50-Year"	1% "100-Year"	0.40% "250-Year"	0.20% "500-Year"
Structure Damage								
Residential Property	$0.00	$2,157.13	$8,547.84	$17,646.96	$27,465.85	$36,398.65	$47,716.98	$54,611.13
Commercial Property	$0.00	$422.47	$1,717.77	$3,784.31	$5,633.65	$8,052.69	$11,431.01	$14,557.29
Public Property	$0.00	$4.56	$293.51	$701.87	$1,291.51	$1,573.91	$2,086.22	$2,385.04
Hospital	$0.00	$0.00	$0.00	$0.00	$808.30	$3,797.64	$14,943.96	$19,404.68
Content Damage								
Residential Property	$0.00	$1,396.06	$5,168.67	$10,414.87	$15,925.20	$20,607.34	$26,886.48	$30,557.91
Commercial Property	$0.00	$1,175.27	$6,146.72	$13,862.11	$21,486.17	$32,026.26	$48,662.71	$61,319.64
Public Property	$0.00	$0.66	$191.21	$715.55	$1,761.19	$2,172.83	$3,138.00	$3,945.56
Hospital	$0.00	$0.00	$0.00	$0.00	$0.00	$914.39	$4,573.44	$5,737.89
Totals								
Residential Property	$0.00	$3,553.19	$13,716.51	$28,061.82	$43,391.05	$57,005.99	$74,603.46	$85,169.04
Commercial Property	$0.00	$1,597.74	$7,864.49	$17,646.41	$27,119.82	$40,078.96	$60,093.72	$75,876.93
Public Property	$0.00	$5.22	$484.72	$1,417.42	$3,052.70	$3,746.75	$5,224.22	$6,330.60
Hospital	$0.00	$0.00	$0.00	$0.00	$808.30	$4,712.03	$19,517.40	$25,142.57
Total Property Damages	**$0.00**	**$5,156.15**	**$22,065.73**	**$47,125.66**	**$74,371.87**	**$105,543.72**	**$159,438.81**	**$192,519.14**
Post Disaster Costs	$0.00	$3,481.49	$10,814.48	$22,615.29	$34,638.10	$41,346.56	$50,713.42	$56,486.79
Road Damages	$10.50	$219.80	$555.61	$1,000.47	$1,410.66	$1,561.97	$1,664.88	$1,783.38
Utility Damages	$0.00	$85.13	$264.44	$549.97	$842.35	$1,005.51	$1,233.30	$1,373.70
Vehicle Damages	$0.00	$132.98	$1,591.67	$4,476.63	$8,286.04	$11,034.84	$15,489.79	$18,688.12
Total by Event	**$10.50**	**$9,075.55**	**$35,291.93**	**$75,768.02**	**$119,549.03**	**$160,492.60**	**$228,540.19**	**$270,851.12**
Percent Distribution								
Residential Property	0.00%	39.15%	38.87%	37.04%	36.30%	35.52%	32.64%	31.44%
Commercial Property	0.00%	17.60%	22.28%	23.29%	22.69%	24.97%	26.29%	28.01%
Public Property	0.00%	0.06%	1.37%	1.87%	2.55%	2.33%	2.29%	2.34%
Hospital	0.00%	0.00%	0.00%	0.00%	0.68%	2.94%	8.54%	9.28%
Post Disaster Costs	0.00%	38.36%	30.64%	29.85%	28.97%	25.76%	22.19%	20.86%
Road Damages	100.00%	2.42%	1.57%	1.32%	1.18%	0.97%	0.73%	0.66%
Utility Damages	0.00%	0.94%	0.75%	0.73%	0.70%	0.63%	0.54%	0.51%
Vehicle Damages	0.00%	1.47%	4.51%	5.91%	6.93%	6.88%	6.78%	6.90%
Total by Event	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 4-6:
Distribution of Average Annual Equivalent Value (AAEV) Damages by Reach
Without Project (WOP) Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's
FY2014 Interest Rate – 3.50 Percent and 50-Year Period of Analysis

Reach Name	Residential	Commercial	Public	Hospital	Post-Disaster	Road	Utility	Vehicle	Total	Percent Distribution
D	$0.00	$0.00	$0.00	$0.00	$0.00	$0.85	$0.00	$0.00	$0.85	0.0%
H	$0.00	$0.00	$0.00	$0.00	$0.00	$0.06	$0.00	$0.00	$0.06	0.0%
L	$3.06	$0.00	$0.00	$0.00	$0.00	$0.32	$0.00	$0.15	$3.53	0.0%
M	$42.50	$7.49	$0.48	$0.00	$8.80	$0.58	$0.21	$7.42	$67.48	0.3%
O	$4.25	$0.00	$0.27	$0.00	$0.00	$0.00	$0.00	$0.48	$5.00	0.0%
P	$2.17	$2.87	$0.00	$0.00	$0.00	$0.15	$0.00	$0.16	$5.35	0.0%
R-Left	$25.10	$299.14	$0.00	$0.00	$8.12	$1.11	$0.20	$0.68	$334.35	1.7%
R-Right	$157.49	$234.56	$0.69	$0.00	$34.00	$3.18	$0.83	$14.40	$445.15	2.2%
T-Left	$196.96	$1.39	$0.00	$0.00	$45.65	$1.68	$1.11	$8.15	$254.94	1.3%
T-Right	$668.76	$3.50	$5.00	$0.00	$250.23	$4.15	$6.08	$51.75	$989.47	5.0%
U-Left	$7.90	$3.83	$0.00	$0.00	$0.00	$0.06	$0.00	$0.20	$11.99	0.1%
U-Right	$146.44	$0.00	$0.00	$0.00	$30.41	$0.00	$0.74	$5.24	$182.83	0.9%
V	$0.00	$10.29	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$10.29	0.1%
X	$46.25	$127.35	$0.00	$0.00	$18.26	$2.81	$0.44	$3.01	$198.12	1.0%
Z	$103.47	$159.37	$2.57	$0.00	$38.35	$2.11	$0.93	$2.23	$309.03	1.6%
AE	$6.35	$2,321.43	$0.01	$0.00	$14.83	$12.38	$0.36	$1.22	$2,356.58	11.9%
AF	$83.14	$856.01	$3.15	$0.00	$68.16	$15.09	$1.66	$4.75	$1,031.96	5.2%
AG	$98.72	$67.91	$0.64	$0.00	$10.85	$3.45	$0.26	$1.52	$183.35	0.9%
AH	$2.73	$44.12	$0.00	$0.00	$1.07	$3.48	$0.03	$0.22	$51.65	0.3%
AI	$183.14	$551.04	$25.75	$0.00	$88.66	$12.82	$2.16	$12.91	$876.48	4.4%
AL	$269.46	$503.40	$8.64	$0.00	$179.24	$12.66	$4.36	$51.91	$1,029.67	5.2%
AP	$3,210.49	$748.60	$254.48	$750.20	$2,682.90	$71.15	$65.25	$576.88	$8,359.95	42.2%
AZ	$1,268.36	$521.99	$91.65	$0.00	$974.38	$57.87	$24.01	$145.76	$3,084.02	15.6%
Total	**$6,526.74**	**$6,464.29**	**$393.33**	**$750.20**	**$4,453.91**	**$205.96**	**$108.63**	**$889.04**	**$19,792.10**	**100.0%**
Percent Distribution	**33.0%**	**32.7%**	**2.0%**	**3.8%**	**22.5%**	**1.0%**	**0.5%**	**4.5%**	**100.0%**	

Colors designate lower, middle and upper stream segments.

4.9.5 Refining the National Economic Development Plan, 2013

In 2009, the NED Plan of channel modification, bridge replacement and offline detention components was refined into an array of 32 possible combinations in an attempt to identify the scale that maximized net excess benefits. Based on the WOP condition update, the 32 NED Plan scales were updated with current planning level costs and were reanalyzed and compared for net excess benefit production. *Table 4-7* presents the 32-scale array's performance under current conditions.

With the update to current conditions, the NED Plan scale that maximizes net excess benefits changed from B90-A50 in 2009 to B60-A50 in 2013. The NED Plan scale that maximized net excess benefits at the least cost remained B50-A25.

When evaluated against the current 2013 condition within the watershed, 19 channel bottom-width and detention basin size combinations produced net excess benefits within 5 percent of B60-A50. Of these 19, the B50-A25 NED Plan scale "reasonably" maximizes net excess benefits at the least cost. However, B50-A25 ranks last among the 32-scale array for inundation damages reduced.

Table 4-7:
Economic Performance of 32 NED Plan Scales
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's, FY2014 Interest Rate of 3.5 Percent

2013 Net Excess Benefit Rank	NED Plan Scale	Equivalent Annual Damage (x $1,000)	Equivalent Annual Inundation Damage Reduction Benefit (x $1,000)	Advance Bridge Replacement Benefit	Total Annual Equivalent NED Benefits	2013 Total Project Cost (x $1,000)^1	Annual Equivalent Project Cost (x $1,000)^1	Annual Equivalent Net Excess Benefits (x $1,000)	BCR	Difference in Net Excess Benefits vs Top Performer (%)	Rank Order Least Cost	Rank Order Inundation Damages Reduced
	WOP	**$19,792.10**										
1	B60-A50	$5,562.01	$14,230.09	$981.42	$15,211.51	$151,345.80	$6,596.02	$8,615.48	2.31	0.00%	9	20
2	B90-A25	$5,945.02	$13,847.08	$981.42	$14,828.50	$147,070.47	$6,362.52	$8,465.98	2.33	1.74%	6	26
3	B90-A50	$5,149.44	$14,642.66	$981.42	$15,624.08	$164,509.92	$7,163.91	$8,460.17	2.18	1.80%	16	14
4	B140-A25	$5,197.64	$14,594.46	$981.42	$15,575.88	$165,212.99	$7,150.61	$8,425.27	2.18	2.21%	15	15
5	B80-A25	$6,136.00	$13,656.10	$981.42	$14,637.52	$143,594.25	$6,212.79	$8,424.72	2.36	2.21%	4	28
6	B100-A25	$5,843.27	$13,948.83	$981.42	$14,930.25	$150,772.97	$6,521.84	$8,408.41	2.29	2.40%	8	24
7	B70-A25	$6,333.76	$13,458.34	$981.42	$14,439.76	$139,459.70	$6,033.79	$8,405.97	2.39	2.43%	3	29
8	B60-A25	$6,598.01	$13,194.09	$981.42	$14,175.51	$133,710.30	$5,786.26	$8,389.25	2.45	2.63%	2	31
9	B110-A25	$5,682.11	$14,109.99	$981.42	$15,091.41	$154,955.70	$6,705.04	$8,386.37	2.25	2.66%	10	23
10	B80-A50	$5,382.33	$14,409.77	$981.42	$15,391.19	$161,084.70	$7,016.36	$8,374.82	2.19	2.79%	13	17
11	B120-A25	$5,548.09	$14,244.01	$981.42	$15,225.43	$158,566.03	$6,861.59	$8,363.84	2.22	2.92%	12	19
12	B70-A50	$5,591.42	$14,200.68	$981.42	$15,182.10	$157,022.56	$6,840.45	$8,341.65	2.22	3.18%	11	21
13	B50-A25	$6,820.55	$12,971.55	$981.42	$13,952.97	$129,858.40	$5,620.19	$8,332.78	2.48	3.28%	1	32
14	B100-A50	$5,122.05	$14,670.05	$981.42	$15,651.47	$168,162.65	$7,321.10	$8,330.37	2.14	3.31%	18	13
15	B110-A50	$4,944.79	$14,847.31	$981.42	$15,828.73	$172,318.55	$7,503.16	$8,325.57	2.11	3.37%	20	11
16	B120-A50	$4,848.24	$14,943.86	$981.42	$15,925.28	$175,906.01	$7,658.74	$8,266.54	2.08	4.05%	21	9
17	B50-A50	$6,080.03	$13,712.07	$981.42	$14,693.49	$147,546.13	$6,432.18	$8,261.30	2.28	4.11%	7	27
18	B140-A50	$4,654.30	$15,137.80	$981.42	$16,119.22	$182,637.84	$7,951.36	$8,167.86	2.03	5.20%	24	6
19	B40-A50	$6,352.70	$13,439.40	$981.42	$14,420.82	$143,631.82	$6,262.54	$8,158.27	2.30	5.31%	5	30
20	B200-A25	$4,670.27	$15,121.83	$981.42	$16,103.25	$185,768.74	$8,044.00	$8,059.24	2.00	6.46%	26	7
21	B60-A75	$5,409.89	$14,382.21	$981.42	$15,363.63	$171,135.52	$7,463.38	$7,900.25	2.06	8.30%	19	18
22	B80-A75	$5,047.02	$14,745.08	$981.42	$15,726.50	$181,082.50	$7,892.54	$7,833.95	1.99	9.07%	23	12
23	B90-A75	$4,899.96	$14,892.14	$981.42	$15,873.56	$184,583.20	$8,043.29	$7,830.27	1.97	9.11%	25	10
24	B70-A75	$5,235.57	$14,556.53	$981.42	$15,537.95	$176,910.38	$7,711.96	$7,825.98	2.01	9.16%	22	16
25	B200-A50	$4,102.56	$15,689.54	$981.42	$16,670.96	$203,348.54	$8,851.33	$7,819.63	1.88	9.24%	30	2
26	B50-A75	$5,666.26	$14,125.84	$981.42	$15,107.26	$167,247.81	$7,295.80	$7,811.45	2.07	9.33%	17	22
27	B100-A75	$4,780.54	$15,011.56	$981.42	$15,992.98	$188,310.64	$8,203.65	$7,789.32	1.95	9.59%	27	8
28	B40-A75	$5,887.32	$13,904.78	$981.42	$14,886.20	$163,221.76	$7,121.42	$7,764.77	2.09	9.87%	14	25
29	B110-A75	$4,636.54	$15,155.56	$981.42	$16,136.98	$192,561.14	$8,389.72	$7,747.25	1.92	10.08%	28	5
30	B120-A75	$4,520.57	$15,271.53	$981.42	$16,252.95	$196,315.42	$8,552.40	$7,700.54	1.90	10.62%	29	4
31	B140-A75	$4,298.28	$15,493.82	$981.42	$16,475.24	$203,272.90	$8,854.65	$7,620.59	1.86	11.55%	31	3
32	B200-A75	$3,790.26	$16,001.84	$981.42	$16,983.26	$224,687.26	$9,784.63	$7,198.63	1.74	16.45%	32	1

Note: Plans 22 through 32 were eliminated from further consideration based on information presented in Secion 4.9.6.

4.9.6 Induced Damages

During the plan refinement process, it was determined that implementing most of the NED Plan scales eligible to be named the NED Plan will raise the WSELs from probabilistic storm events above levels expected without the project in place. Inducing higher WSELs above the WOP condition can damage vulnerable property and habitable structures. Induced damages are captured in the overall damage estimate for each plan scale, but are not readily apparent because HED-FDA outputs are aggregated with damages reduced overshadowing damages induced.

An analysis of induced damages revealed all NED Plan scales performing within 10 percent of the top net excess benefit producer, B60-A50, induce damages primarily downstream in the middle stream segment between cross-sections 285+13 and 565+44. As shown in *Table 4-8*, the scale combinations which include a 25-acre basin generally induce damages beginning at the 4 percent event. The scale combinations which include a 50-acre basin induce damages beginning at the 2 percent event. The scale combination producing the highest net excess benefits among those scales with 75-acre detention basins is B60-A75. B60-A75 induces damages, but only above the 1 percent event.

Based on their rank order for net excess damages produced, the number of NED Plan scales was truncated from 32 to 21 since B60-A75 was the highest-ranking NED Plan scale to have a 75-acre basin and produce no damages at the 1 percent or more frequent event. Any lower ranking NED Plan scale would have to induce no damage downstream to overcome its lack of net excess benefit production to improve its rank order. This distinction was important for subsequent evaluation of FEMA mitigation costs associated with identifying a NED Plan. *Table 4-9* displays damages induced by the top 21 NED Plan scales and their rank order. The least cost NED Plan scale B50-A25 ranks highest overall in induced damages. NED Plan scale B60-A75 induces the least damages. Overall the rank order for net excess benefit production of the NED Plan scales did not change appreciably, demonstrating that induced damages would not likely influence the identification of the NED Plan.

Table 4-8:
Number of Structures Impacted by a Rise in Water Surface Elevation (WSEL) by Annual Exceedance Probability (AEP) Event and NED Plan Scale

NED Plan Scale	Annual Exceedance Probability (AEP) Event							
	50%	20%	10%	4%	2%	1%	0.40%	0.20%
B50-A25	0	0	0	109	146	171	373	477
B60-A25	0	0	0	94	146	171	370	473
B70-A25	0	0	0	92	144	184	367	463
B80-A25	0	0	0	80	135	184	368	466
B90-A25	0	0	0	68	129	152	367	473
B100-A25	0	0	0	59	126	184	367	464
B110-A25	0	0	0	45	125	167	344	463
B120-A25	0	0	0	0	125	184	341	462
B140-A25	0	0	0	0	123	163	338	461
B200-A25	0	0	0	0	71	162	265	440
B40-A50	0	0	0	0	98	184	337	459
B50-A50	0	0	0	0	102	166	334	460
B60-A50	0	0	0	0	71	167	265	439
B70-A50	0	0	0	0	71	167	334	460
B80-A50	0	0	0	0	70	144	333	460
B90-A50	0	0	0	0	45	142	264	437
B100-A50	0	0	0	0	45	153	264	460
B110-A50	0	0	0	0	0	141	264	439
B120-A50	0	0	0	0	0	153	264	439
B140-A50	0	0	0	0	0	153	260	434
B60-A75	0	0	0	0	0	0	173	411

Table 4-9:
Induced Damages of Top 21 NED Plan Scales
2Q2013 (FY13) Structure Inventory Update, FY2014 Interest Rate of 3.5 Percent

2013 Net Excess Benefit Rank	NED Plan Scale	Expected Annual Induced Damages	Present Worth Equivalent Induced Damages (x $1,000)	Rank Order Induced Damages
1	B60-A50	$81.89	$1,920.88	13
2	B90-A25	$131.94	$3,094.84	6
3	B90-A50	$65.15	$1,528.05	19
4	B140-A25	$106.40	$2,495.58	9
5	B80-A25	$168.52	$3,952.79	4
6	B100-A25	$143.16	$3,357.99	5
7	B70-A25	$177.07	$4,153.28	3
8	B60-A25	$183.36	$4,300.77	2
9	B110-A25	$129.55	$3,038.57	7
10	B80-A50	$70.88	$1,662.64	16
11	B120-A25	$126.52	$2,967.70	8
12	B70-A50	$84.41	$1,980.00	12
13	B50-A25	$200.75	$4,708.70	1
14	B100-A50	$71.19	$1,669.80	15
15	B110-A50	$64.35	$1,509.38	20
16	B120-A50	$68.94	$1,616.99	17
17	B50-A50	$89.37	$2,096.22	11
18	B140-A50	$66.11	$1,550.76	18
19	B40-A50	$93.09	$2,183.43	10
20	B200-A25	$76.55	$1,795.61	14
21	B60-A75	$26.37	$618.59	21

3.50 percent interest rate

4.9.7 Reassessment of the Least Cost NED Plan Scale

The uncompensated cost of induced damages was added to the NED project cost estimate as a negative externality. *Table 4-10* demonstrates the outcome of the rank order of the NED Plan scales that reasonably maximize net excess benefits. B60-A50 remains the NED Plan scale that maximizes net excess benefits. B50-A25 maximizes net excess benefits within five percent of the top net excess benefit performer and remains the least cost NED Plan scale. Including the uncompensated induced damages to the economic cost of the NED Plan scales did not change the identification of the NED Plan.

Table 4-10:
Net Excess Benefits of NED Plan Scales
Including Uncompensated Induced Damages*

NED Plan Scale	Expected Annual Induced Damages	Project Cost with Induced Damages Included	Net Excess Benefits with Induced Damages included in Cost	Revised Rank Order Net Excess Benefits	Rank Order Least Cost	Difference in Net Excess Benefits vs Top Performer (x $1,000)
B60-A50	$81.89	$6,677.92	$7,552.17	1	9	0.0%
B90-A25	$131.94	$6,494.46	$7,352.62	3	6	2.6%
B90-A50	$65.15	$7,229.05	$7,413.61	2	14	1.8%
B140-A25	$106.40	$7,257.01	$7,337.45	4	15	2.8%
B80-A25	$168.52	$6,381.32	$7,274.78	11	5	3.7%
B100-A25	$143.16	$6,665.00	$7,283.83	6	8	3.6%
B70-A25	$177.07	$6,210.86	$7,247.48	13	3	4.0%
B60-A25	$183.36	$5,969.62	$7,224.47	14	2	4.3%
B110-A25	$129.55	$6,834.58	$7,275.41	10	10	3.7%
B80-A50	$70.88	$7,087.25	$7,322.52	5	13	3.0%
B120-A25	$126.52	$6,988.11	$7,255.90	12	12	3.9%
B70-A50	$84.41	$6,924.86	$7,275.82	9	11	3.7%
B50-A25	$200.75	$5,820.93	$7,150.62	17	1	5.3%
B100-A50	$71.19	$7,392.29	$7,277.76	8	16	3.6%
B110-A50	$64.35	$7,567.51	$7,279.80	7	18	3.6%
B120-A50	$68.94	$7,727.68	$7,216.18	15	19	4.4%
B50-A50	$89.37	$6,521.55	$7,190.52	16	7	4.8%
B140-A50	$66.11	$8,017.48	$7,120.32	18	20	5.7%
B40-A50	$93.09	$6,355.63	$7,083.77	19	4	6.2%
B200-A25	$76.55	$8,120.56	$7,001.27	20	21	7.3%
B60-A75	$26.37	$7,489.75	$6,892.46	21	17	8.7%

**3.50 percent interest rate, 2Q13 price level*

4.9.8 Mitigating Induced Damages

ER 1105-2-100 states in Section 3-3.b.(5) Induced Flooding:

> "When a project results in induced damages, mitigation should be investigated and recommended if appropriate. Mitigation is appropriate when economically justified or there are overriding reasons of safety, economic or social concerns, or a determination of a real estate taking (flowage easement, etc.) has been made. Remaining induced damages are to be accounted for in the economic analysis and the impacts should be displayed and discussed in the report."

Plan B50-A25 "reasonably" maximizes net excess benefits at the least cost and could be considered the NED Plan. However, inspecting its performance indicates that, of the top 21 NED Plan scales evaluated, B50-A25 produces the highest induced damages downstream from the project area. The AAEV of the induced damages for B50-A25 is $201,000 or $4.7 million in present value equivalents at 3.5 percent interest. To economically justify full mitigation of these induced damages, the cost for mitigation would need to be $4.7 million or less to reach parity with the benefits realized.

4.9.8.1 Economic Justification of Mitigation

Opportunities for mitigating induced damages in a cost effective manner are limited. Levee construction along the middle stream segment would be cost-prohibitive and would serve to further exacerbate the transfer of risk and damages further downstream. Increasing the detention basin size is an option since opportunities may exist for economies of scale; and storage volume upstream is a strong indicator of downstream impacts. By comparing the estimated costs for B50-A25 and B50-A50 from *Table 4-7*, the difference in costs is approximately $17.5 million. It is apparent that a larger detention increment is not economically justifiable as a mitigation strategy since the cost for the next larger storage increment is greater than the $4.7 million in present worth equivalent induced damages and would not fully mitigate the downstream impacts from B50-A25 shown in *Table 4-9*.

With induced damages impacting structures at infrequent events, little expectation exists to economically justify mitigating induced damages by nonstructural means. The low probability of damages occurring diminishes their expected AAEV and consequently limits any economical remedy.

4.9.8.2 Mitigation based on Safety, Economic or Social Concerns

Mitigating induced damages could be appropriate based on safety, economic or social concerns. Transferring risk and damages to an area downstream from the project area on Hunting Bayou is considered to be socially unacceptable by the non-federal sponsor, HCFCD, and it violates the non-federal sponsor's local policies to not induce damages at or below the 1 percent AEP event. Inducing additional damages on a local population which has limited ability to respond to and recover from catastrophic events is neither acceptable nor implementable.

However, minimizing disruption of neighborhoods is a study objective and displacing the population to mitigate for induced damages using buyout as a mitigating measure violates a study objective. A measure which would adhere to study objectives and potentially be less costly with regard to mitigating induced damages is the implementation of B60-A75.

4.9.8.3 Mitigation based on a Determination of a Real Estate Taking

Inducing damages might constitute a real estate taking according to the Fifth Amendment Takings Clause of the U.S. Constitution. If a legal real estate taking determination is made, payment of just compensation to the property owner is required. The value of that compensation would be included in the total project cost, which would influence not only its total cost but also the net excess benefits attributable to that project. An Attorney's Takings Opinion for B60-A75 has been completed, assessing the character of induced damages with regard to frequency, extent, flooding depth, and damages incurred. The Attorney's Takings Opinion concluded that no additional property is required to be acquired by law for B60-A75 due to induced flooding. Furthermore, it was determined that there is no policy reason to acquire additional land, as there is no induced flooding due to B60-A75 for events up to and including the 1% AEP storm event.

4.10 Identification of the NED Plan

Even though B50-A25 induces the greatest damages downstream and violates other study objectives, it best addresses the federal objective by reasonably maximizing net excess NED benefits at the least cost. Therefore, B50-A25 is identified as the NED Plan.

4.10.1 Economic Performance of B50-A25

As the NED Plan scale which "reasonably" maximizes NED net excess benefits at least cost, B50-A25 is, by definition, the NED Plan. B50-A25 is described by its economic performance characteristics.

4.10.2 Economic Assets in the Residual Floodplain of B50-A25

The distribution of economic assets remaining at risk in the residual floodplain of B50-A25 is shown in *Table 4-11*. Total structures at risk from a 0.2 percent AEP event along Hunting Bayou decrease 45 percent from 7,329 to 3,998 by implementing B50-A25. Residential structures at risk from the 0.2 percent AEP event are reduced from 6,616 to 3,506 in the B50-A25 With Project condition.

An estimated 79 percent of the structures in the WOP condition 1 percent AEP floodplain would experience reduced risk from a 1 percent AEP event by implementing B50-A25. Approximately 5,015 structures are currently exposed to the risk of a 1 percent AEP event. By implementing B50-A25, structures at risk in the residual 1 percent AEP floodplain would drop to 1,089, of which 942 are residential.

4.10.3 Single Occurrence Damages in the Residual Floodplain of B50-A25

Table 4-12 displays the single occurrence damages expected to occur in B50-A25's residual floodplain. Damages to economic assets are expected from a 0.2 percent AEP event would drop about 38 percent to $168 million by implementing B50-A25. Damages to assets from a 1 percent event are expected to decline 67 percent to $53.1 million by implementing B50-A25.

4.10.4 Average Annual Equivalent Damages Reduced by Implementing B50-A25

Table 4-13 displays the AAEV damages reduced by B50-A25. *Table 4-14* shows the AAEV damages remaining in the residual 0.2 percent AEP floodplain of B50-A25. By implementing B50-A25, AAEV damages are reduced by 65 percent over the WOP condition.

Table 4-11:
Economic Assets by Annual Exceedance Probability (AEP) Event
B50-A25 With Project Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's

	Bank to 50% Floodplain "2-Year"	Bank to 20% Floodplain "5-Yeare"	Bank to 10% Floodplain "10-Year"	Bank to 4% Floodplain "25-Year"	Bank to 2% Floodplain "50-Year"	Bank to 1% Floodplain "100-Year"	Bank to 0.4% Floodplain "250-Year"	Bank to 0.2% Floodplain "500-Year"
Residential Property								
Number of Structures	0	5	30	162	417	942	2,033	3,506
Single-Family	0	5	30	161	368	815	1,841	3,212
Multi-Family	0	0	0	1	49	127	192	294
Mobile Homes	0	0	0	0	0	0	0	0
Distribution	0.0%	0.1%	0.9%	4.6%	11.9%	26.9%	58.0%	100.0%
Structure Value	$0.00	$366.20	$1,723.84	$7,497.81	$16,597.59	$40,017.92	$72,210.41	$114,206.15
Content Value*	$0.00	$183.10	$861.92	$3,729.05	$8,136.44	$18,948.39	$34,700.08	$55,219.81
Total Value	$0.00	$549.30	$2,585.76	$11,226.86	$24,734.03	$58,966.31	$106,910.49	$169,425.96
Commercial Property								
Number of Structures	0	1	15	57	84	139	259	447
Distribution	0.0%	0.2%	3.4%	12.8%	18.8%	31.1%	57.9%	100.0%
Structure Value	$0.00	$116.40	$12,700.48	$32,241.29	$42,182.69	$61,151.13	$101,397.80	$149,746.20
Content Value*	$0.00	$195.55	$21,170.13	$53,570.66	$64,528.71	$89,724.03	$149,189.58	$207,031.66
Total Value	$0.00	$311.95	$33,870.61	$85,811.95	$106,711.40	$150,875.16	$250,587.38	$356,777.86
Public Property								
Number of Structures	0	0	0	4	4	8	21	45
Distribution	0.0%	0.0%	0.0%	8.9%	8.9%	17.8%	46.7%	100.0%
Structure Value	$0.00	$0.00	$0.00	$184.02	$184.02	$2,571.52	$3,967.29	$9,381.17
Content Value*	$0.00	$0.00	$0.00	$209.78	$209.78	$2,931.53	$4,522.71	$10,694.53
Total Value	$0.00	$0.00	$0.00	$393.80	$393.80	$5,503.05	$8,490.00	$20,075.70
Hospital Property								
Number of Structures	0	0	0	0	0	0	0	0
Distribution	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Structure Value	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Content Value*	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Value	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Property								
Number of Structures	0	6	45	223	505	1,089	2,313	3,998
Distribution	0.0%	0.2%	1.1%	5.6%	12.6%	27.2%	57.9%	100.0%
Structure Value	$0.00	$482.60	$14,424.32	$39,923.12	$58,964.30	$103,740.57	$177,575.50	$273,333.52
Content Value*	$0.00	$378.65	$22,032.05	$57,509.49	$72,874.93	$111,603.95	$188,412.37	$272,946.01
Total Value	$0.00	$861.25	$36,456.37	$97,432.61	$131,839.23	$215,344.52	$365,987.87	$546,279.53
Passenger Vehicles								
Number of Vehicles	0	6	40	170	401	874	1,973	3,445
Distribution	0.0%	0.2%	1.2%	4.9%	11.6%	25.4%	57.3%	100.0%
Vehicle Value	$0.00	$33.44	$264.23	$1,072.84	$2,736.67	$6,662.10	$14,457.42	$26,641.10
Total Roads								
Roadway Lengths (Miles)	1	2	7	9	12	19	37	50
Distribution	2.0%	4.0%	14.0%	18.0%	24.0%	38.0%	74.0%	100.0%

Table 4-12:
Single Occurrence Damages by Annual Exceedance Probability (AEP) Event
B50-A25 Project Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's

	50% "2-Year"	20% "5-Year"	10%e "10-Year"	4% "25-Year"	2% "50-Year"	1% "100-Year"	0.40% "250-Year"	0.20% "500-Year"
Structure Damage								
Residential Property	$0.00	$118.61	$837.31	$2,618.07	$5,512.77	$11,635.14	$20,824.07	$33,218.08
Commercial Property	$0.00	$8.10	$568.49	$2,250.53	$3,096.98	$4,505.58	$8,239.13	$12,745.13
Public Property	$0.00	$0.00	$1.95	$28.11	$36.91	$102.23	$397.29	$1,058.62
Hospital	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$131.52
Content Damage								
Residential Property	$0.00	$78.91	$515.23	$1,661.81	$3,387.94	$6,722.11	$12,240.25	$19,076.47
Commercial Property	$0.00	$29.36	$2,404.29	$9,833.05	$13,692.56	$19,616.86	$36,177.38	$57,939.00
Public Property	$0.00	$0.00	$0.00	$9.34	$22.84	$67.12	$299.95	$1,057.76
Hospital	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Totals								
Residential Property	$0.00	$197.52	$1,352.54	$4,279.87	$8,900.71	$18,357.25	$33,064.32	$52,294.54
Commercial Property	$0.00	$37.46	$2,972.79	$12,083.58	$16,789.53	$24,122.44	$44,416.51	$70,684.13
Public Property	$0.00	$0.00	$1.95	$37.45	$59.75	$169.35	$697.24	$2,116.39
Hospital	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$131.52
Total Property Damages	**$0.00**	**$234.98**	**$4,327.27**	**$16,400.90**	**$25,750.00**	**$42,649.04**	**$78,178.08**	**$125,226.58**
Post Disaster Costs	$0.00	$222.37	$993.95	$3,348.91	$5,766.85	$8,157.60	$18,461.17	$33,206.67
Road Damages	$9.87	$35.34	$90.55	$331.71	$491.44	$622.96	$1,047.93	$1,424.31
Utility Damages	$0.00	$5.40	$24.16	$81.59	$140.60	$198.93	$448.95	$807.54
Vehicle Damages	$0.00	$2.62	$43.85	$273.73	$542.80	$1,440.90	$3,449.63	$7,585.73
Total by Event	**$9.87**	**$500.71**	**$5,479.78**	**$20,436.85**	**$32,691.69**	**$53,069.43**	**$101,585.75**	**$168,250.83**
Percent Distribution								
Residential Property	0.00%	39.45%	24.68%	20.94%	27.23%	34.59%	32.55%	31.08%
Commercial Property	0.00%	7.48%	54.25%	59.13%	51.36%	45.45%	43.72%	42.01%
Public Property	0.00%	0.00%	0.04%	0.18%	0.18%	0.32%	0.69%	1.26%
Hospital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.08%
Post Disaster Costs	0.00%	44.41%	18.14%	16.39%	17.64%	15.37%	18.17%	19.74%
Road Damages	100.00%	7.06%	1.65%	1.62%	1.50%	1.17%	1.03%	0.85%
Utility Damages	0.00%	1.08%	0.44%	0.40%	0.43%	0.37%	0.44%	0.48%
Vehicle Damages	0.00%	0.52%	0.80%	1.34%	1.66%	2.72%	3.40%	4.51%
Total by Event	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 4-13:
Distribution of Average Annual Equivalent Value (AAEV) Damages Reduced by Reach
B50-A25 Project Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's
FY2014 Interest Rate – 3.50 Percent

Reaches	Residential	Commercial	Public	Hospital	Post-Disaster	Road	Utility	Vehicle	Total	Percent Distribution
D	$0.00	$0.00	$0.00	$0.00	$0.00	-$0.01	$0.00	$0.00	-$0.01	0.0%
H	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.0%
L	$0.17	$0.00	$0.00	$0.00	$0.00	$0.02	$0.00	$0.01	$0.20	0.0%
M	$3.21	$0.42	$0.03	$0.00	$0.83	$0.03	$0.02	$0.46	$5.00	0.0%
O	$0.63	$0.00	$0.05	$0.00	$0.00	$0.00	$0.00	$0.08	$0.76	0.0%
P	$0.35	$0.47	$0.00	$0.00	$0.00	$0.00	$0.00	$0.03	$0.85	0.0%
R-Left	$5.09	$59.89	$0.00	$0.00	$1.71	$0.13	$0.04	$0.12	$66.98	0.5%
R-Right	$31.19	$48.22	$0.14	$0.00	$6.37	$0.50	$0.16	$2.85	$89.43	0.7%
T-Left	$46.08	$0.33	$0.00	$0.00	$10.99	$0.39	$0.27	$1.97	$60.03	0.5%
T-Right	$142.90	$0.82	$1.07	$0.00	$51.61	$0.83	$1.25	$11.86	$210.34	1.6%
U-Left	$1.87	$0.92	$0.00	$0.00	$0.00	$0.01	$0.00	$0.05	$2.85	0.0%
U-Right	$33.80	$0.00	$0.00	$0.00	$7.43	$0.00	$0.18	$1.28	$42.69	0.3%
V	$0.00	$2.21	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2.21	0.0%
X	$9.17	$22.79	$0.00	$0.00	$3.85	$0.37	$0.09	$0.59	$36.86	0.3%
Z	$21.58	$34.52	$0.41	$0.00	$9.34	$0.48	$0.22	$0.16	$66.71	0.5%
AE	$1.26	$363.75	$0.00	$0.00	$3.34	$2.33	$0.08	$0.21	$370.97	2.9%
AF	$16.04	$142.68	$0.20	$0.00	$15.54	$3.20	$0.38	$0.66	$178.70	1.4%
AG	$18.13	$6.06	$0.02	$0.00	$1.73	$0.66	$0.04	-$0.62	$26.02	0.2%
AH	$1.87	$30.47	$0.00	$0.00	$0.76	$1.95	$0.02	$0.15	$35.22	0.3%
AI	$147.87	$459.68	$21.57	$0.00	$73.05	$9.20	$1.78	$11.29	$724.44	5.6%
AL	$232.78	$436.80	$7.78	$0.00	$154.89	$9.48	$3.77	$47.33	$892.83	6.9%
AP	$2,765.68	$667.32	$227.21	$702.09	$2,317.76	$60.04	$56.37	$520.60	$7,317.07	56.4%
AZ	$1,179.26	$484.85	$84.37	$0.00	$881.37	$49.61	$21.70	$140.22	$2,841.38	21.9%
Total	**$4,658.93**	**$2,762.20**	**$342.85**	**$702.09**	**$3,540.57**	**$139.22**	**$86.37**	**$739.30**	**$12,971.53**	**100.0%**
Percent Distribution	**35.9%**	**21.3%**	**2.6%**	**5.4%**	**27.3%**	**1.1%**	**0.7%**	**5.7%**	**100.0%**	

Colors designate lower, middle, and upper stream segments

Table 4-14:
Distribution of Average Annual Equivalent Value (AAEV) Residual Damages by Reach
B50-A25 Project Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000- 's
FY2014 Interest Rate – 3.50 Percent

Reaches	Residential	Commercial	Public	Hospital	Post-Disaster	Road	Utility	Vehicle	Total	Percent Distribution
D	$0.00	$0.00	$0.00	$0.00	$0.00	$0.86	$0.00	$0.00	$0.86	0.0%
H	$0.00	$0.00	$0.00	$0.00	$0.00	$0.06	$0.00	$0.00	$0.06	0.0%
L	$2.89	$0.00	$0.00	$0.00	$0.00	$0.30	$0.00	$0.14	$3.33	0.0%
M	$39.29	$7.07	$0.45	$0.00	$7.97	$0.55	$0.19	$6.96	$62.48	0.9%
O	$3.62	$0.00	$0.22	$0.00	$0.00	$0.00	$0.00	$0.40	$4.24	0.1%
P	$1.82	$2.40	$0.00	$0.00	$0.00	$0.15	$0.00	$0.13	$4.50	0.1%
R-Left	$20.01	$239.25	$0.00	$0.00	$6.41	$0.98	$0.16	$0.56	$267.37	3.9%
R-Right	$126.30	$186.34	$0.55	$0.00	$27.63	$2.68	$0.67	$11.55	$355.72	5.2%
T-Left	$150.88	$1.06	$0.00	$0.00	$34.66	$1.29	$0.84	$6.18	$194.91	2.9%
T-Right	$525.86	$2.68	$3.93	$0.00	$198.62	$3.32	$4.83	$39.89	$779.13	11.4%
U-Left	$6.03	$2.91	$0.00	$0.00	$0.00	$0.05	$0.00	$0.15	$9.14	0.1%
U-Right	$112.64	$0.00	$0.00	$0.00	$22.98	$0.00	$0.56	$3.96	$140.14	2.1%
V	$0.00	$8.08	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$8.08	0.1%
X	$37.08	$104.56	$0.00	$0.00	$14.41	$2.44	$0.35	$2.42	$161.26	2.4%
Z	$81.89	$124.85	$2.16	$0.00	$29.01	$1.63	$0.71	$2.07	$242.32	3.6%
AE	$5.09	$1,957.68	$0.01	$0.00	$11.49	$10.05	$0.28	$1.01	$1,985.61	29.1%
AF	$67.10	$713.33	$2.95	$0.00	$52.62	$11.89	$1.28	$4.09	$853.26	12.5%
AG	$80.59	$61.85	$0.62	$0.00	$9.12	$2.79	$0.22	$2.14	$157.33	2.3%
AH	$0.86	$13.65	$0.00	$0.00	$0.31	$1.53	$0.01	$0.07	$16.43	0.2%
AI	$35.27	$91.36	$4.18	$0.00	$15.61	$3.62	$0.38	$1.62	$152.04	2.2%
AL	$36.68	$66.60	$0.86	$0.00	$24.35	$3.18	$0.59	$4.58	$136.84	2.0%
AP	$444.81	$81.28	$27.27	$48.11	$365.14	$11.11	$8.88	$56.28	$1,042.88	15.3%
AZ	$89.10	$37.14	$7.28	$0.00	$93.01	$8.26	$2.31	$5.54	$242.64	3.6%
Total	**$1,867.81**	**$3,702.09**	**$50.48**	**$48.11**	**$913.34**	**$66.74**	**$22.26**	**$149.74**	**$6,820.57**	**100.0%**
Percent Distribution	**27.4%**	**54.3%**	**0.7%**	**0.7%**	**13.4%**	**1.0%**	**0.3%**	**2.2%**	**100.0%**	

Colors designate lower, middle, and upper stream segments

4.11 Determining the Tentatively Selected Plan (TSP), 2013

The NED Plan met the federal objective, but failed to adequately meet the other stated planning study objectives for reducing flood risk to a socially vulnerable population. Other factors described below contributed to naming the non-federal sponsor's, HCFCD, Locally Preferred Plan and subsequently to identifying the TSP.

4.11.1 Compliance with FEMA Requirements

The Memorandum, "Federal Emergency Management Agency (FEMA)/USACE Joint Actions on Planning for Flood Risk Management Projects," signed on June 2012, addresses the requirement to perform mitigation when proposed USACE flood-risk reduction projects increase the Base Flood Elevation (BFE) (1 percent annual chance event). National Flood Insurance Program (NFIP) regulations, found in 44 CFR 65.12, require revisions to flood insurance rate

maps to reflect BFE and/or floodway changes caused by encroachments permitted by an NFIP participating community. Once the area subject to map revision has been defined, the community must certify to the Federal Flood Insurance Administrator that no structures are impacted by the increase to the BFE in order to maintain the community's participation in the NFIP. Mitigation for all structures impacted is a necessary cost for the local community in association with project implementation and realization of federal project benefits. This action could be considered an NED associated cost.

If B50-A25 or any other NED Plan scale that induced damages by raising the BFE were to be implemented, NFIP regulation would require the non-federal sponsor, HCFCD, to mitigate the induced damages within the 1 percent AEP flood hazard area. Options for structural mitigation are limited by the same factors limiting mitigation for induced damages as described in Section 4.9.8. One structural measure by which all induced damages would be fully mitigated at the 1 percent AEP event is the construction of B60-A75, since NED Plan scale B60-A75 does not induce damages at the 1 percent AEP or more frequent events.

A comparison of nonstructural buyout of impacted structures versus constructing B60-A75 as a mitigating NED Plan scale was made and is displayed in *Table 4-15*. For all but two NED Plan scales, B60-A25 and B50-A25, implementing B60-A75 is the least cost mitigation option. Buyout is less costly for B60-A25 and B50-A25. Buyout for either B60-A25 or B50-A25 would involve acquiring 171 residential and commercial properties.

Table 4-15:
NED Plan Scale Economic Performance with Uncompensated Induced Damages and FEMA/NFIP Least Cost Mitigation Included

2Q13 (FY 2013 Price Level, FY2014 Interest Rate of 3.5 Percent

NED Plan Scale	Equivalent Annual Damage (x $1,000)	Equivalent Annual Inundation Damage Reduction Benefit (x $1,000)	Advance Bridge Replacement Benefit (x $1,000)	Total Equivalent Annual NED Benefits (x $1,000)	2013 Total Project Cost (x 1,000)^1	Equivalent Annual Project Cost (x 1,000)^1	Equivalent Annual Induced Damages (x $1,000)	Equivalent Annual Project Cost with Uncompensated Induced Damages Included (x $1,000)	Present Worth Equivalent of Project Cost with Induced Damages Included (x $1,000)	Net Excess Benefits with Uncompensated Induced Damages included in Cost (x $1,000)	Revised Rank Order Net Excess Benefits	Rank Order Least Cost	Difference in Net Excess Benefits vs. Top Performer (x $1,000)	No. Structures Impacted by Rise in BFE at 1 Percent Event	Cost for Buyout as Mitigation for Rise in BFE (x $1,000)	Incremental Cost of B60-A75 as Mitigation for Rise in BFE (x $1,000)	Least Cost Option to Mitigate for Rise in BFE--Buyouts or B60-A75	Revised Cost for Project Implementation and Least Cost FEMA/NFIP Mitigation
WOP	**$19,792.10**																	
B60-A50	$5,562.01	$14,230.09	$981.42	$15,211.51	$151,345.80	$6,596.02	$81.89	$6,677.92	$156,634.72	$7,552.17	1	9	0.0%	167	$35,481.10	$19,042.06	B60-A75	$175,676.77
B90-A25	$5,945.02	$13,847.08	$981.42	$14,828.50	$147,070.47	$6,362.52	$131.94	$6,494.46	$152,331.64	$7,352.62	3	6	2.6%	152	$31,069.61	$23,345.13	B60-A75	$175,676.77
B90-A50	$5,149.44	$14,642.66	$981.42	$15,624.08	$164,509.92	$7,163.91	$65.15	$7,229.05	$169,561.89	$7,413.61	2	14	1.8%	142	$28,721.60	$6,114.88	B60-A75	$175,676.77
B140-A25	$5,197.64	$14,594.46	$981.42	$15,575.88	$165,212.99	$7,150.61	$106.40	$7,257.01	$170,217.54	$7,337.45	4	15	2.8%	163	$35,044.08	$5,459.23	B60-A75	$175,676.77
B80-A25	$6,136.00	$13,656.10	$981.42	$14,637.52	$143,594.25	$6,212.79	$168.52	$6,381.32	$149,677.72	$7,274.78	11	5	3.7%	184	$37,722.95	$25,999.05	B60-A75	$175,676.77
B100-A25	$5,843.27	$13,948.83	$981.42	$14,930.25	$150,772.97	$6,521.84	$143.16	$6,665.00	$156,331.74	$7,283.83	6	8	3.6%	184	$37,722.95	$19,345.03	B60-A75	$175,676.77
B70-A25	$6,333.76	$13,458.34	$981.42	$14,439.76	$139,459.70	$6,033.79	$177.07	$6,210.86	$145,679.45	$7,247.48	13	3	4.0%	184	$37,722.95	$29,997.32	B60-A75	$175,676.77
B60-A25	$6,598.01	$13,194.09	$981.42	$14,175.51	$133,710.30	$5,786.26	$183.36	$5,969.62	$140,021.01	$7,224.47	14	2	4.3%	171	$34,589.54	$35,655.76	BUYOUT	$174,610.55
B110-A25	$5,682.11	$14,109.99	$981.42	$15,091.41	$154,955.70	$6,705.04	$129.55	$6,834.58	$160,309.33	$7,275.41	10	10	3.7%	167	$35,481.10	$15,367.44	B60-A75	$175,676.77
B80-A50	$5,382.33	$14,409.77	$981.42	$15,391.19	$161,084.70	$7,016.36	$70.88	$7,087.25	$166,235.74	$7,322.52	5	13	3.0%	144	$29,495.00	$9,441.03	B60-A75	$175,676.77
B120-A25	$5,548.09	$14,244.01	$981.42	$15,225.43	$158,566.03	$6,861.59	$126.52	$6,988.11	$163,910.47	$7,255.90	12	12	3.9%	184	$37,722.95	$11,766.30	B60-A75	$175,676.77
B70-A50	$5,591.42	$14,200.68	$981.42	$15,182.10	$157,022.56	$6,840.45	$84.41	$6,924.86	$162,426.94	$7,275.82	9	11	3.7%	167	$35,481.10	$13,249.83	B60-A75	$175,676.77
B50-A25	$6,820.55	$12,971.55	$981.42	$13,952.97	$129,858.40	$5,620.19	$200.75	$5,820.93	$136,533.61	$7,150.62	17	1	5.3%	171	$34,589.54	$39,143.16	BUYOUT	$171,123.15
B100-A50	$5,122.05	$14,670.05	$981.42	$15,651.47	$168,162.65	$7,321.10	$71.19	$7,392.29	$173,390.69	$7,277.76	8	16	3.6%	153	$32,702.18	$2,286.09	B60-A75	$175,676.77
B110-A50	$4,944.79	$14,847.31	$981.42	$15,828.73	$172,318.55	$7,503.16	$64.35	$7,567.51	$177,500.58	$7,279.80	7	18	3.6%	141	$28,129.06	-$1,823.81	B60-A75	$175,676.77
B120-A50	$4,848.24	$14,943.86	$981.42	$15,925.28	$175,906.01	$7,658.74	$68.94	$7,727.68	$181,257.44	$7,216.18	15	19	4.4%	153	$32,702.18	-$5,580.67	B60-A75	$175,676.77
B50-A50	$6,080.03	$13,712.07	$981.42	$14,693.49	$147,546.13	$6,432.18	$89.37	$6,521.55	$152,967.09	$7,190.52	16	7	4.8%	166	$35,458.60	$22,709.68	B60-A75	$175,676.77
B140-A50	$4,654.30	$15,137.80	$981.42	$16,119.22	$182,637.84	$7,951.36	$66.11	$8,017.48	$188,054.84	$7,120.32	18	20	5.7%	153	$32,702.18	-$12,378.07	B60-A75	$175,676.77
B40-A50	$6,352.70	$13,439.40	$981.42	$14,420.82	$143,631.82	$6,262.54	$93.09	$6,355.63	$149,075.27	$7,083.77	19	4	6.2%	184	$37,722.95	$26,601.50	B60-A75	$175,676.77
B200-A25	$4,670.27	$15,121.83	$981.42	$16,103.25	$185,768.74	$8,044.00	$76.55	$8,120.56	$190,472.68	$7,001.27	20	21	7.3%	162	$34,956.21	-$14,795.91	B60-A75	$175,676.77
B60-A75	$5,409.89	$14,382.21	$981.42	$15,363.63	$171,135.52	$7,463.38	$26.37	$7,489.75	$175,676.77	$6,892.46	21	17	8.7%	0	$0.00	$0.00		$175,676.77

4.11.2 Meeting Study Objectives

The study objectives for the Hunting Bayou Federal Flood Risk Management Study are as follows.

- Reduce residential and business flood risk due to riverine flooding to a socially vulnerable population along Hunting Bayou from its mouth to US 59.

  The study area has been established as an area of social vulnerability having a high minority population with limited economic resources and having a demographic profile comprised of more younger and older residents than in Harris County as a whole.

- Minimize adverse effects from implementing flood risk reduction measures on existing neighborhoods and wildlife habitat.

  Minimizing adverse effects from implementing flood risk reduction measures on existing neighborhoods is an important study objective. Community concern over residential and other population displacements was expressed repeatedly in public outreach sessions. Social anxiety over the ability to relocate in the same neighborhood, the extreme difficulty, if not impossibility, of relocating elderly or ill community members and other constraints on relocation including cost, warranted a close review when evaluating required displacements.

- Provide FRM to structures and infrastructure in the Hunting Bayou watershed without increasing the potential for flooding in other areas.

  As part of their agency's mission, the non-federal sponsor, HCFCD, has adopted policies and practices stipulating new residential, commercial, industrial or other land development must include measures to assure no adverse impact to the surrounding area's WSELs. This requirement is in line with FEMA/NFIP requirements for full mitigation from an NFIP-participating community's permit of a rise in the BFE in that the local community must certify that no structures are impacted by the proposed increase in the BFE.

- Maintain and protect community cohesiveness for the residents living within Hunting Bayou watershed.

  This study objective is similar to minimizing adverse effects from implementing flood risk reduction measures on existing neighborhoods with the intent to minimize displacements which tear at the community's social fabric.

4.11.3 Comparing the NED Plan Scales, B50-A25 and B60-A75 and the 1990 Authorized Plan

"Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)," 1983, define four evaluation criteria for formulating alternatives: completeness, effectiveness, efficiency and acceptability. These criteria were applied to a comparison of the designated NED Plan and to the non-federal sponsor's, HCFCD, preferred alternative to the NED Plan, B60-A75. The NED Plan scale B50-A25 is compared against B60-A75 and the Authorized Plan for project performance and for meeting study objectives.

4.11.3.1 Completeness

Completeness is the extent to which a given plan provides and accounts for all necessary investments or other actions to ensure the planned effects are realized. The expected project effects that are attributed to the TSP, the NED Plan, or the Authorized Plan are realized with implementation of their respective project features. The structural measures of channel modification, bridge replacement, and offline detention for the TSP and the NED Plan are sufficient to realize the NED benefits claimed. No other actions, programs, or features are required in order to realize the economic and life, health, and safety effects attributed to the NED Plan or the TSP. The project features of the Authorized Design as authorized and described in Section 1.5 are sufficient to produce the effects claimed. Therefore, there is no difference in completeness with regard to implementation of the TSP, the NED Plan, or the Authorized Plan.

However, while B50-A25 reasonably maximizes net excess benefits at least cost, B50-A25 also produces the least amount of AAEV inundation reduction benefits, $12.9 million, (65 percent over WOP) ranking last within the 32 NED Plan scale array. B60-A75 reduces AAEV inundation damages by $14.4 million, or 73 percent over the WOP condition. This is an important consideration for the study objective of providing flood risk management to a socially vulnerable population because greater residual damages are associated with B50-A25 than for B60-A75. These residual damages will be experienced by a resident population with limited resources for response and recovery.

The Authorized Design reduces WOP condition AAEV inundation damages by 99 percent. When assessing the sole objective of flood damage reduction without regard for environmental or social impacts, the 1990 Authorized Plan is nearly perfect in its FRM performance.

4.11.3.2 Acceptability

Acceptability is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public, and compatibility with existing laws, regulations and public policies. Study objectives were to minimize adverse effects from implementing flood risk reduction measures on existing neighborhoods and to maintain community cohesiveness. The operational metric for that objective was the number of displacements necessary to implement a plan.

Table 4-16 shows the displacements required from implementing the NED Plan, B60-A75 or the 1990 Authorized Plan under current conditions.

The 1990 Authorized Plan would require displacing 125 residential units and 15 commercial businesses directly impacting an estimated 316 residents based on ROW acquisition needs.

B60-A75 would require 70 displacements impacting an estimated 167 persons. Of the 70 displacements, 66 are residential and 4 are nonresidential.

The NED Plan B50-A25 would require 240 displacements, of which 171 would occur in the middle stream reach to comply with FEMA/NFIP regulations.

Of these FEMA/NFIP compliance displacements, 86 are residential structures housing an estimated 218 residents. In total, buyout and relocation due to implementing the NED Plan B50-A25 would directly impact approximately 380 residents along Hunting Bayou.

Table 4-16:
Displacements by Plan for Project Construction (Not structure acquisitions)

Plan	Reason	Single Family Residential	Multifamily Residential (4 units/ea)	Commercial	Religious	Industrial	Total	Residents
B50-A25	**ROW**	57	8	2	1	1	69	164
	Rise in BFE^1	86		85			171	218
B60-A75	**ROW**	58	8	2	1	1	70	167
Authorized Design	**ROW**	115	10	15	0	0	140	316

^1 FEMA requires certification that no structures are impacted by rise in BFE due to project implementation. Buyout is lease cost option for FEMA mitigation.

The NED Plan scale B50-A25 induces the greatest damages downstream from the project area among the top NED Plan scales and violates local policy of "no adverse impact" at the 1 percent AEP or more frequent events. NED Plan scale B50-A25, in effect, transfers some flood risk from the upper stream segment to the middle stream segment with its implementation. To mitigate for the rise in the BFE from implementing B50-A25, the non-federal sponsor, HCFCD, and local communities will be required to fully mitigate for structures impacted and to certify to the National Floodplain Administrator that no structures are impacted by the change to the BFE. To mitigate for these impacts, 171 residential and commercial structures will be subjected to buyout and relocation as a least cost mitigating measure for implementing B50-A25, the designated NED Plan. This requirement is unacceptable to the local community regarding disrupting community cohesiveness by displacing the resident population.

B60-A75 does not induce damages downstream at the 1 percent or more frequent event. Therefore, no mitigation of downstream effects is required for FEMA/NFIP compliance.

While the 1990 Authorized Plan does not induce damages downstream by design, it still requires over 300 persons be displaced for implementation.

Neither the 1990 Authorized Plan nor B50-A25 is implementable by the non-federal sponsor, HCFCD, based on the number of population displacements required for implementation.

4.11.3.3 Effectiveness

Effectiveness is the extent to which a plan alleviates the specified problems and achieves the specified opportunities. The operational metric for effectiveness was the extent to which flood risk was reduced while minimizing associated consequences or impacts.

Overall the NED Plan scale B60-A75 better addresses study objectives than the designated NED Plan B50-A25. B60-A75 reduces flood damages to a greater extent than B50-A25 without transferring risk downstream to the extent B50-A25 does. In addition, NED Plan scale B60-A75 produces the least induced damages among the NED Plan scales that "reasonably" maximize net excess benefits. No mitigation of downstream impact would be required since implementing B60-A75 does not cause the BFE to rise in the 1 percent or more frequent AEP event and would therefore be less disruptive to the local neighborhoods and surrounding community. NED Plan scale B60-A75 would require 70 displacements in total, compared to the 240 required for B50-A25 implementation from project construction and mitigating downstream impacts.

The 1990 Authorized Plan is highly effective when assessing its flood risk reduction performance. The 1990 Authorized Plan reduces 99 percent of the WOP condition flood damages. However, the extent of the environmental and local community impacts associated with its implementation has made the 1990 Authorized Plan unimplementable by the non-federal sponsor, HCFCD.

4.11.3.4 Efficiency

Efficiency is the extent to which an alternatives plan is the most cost effective means to alleviate the specified problems and realize the specified opportunities, consistent with protecting the nation's environment.

NED Plan scale B50-A25 produces the greatest net excess benefits at least cost. However, to implement B50-A25, the non-federal sponsor, HCFCD, will be required to mitigate for the structures impacted by the scale's downstream impact of raising the BFE. The least cost mitigation measure of buying out the 171 structures impacted by a rise in the BFE is approximately $34.5 million, which increases the overall cost to implement B50-A25 to an estimated $171 million, about $5 million less than the $176 million estimated to construct B60-A75.

NED Plan scale B60-A75 reasonably maximizes net excess benefits, but not at least cost.

The 1990 Authorized Plan was not cost effective when compared against an economically optimized alternative in the Final Array of Alternatives evaluation in Section 4.6. The 1990 Authorized Plan failed to compete successfully for net excess benefit production under current watershed conditions.

4.11.4 Elimination of the Remaining NED Plan Scales

All other plan scales within the 32 NED Plan scale array, apart from B50-A25 and B60-A75, fail to meet key study objectives and are dismissed from further detailed evaluation in the GRR/EA. For detailed impact assessment, subsequent sections of this document will further evaluate and assess the B60-A75 and B50-A25 plan scales, the 1990 Authorized Plan and the No Action Alternative.

Council on Environmental Quality regulations at 40 CFR 1502.14 stipulate all reasonable alternatives should be explored and evaluated, as has been accomplished with the multiple plan scales. However, this regulation section also provides for "alternatives which (are) eliminated from detailed study, briefly discuss the reasons for their having been eliminated." Consequently, the NEPA regulations do not specify a floor or ceiling regarding how many alternatives must be carried into detailed analysis (for a specific ruling on this matter see Native Ecosystems Council v. U.S. Forest Service No. 04-35274. U.S. Court of Appeals, 9th Circuit 428F3d. 2005 which upheld a Forest Service decision to provide a detailed analysis for only two alternatives—the preferred alternative and No Action Alternative—in an environmental assessment.)

It is reasonably believed that a more detailed evaluation of the two plan scales which reasonably maximize benefits and the 1990 Authorized Plan along with the No Action Alternative is appropriate for this GRR/EA.

4.11.5 Refinement of Project Costs

MII cost estimates were developed for two NED Plan scales, B50-A25 and B60-A75, and are shown in *Table 4-17*. The 1990 Authorized Plan was also brought to current prices, discount rate and period of analysis. The first cost of the Authorized Design was escalated to current prices using EM 1110-2-1304 with 2Q88 and 2Q13 quarterly composite indices and then adjusted using the FY14 discount rate of 3.50 percent and 50-year period of analysis. *Table 4-17* displays the 1990 Authorized Plan at the authorized cost and at current cost.

Table 4-17:
Cost Estimates for NED Plan Scales B50-A25 and B60-A75 and 1990 Authorized Plan

	B50A25 3.50%	B50A25 7%	B60A75 3.50%	B60A75 7%	Authorized Plan [2]	Authorized Plan [3]
Price Level	Jan-13	Jan-13	Jan-13	Jan-13	Jan-88	Jan-13
Interest Rate	0.035	0.07	0.035	0.07	0.08625	0.035
Period of Analysis, years	50	50	50	50	100	50
Flood Control (includes Mitigation) – First Cost [1]						
GRR Study	$9,334,488	$9,334,488	$9,334,488	$9,334,488		
Lands and Damages, Relocations	$67,764,915	$67,764,915	$74,085,922	$74,085,922		
PED and Construction Management	$17,247,431	$17,247,431	$19,142,431	$19,142,431		
Construction	$21,142,814	$21,142,814	$28,755,459	$28,755,459		
Construction Contingency	$19,427,083	$19,427,083	$23,001,328	$23,001,328		
Total First Cost	$134,916,730	$134,916,730	$154,319,628	$154,319,628	$59,581,000	$125,523,114
IDC	$26,665,001	$56,343,556	$28,535,540	$64,853,813		
Uncompensated NED Losses	$4,708,700	$2,770,489	$618,590	$363,964		
Recreation First Cost [4]	n/a	n/a	n/a	n/a	$441,000	$929,083
Total Economic Cost	$166,290,431	$194,030,775	$183,473,758	$219,537,405	$60,022,000	$126,452,197
AAEV Total First Cost						
Flood Control	$7,089,578	$14,059,441	$7,822,167	$15,907,647	$5,870,000	$5,351,516
Recreation	n/a	n/a	n/a		$62,000	$39,610
AAEV Operations & Maintenance (O&M)						
Flood Control	$123,896	$123,896	$168,756	$168,756	$193,200	$95,475
Recreation	n/a	n/a	n/a	n/a	$17,100	$8,450
AAEV Total NED Cost	$7,213,474	$14,183,337	$7,990,923	$16,076,403	$6,142,300	$5,495,052
AAEV Total NED Benefits						
Flood Control	$13,952,966	$13,952,966	$15,363,566	$15,363,566	$59,919,000	$29,610,633
Recreation	n/a	n/a	n/a	n/a	$336,400	$166,241
BCR						
Flood Control	1.93	0.98	1.92	0.96	10.2	5.39
Recreation	n/a	n/a	n/a		4.25	3.46
AAEV Net Excess Benefits						
Flood Control	$6,739,492	($230,371)	$7,372,643	($712,837)	$54,049,000	$24,115,581
Recreation	n/a	n/a	n/a	n/a	$274,400	$157,791

[1]: *MII cost estimate for B50-A25 and B60-A75*
[2] *The authorized data is taken from Buffalo Bayou and Tributaries, Texas Feasibility Report, House Document 101-208 (1990).*
[3] *Updated based on EM1110-2-1304*
[4] *Non-federal sponsor, HCFCD, is not exercising its recreational authority at the present time.*

The project costs for B50-A25 and B60-A75 were developed using the MII cost estimator program and adhere to COE policy and practices for cost estimation. The costs for the two NED Plan scales, when compared against the estimated AAEV economic benefits, produce results which are somewhat different from the planning level estimates. The total first cost for construction is estimated to be $134.9 million for the NED Plan scale B50-A25 and $154.3 million for B60-A75, a $19.5 million difference.

While B50-A25 still costs less, B60-A75 produces greater net excess benefits than B50-A25 at a 3.5 percent interest rate. The difference between net excess benefit production is 9 percent lower for B50-A25 than for B60-A75. *Table 4-18* compares the overall performance characteristics of the NED Plan scale B50-A25, B60-A75 and the 1990 Authorized Plan.

Table 4-18:
Project Performance for NED Plan Scales B50-A25 and B60-A75, and the 1990 Authorized Plan
3.5 percent interest rate, 2(Q)13 price levels, 2013 conditions

Performance Variables	No Action Alternative	NED Plan Scales		Difference between NED Plan Scales	1990 Authorized Design
	WOP	B60-A75 TSP	B50-A25 NED Plan	B60-A75 minus B50-A25	
Structures with Reduced Risk over the No Action Alternative					
from 0.2 percent flood event	0	4,287	3,331	+956	7,062
from 1 percent flood event	0	4,465	4,021	+444	5,093
Residential Structures with Reduced Risk over the No Action Alternative					
from 0.2 percent flood event	0	3,971	3,110	+861	6,376
from 1 percent flood event	0	4,061	3,672	+389	4,597
Population with Reduced Risk over the No Action Alternative					
from 0.2 percent flood event	0	10,047	7,868	+2,178	16,131
from 1 percent flood event	0	10,274	9,290	+984	11,630
Single Occurrence Damages in $1,000s					
from 0.2 percent flood event	$270,851	$132,790	$168,251	-$35,461	$13,104
from 1 percent flood event	$160,493	$43,775	$53,069	-$9,294	$828
AAEV Benefits in $1000s	N/A	$15,364	$13,953	$1,411	$19,733
AAEV Net Excess Benefits[^1] in $1,000s	N/A	$7,373	$6,863	$510	$3,008

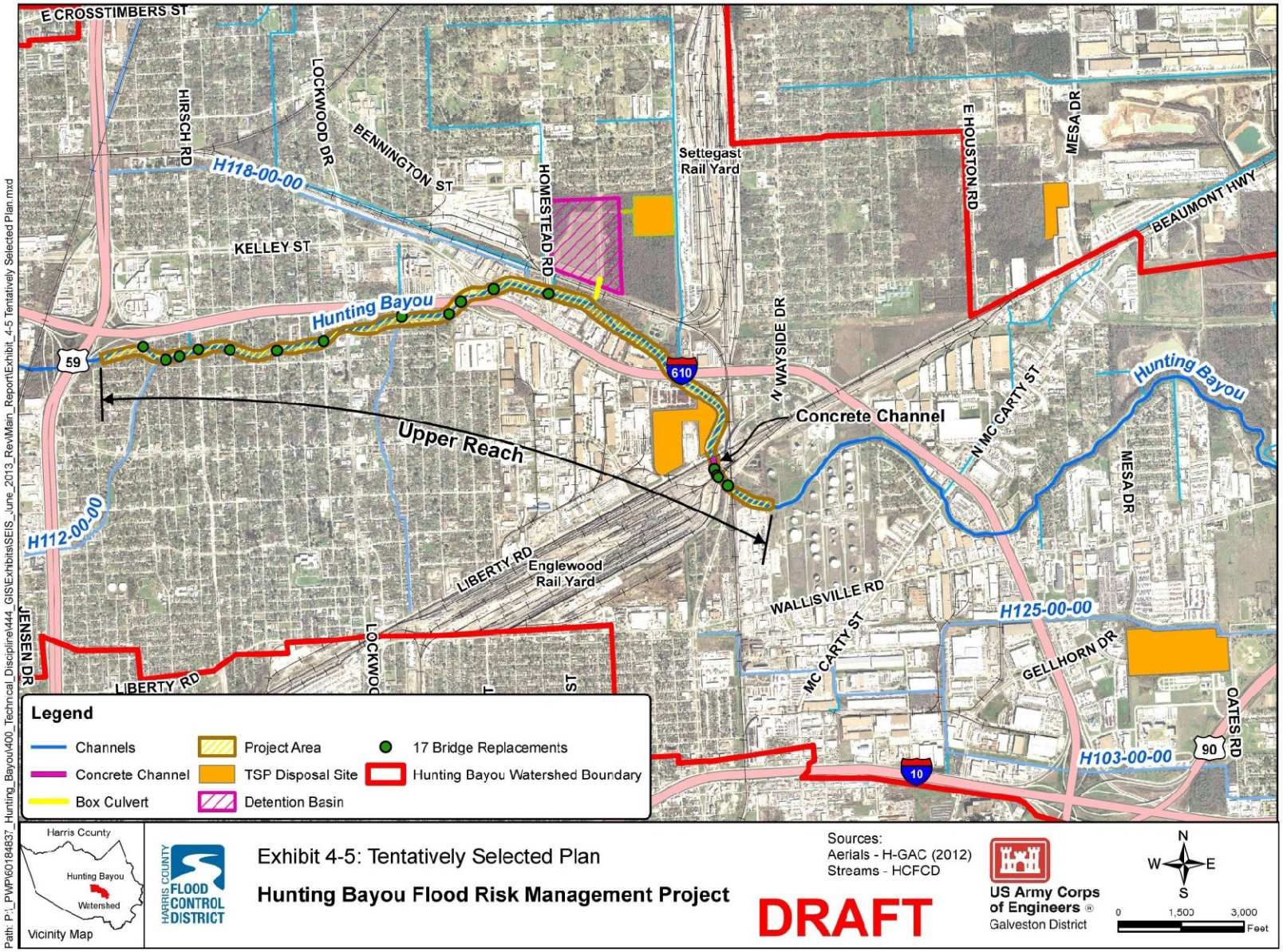
[^1] *Under current conditions*

4.11.6 Identifying the Tentatively Selected Plan (TSP)

NED Plan scale B60-A75 maximizes available off-line detention storage and is the non-federal sponsor's, HCFCD, Locally Preferred Plan because it adheres to the local policy of "no adverse impact" at the 1 percent AEP or more frequent events; maximizes use of available vacant land for detention storage; and best addresses all study objectives by providing flood risk management to a socially vulnerable population while minimizing adverse impacts to the surrounding community and natural resources to the extent possible.

The NED Plan scale B60-A75 better meets the study objectives by providing greater flood risk reduction without displacing the resident population associated with mitigation for downstream BFE increases. Therefore, the NED Plan scale B60-A75 is named the TSP (see *Exhibit 4-5*).

Exhibit 4-5:
Tentatively Selected Plan



4.11.6.1 Economic Performance of B60-A75, the Tentatively Selected Plan

The non-federal sponsor, HCFCD, prefers to implement NED Plan scale, B60-A75. Economic and performance characteristics of B60-A75 are presented in the following discussion.

4.11.6.1.1 Economic Assets in the Residual Floodplain of B60-A75

The distribution for economic assets remaining in the residual floodplain of B60-A75 is shown in *Table 4-19*. Total structures in Hunting Bayou's 0.2 percent AEP floodplain are reduced 58 percent from 7,329 to 3,042 by implementing B60-A75. Residential structures in the 0.2 percent AEP floodplain are reduced 60 percent from 6,616 to 2,645 in the TSP With Project condition.

An estimated 87 percent of the structures in the WOP condition 1 percent AEP floodplain would have reduced risk from the residual 1 percent AEP floodplain. An estimated 5,110 structures are currently in the 1 percent AEP floodplain. By implementing B60-A75, the structure count in the residual 1 percent AEP floodplain would drop to 645.

4.11.6.1.2 Single Occurrence Damages in the Residual Floodplain of B60-A75

Table 4-20 displays the single occurrence damages expected to occur in the residual floodplain of B60-A75. Damages to economic assets are expected from a 0.2 percent AEP event would drop an estimated 51 percent to $132.8 million by implementing B60-A75. Damages to assets from a 1 percent event are expected to decline by 73 percent to $43.8 million by implementing the TSP.

4.11.6.1.3 Average Annual Equivalent Value Damages Reduced with the Implementation of B60-A75

Table 4-21 shows the AAEV damages remaining in the residual 0.2 percent floodplain of B60-A75. *Figure 1* graphically represents the damages in the WOP and with TSP conditions. *Table 4-22* shows the AAEV damages reduced by implementing B60-A75. AAEV damages are reduced by 73 percent by implementing the TSP over the WOP condition.

Table 4-19:
Economic Assets by Annual Exceedance Probability (AEP) Event
B60-A75 Project Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's

Property	Bank to 50% Floodplain "2-Year"	Bank to 20% Floodplain "5-Year"	Bank to 10% Floodplain "10-Year"	Bank to 4% Floodplain "25-Year"	Bank to 2% Floodplain "50-Year"	Bank to 1% Floodplain "100-Year"	Bank to 0.4% Floodplain "250-Year"	Bank to 0.2% Floodplain "500-Year"
Residential Property								
Number of Structures	0	3	25	151	248	553	1272	2645
Single-Family	0	3	25	150	247	506	1141	2434
Multi-Family	0	0	0	1	1	47	131	211
Mobile Homes	0	0	0	0	0	0	0	0
Distribution	0.0%	0.1%	0.9%	5.7%	9.4%	20.9%	48.1%	100.0%
Structure Value	$0.00	$204.88	$1,512.08	$7,241.75	$12,423.73	$29,501.63	$52,369.14	$93,207.52
Content Value*	$0.00	$102.44	$756.04	$3,601.02	$6,192.01	$14,038.43	$25,108.60	$45,013.56
Total Value	**$0.00**	**$307.32**	**$2,268.12**	**$10,842.77**	**$18,615.74**	**$43,540.06**	**$77,477.74**	**$138,221.08**
Commercial Property								
Number of Structures	0	1	10	29	57	87	187	370
Distribution	0.0%	0.3%	2.7%	7.8%	15.4%	23.5%	50.5%	100.0%
Structure Value	$0.00	$116.40	$5,516.11	$21,187.26	$32,241.29	$50,194.21	$89,294.81	$133,282.92
Content Value*	$0.00	$195.55	$9,267.06	$35,009.40	$53,570.66	$71,996.02	$131,183.79	$180,297.96
Total Value	**$0.00**	**$311.95**	**$14,783.17**	**$56,196.66**	**$85,811.95**	**$122,190.23**	**$220,478.60**	**$313,580.88**
Public Property								
Number of Structures	0	0	0	3	4	5	12	27
Distribution	0.0%	0.0%	0.0%	11.1%	14.8%	18.5%	44.4%	100.0%
Structure Value	$0.00	$0.00	$0.00	$132.50	$184.02	$210.76	$3,397.44	$5,308.66
Content Value*	$0.00	$0.00	$0.00	$151.05	$209.78	$240.27	$3,873.08	$6,051.87
Total Value	**$0.00**	**$0.00**	**$0.00**	**$283.55**	**$393.80**	**$451.03**	**$7,270.52**	**$11,360.53**

Property	Bank to 50% Floodplain "2-Year"	Bank to 20% Floodplain "5-Year"	Bank to 10% Floodplain "10-Year"	Bank to 4% Floodplain "25-Year"	Bank to 2% Floodplain "50-Year"	Bank to 1% Floodplain "100-Year"	Bank to 0.4% Floodplain "250-Year"	Bank to 0.2% Floodplain "500-Year"
Hospital Property								
Number of Structures	0	0	0	0	0	0	0	0
Distribution	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Structure Value	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Content Value*	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total Value	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Total Property								
Number of Structures	0	4	35	183	309	645	1471	3042
Distribution	0.0%	0.1%	1.2%	6.0%	10.2%	21.2%	48.4%	100.0%
Structure Value	$0.00	$321.28	$7,028.19	$28,561.51	$44,849.04	$79,906.60	$145,061.39	$231,799.10
Content Value*	$0.00	$297.99	$10,023.10	$38,761.47	$59,972.45	$86,274.73	$160,165.47	$231,363.39
Total Value	**$0.00**	**$619.27**	**$17,051.29**	**$67,322.98**	**$104,821.49**	**$166,181.33**	**$305,226.86**	**$463,162.49**
Passenger Vehicles								
Number of Vehicles	0	4	31	158	255	525	1218	2626
Distribution	0.0%	0.2%	1.2%	6.0%	9.7%	20.0%	46.4%	100.0%
Vehicle Value	$0.00	$22.32	$220.94	$1,010.42	$1,566.79	$3,435.28	$8,740.92	$20,776.53
Total Roads								
Roadway Lengths (Miles)	1	2	7	9	12	19	37	50
Distribution	2.0%	4.0%	14.0%	18.0%	24.0%	38.0%	74.0%	100.0%

Table 4-20:
Single Occurrence Damages by Annual Exceedance Probability (AEP) Event
B60-A75 Project Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's

	50% "2-Year"	20% "5-Year"	10% "10-Year"	4% "25-Year"	2% "50-Year"	1% "100-Year"	0.40% "250-Year"	0.20% "500-Year"
Structure Damage								
Residential Property	$ 0.00	$ 106.03	$ 736.41	$ 2,171.16	$ 4,036.50	$ 8,872.67	$ 16,467.40	$ 26,474.45
Commercial Property	$ 0.00	$ 7.68	$ 367.56	$ 1,492.19	$ 2,329.33	$ 3,847.38	$ 6,218.56	$ 10,832.49
Public Property	$ 0.00	$ 0.00	$ 1.83	$ 14.75	$ 34.73	$ 42.87	$ 246.51	$ 568.55
Hospital	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Content Damage								
Residential Property	$ 0.00	$ 70.82	$ 454.87	$ 1,332.65	$ 2,479.48	$ 5,127.69	$ 9,643.93	$ 15,296.30
Commercial Property	$ 0.00	$ 25.80	$ 1,475.44	$ 6,008.34	$ 10,167.91	$ 17,006.05	$ 27,106.97	$ 47,551.10
Public Property	$ 0.00	$ 0.00	$ 0.00	$ 5.60	$ 20.33	$ 40.64	$ 134.61	$ 479.57
Hospital	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Totals								
Residential Property	$ 0.00	$ 176.85	$ 1,191.27	$ 3,503.81	$ 6,515.98	$ 14,000.35	$ 26,111.32	$ 41,770.75
Commercial Property	$ 0.00	$ 33.48	$ 1,843.00	$ 7,500.53	$ 12,497.25	$ 20,853.43	$ 33,325.53	$ 58,383.59
Public Property	$ 0.00	$ 0.00	$ 1.83	$ 20.35	$ 55.06	$ 83.50	$ 381.12	$ 1,048.12
Hospital	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00	$ 0.00
Total Property Damages	**$ 0.00**	**$ 210.34**	**$ 3,036.10**	**$ 11,024.69**	**$ 19,068.29**	**$ 34,937.28**	**$ 59,817.97**	**$ 101,202.46**
Post Disaster Costs	$ 0.00	$ 212.79	$ 874.93	$ 2,189.99	$ 4,381.04	$ 7,141.43	$ 11,969.93	$ 24,720.07
Road Damages	$ 9.83	$ 34.08	$ 72.92	$ 168.93	$ 366.58	$ 518.34	$ 772.51	$ 1,264.16
Utility Damages	$ 0.00	$ 5.17	$ 21.26	$ 53.29	$ 106.77	$ 174.10	$ 292.92	$ 601.16
Vehicle Damages	$ 0.00	$ 1.85	$ 36.41	$ 246.42	$ 463.46	$ 1,003.69	$ 2,233.27	$ 5,002.38
Total by Event	**$ 9.83**	**$ 464.23**	**$ 4,041.62**	**$ 13,683.33**	**$ 24,386.14**	**$ 43,774.85**	**$ 75,086.61**	**$ 132,790.23**

	50% "2-Year"	20% "5-Year"	10% "10-Year"	4% "25-Year"	2% "50-Year"	1% "100-Year"	0.40% "250-Year"	0.20% "500-Year"
Percent Distribution								
Residential Property	0.00%	38.10%	29.48%	25.61%	26.72%	31.98%	34.77%	31.46%
Commercial Property	0.00%	7.21%	45.60%	54.82%	51.25%	47.64%	44.38%	43.97%
Public Property	0.00%	0.00%	0.05%	0.15%	0.23%	0.19%	0.51%	0.79%
Hospital	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Post Disaster Costs	0.00%	45.84%	21.65%	16.00%	17.97%	16.31%	15.94%	18.62%
Road Damages	100.00%	7.34%	1.80%	1.23%	1.50%	1.18%	1.03%	0.95%
Utility Damages	0.00%	1.11%	0.53%	0.39%	0.44%	0.40%	0.39%	0.45%
Vehicle Damages	0.00%	0.40%	0.90%	1.80%	1.90%	2.29%	2.97%	3.77%
Total by Event	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**	**100.00%**

Table 4-21:
Distribution of Average Annual Equivalent Value (AAEV) Residual Damages by Reach
B60-A75 Project Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000's
FY2014 Interest Rate – 3.50 Percent

Reaches	Residential	Commercial	Public	Hospital	Post-Disaster	Road	Utility	Vehicle	Total	Percent Distribution
D	$0.00	$0.00	$0.00	$0.00	$0.00	$0.86	$0.00	$0.00	$0.86	0.0%
H	$0.00	$0.00	$0.00	$0.00	$0.00	$0.06	$0.00	$0.00	$0.06	0.0%
L	$2.90	$0.00	$0.00	$0.00	$0.00	$0.30	$0.00	$0.14	$3.34	0.1%
M	$39.12	$7.07	$0.45	$0.00	$7.88	$0.55	$0.19	$6.95	$62.21	1.1%
O	$3.61	$0.00	$0.23	$0.00	$0.00	$0.00	$0.00	$0.41	$4.25	0.1%
P	$1.83	$2.40	$0.00	$0.00	$0.00	$0.15	$0.00	$0.13	$4.51	0.1%
R-Left	$19.90	$237.84	$0.00	$0.00	$6.37	$0.98	$0.16	$0.56	$265.81	4.9%
R-Right	$125.21	$185.35	$0.55	$0.00	$27.27	$2.66	$0.66	$11.44	$353.14	6.5%
T-Left	$151.40	$1.07	$0.00	$0.00	$34.89	$1.29	$0.85	$6.23	$195.73	3.6%
T-Right	$522.69	$2.69	$3.90	$0.00	$196.49	$3.27	$4.78	$39.91	$773.73	14.3%
U-Left	$5.98	$2.87	$0.00	$0.00	$0.00	$0.04	$0.00	$0.15	$9.04	0.2%
U-Right	$111.41	$0.00	$0.00	$0.00	$22.91	$0.00	$0.56	$3.93	$138.81	2.6%
V	$0.00	$7.21	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$7.21	0.1%
X	$34.12	$90.61	$0.00	$0.00	$13.89	$2.38	$0.34	$2.19	$143.53	2.7%
Z	$70.84	$107.65	$1.81	$0.00	$25.43	$1.52	$0.62	$1.55	$209.42	3.9%
AE	$4.44	$1,597.17	$0.01	$0.00	$10.71	$8.52	$0.26	$0.81	$1,621.92	30.0%
AF	$56.35	$564.41	$2.11	$0.00	$46.97	$10.52	$1.14	$3.06	$684.56	12.7%
AG	$59.32	$41.27	$0.40	$0.00	$6.03	$2.21	$0.15	$1.12	$110.50	2.0%
AH	$0.36	$5.25	$0.00	$0.00	$0.11	$1.34	$0.00	$0.02	$7.08	0.1%
AI	$15.60	$33.92	$1.55	$0.00	$4.85	$2.44	$0.12	$0.34	$58.82	1.1%
AL	$15.22	$26.05	$0.30	$0.00	$8.32	$2.11	$0.20	$1.33	$53.53	1.0%
AP	$234.28	$39.97	$12.89	$14.87	$204.69	$6.68	$4.98	$25.09	$543.45	10.0%
AZ	$51.13	$23.80	$4.73	$0.00	$68.24	$6.47	$1.70	$2.38	$158.45	2.9%
Total	**$1,525.71**	**$2,976.60**	**$28.93**	**$14.87**	**$685.05**	**$54.35**	**$16.71**	**$107.74**	**$5,409.96**	**100.0%**
Percent Distribution	28.2%	55.0%	0.5%	0.3%	12.7%	1.0%	0.3%	2.0%	100.0%	

Colors designate lower, middle, and upper stream segments

Figure 4-1:
Average Annual Equivalent Inundation Damages in the Without Project (WOP) and With B60-A75 Conditions

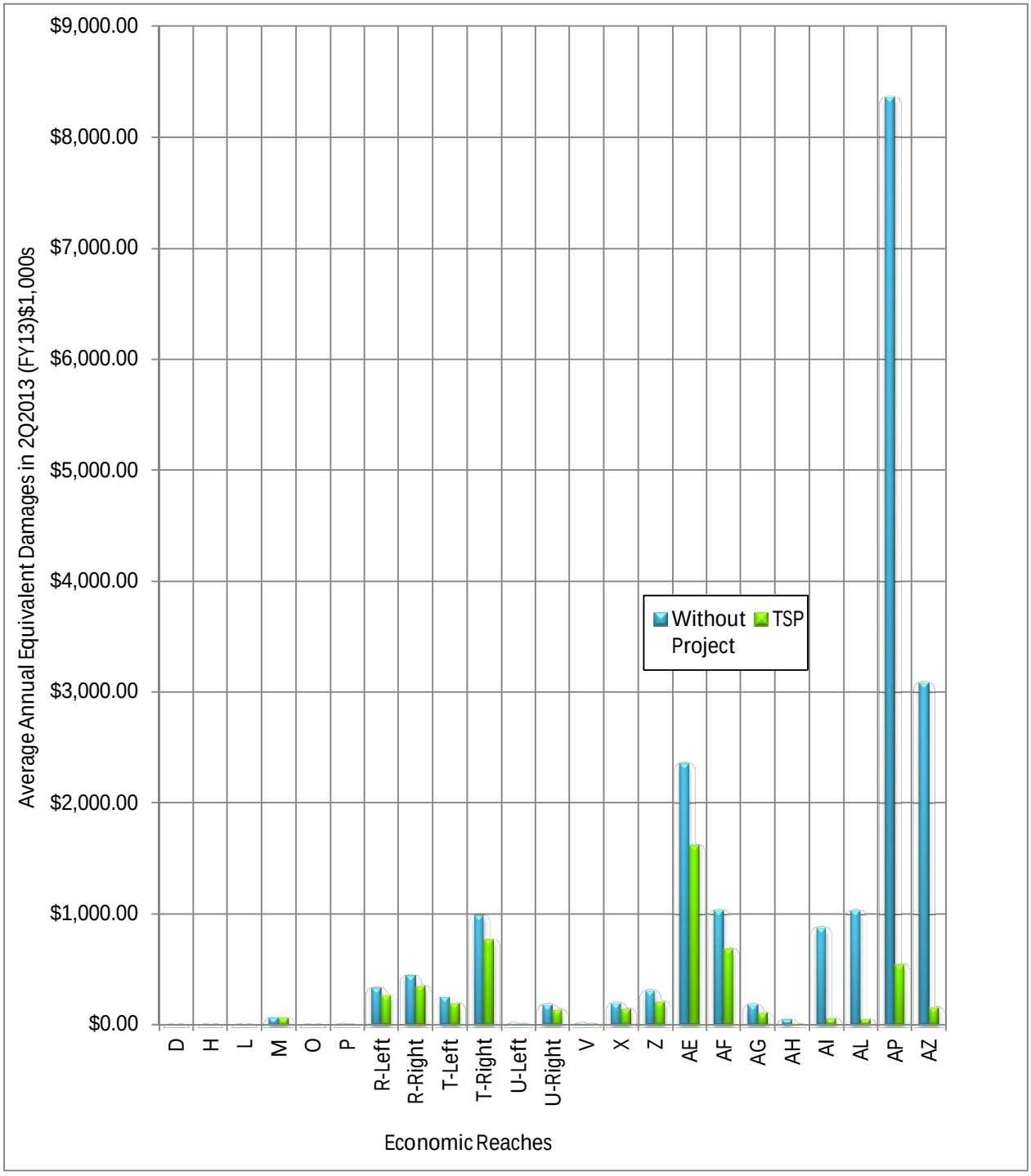


Table 4-22:
Distribution of Average Annual Equivalent Value (AAEV) Damages Reduced by Reach
B60-A75 Condition
2Q2013 (FY13) Structure Inventory Update and Values in $1,000s
FY 2014 Interest Rate—3.50 Percent

Reaches	Residential	Commercial	Public	Hospital	Post-Disaster	Road	Utility	Vehicle	Total	Percent Distribution
D	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.0%
H	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	0.0%
L	$0.16	$0.00	$0.00	$0.00	$0.00	$0.02	$0.00	$0.01	$0.19	0.0%
M	$3.38	$0.42	$0.03	$0.00	$0.92	$0.03	$0.02	$0.47	$5.27	0.0%
O	$0.64	$0.00	$0.04	$0.00	$0.00	$0.00	$0.00	$0.07	$0.75	0.0%
P	$0.34	$0.47	$0.00	$0.00	$0.00	$0.00	$0.00	$0.03	$0.84	0.0%
R-Left	$5.20	$61.30	$0.00	$0.00	$1.75	$0.13	$0.04	$0.12	$68.54	0.5%
R-Right	$32.28	$49.21	$0.14	$0.00	$6.73	$0.52	$0.17	$2.96	$92.01	0.6%
T-Left	$45.56	$0.32	$0.00	$0.00	$10.76	$0.39	$0.26	$1.92	$59.21	0.4%
T-Right	$146.07	$0.81	$1.10	$0.00	$53.74	$0.88	$1.30	$11.84	$215.74	1.5%
U-Left	$1.92	$0.96	$0.00	$0.00	$0.00	$0.02	$0.00	$0.05	$2.95	0.0%
U-Right	$35.03	$0.00	$0.00	$0.00	$7.50	$0.00	$0.18	$1.31	$44.02	0.3%
V	$0.00	$3.08	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3.08	0.0%
X	$12.13	$36.74	$0.00	$0.00	$4.37	$0.43	$0.10	$0.82	$54.59	0.4%
Z	$32.63	$51.72	$0.76	$0.00	$12.92	$0.59	$0.31	$0.68	$99.61	0.7%
AE	$1.91	$724.26	$0.00	$0.00	$4.12	$3.86	$0.10	$0.41	$734.66	5.1%
AF	$26.79	$291.60	$1.04	$0.00	$21.19	$4.57	$0.52	$1.69	$347.40	2.4%
AG	$39.40	$26.64	$0.24	$0.00	$4.82	$1.24	$0.11	$0.40	$72.85	0.5%
AH	$2.37	$38.87	$0.00	$0.00	$0.96	$2.14	$0.03	$0.20	$44.57	0.3%
AI	$167.54	$517.12	$24.20	$0.00	$83.81	$10.38	$2.04	$12.57	$817.66	5.7%
AL	$254.24	$477.35	$8.34	$0.00	$170.92	$10.55	$4.16	$50.58	$976.14	6.8%
AP	$2,976.21	$708.63	$241.59	$735.33	$2,478.21	$64.47	$60.27	$551.79	$7,816.50	54.3%
AZ	$1,217.23	$498.19	$86.92	$0.00	$906.14	$51.40	$22.31	$143.38	$2,925.57	20.3%
Total	**$5,001.03**	**$3,487.69**	**$364.40**	**$735.33**	**$3,768.86**	**$151.62**	**$91.92**	**$781.30**	**$14,382.15**	**100.0%**
Percent Distribution	**34.8%**	**24.3%**	**2.5%**	**5.1%**	**26.2%**	**1.1%**	**0.6%**	**5.4%**	**100.0%**	

4.11.7 Characterization of the Residual Floodplain and the TSP Project Performance

4.11.7.1 Areal Extent of the TSP Residual Floodplain

By implementing the TSP, the "most likely" future 0.2 percent AEP floodplain will cover approximately 4,500 acres. This reduction represents a 33 percent reduction in the spatial coverage of the "most likely" future" WOP 0.2 percent AEP floodplain. *Exhibit 4-6* through *Exhibit 4-9* illustrate the TSP versus the existing or WOP condition for the 10 percent, 4 percent, 1 percent and 0.2 percent AEP floodplains.

4.11.7.2 Population within the Residual Floodplain of the TSP

The population impacted by a 0.2 percent AEP flood is expected to be reduced by 60 percent by implementing the TSP. Currently an estimated 16,700 persons reside within Hunting Bayou's 0.2 percent AEP floodplain, based on a residential structure count of 6,600 residences. The TSP residual 0.2 percent AEP floodplain is projected to contain 6,700 persons living in 2,600 residences.

However, 66 residential structures housing an estimated 165 persons are part of the structure inventory allowed under Section 575, WRDA 1996 for preserving economic benefits. When these structures are not counted in the residual floodplain, the corrected estimate of residual population and housing in the TSP condition is more likely to be about 6,500 persons and 2,500 residences.

The population living within the TSP's residual floodplain remains at risk for flooding and shares the same social and economic characteristics indicating high vulnerability to hazards. The residual population is 95 percent minority, predominantly either Hispanic or black American. Like the population within the "most likely" future WOP 0.2 percent AEP floodplain, the residual population contains proportionately more younger and older persons than Harris County in general, which also indicates social vulnerability. In addition, over 30 percent of the population within the residual floodplain lives below the poverty level.

Exhibit 4-6:
10% AEP Floodplain Comparison for the TSP and WOP Conditions

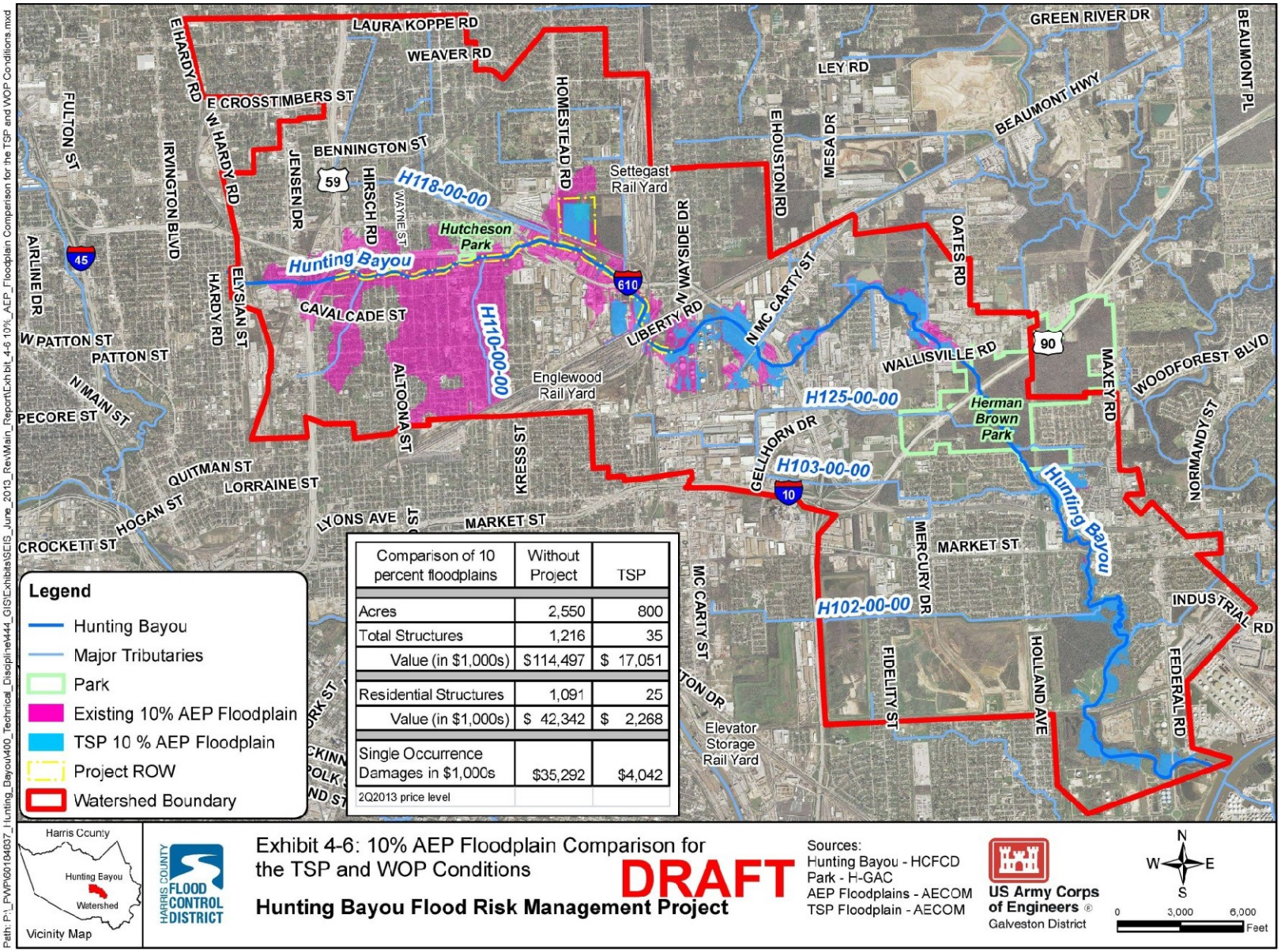


Exhibit 4-7:
4% AEP Floodplain Comparison for the TSP and WOP Conditions

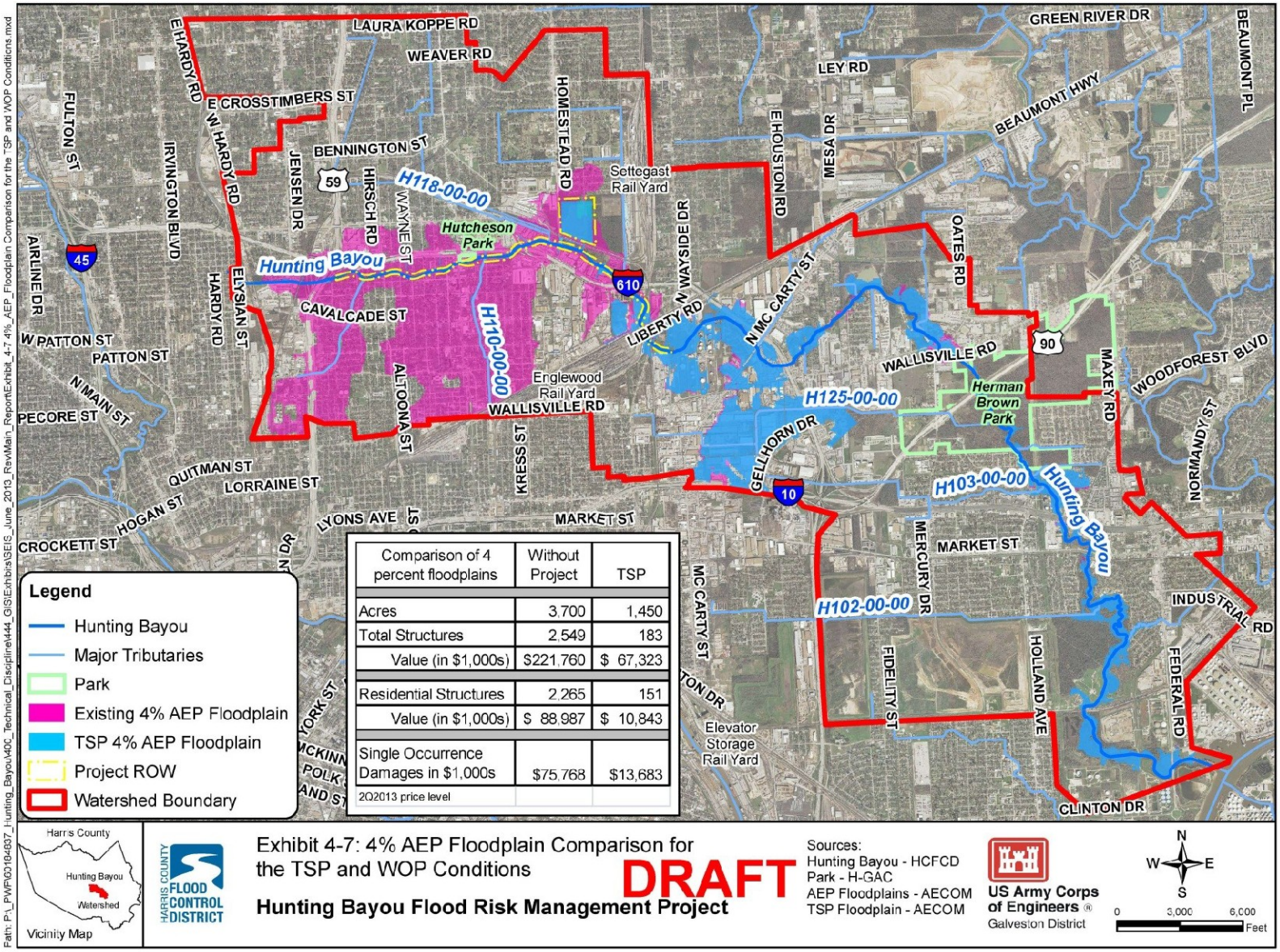


Exhibit 4-8:
1% AEP Floodplain Comparison for the TSP and WOP Conditions

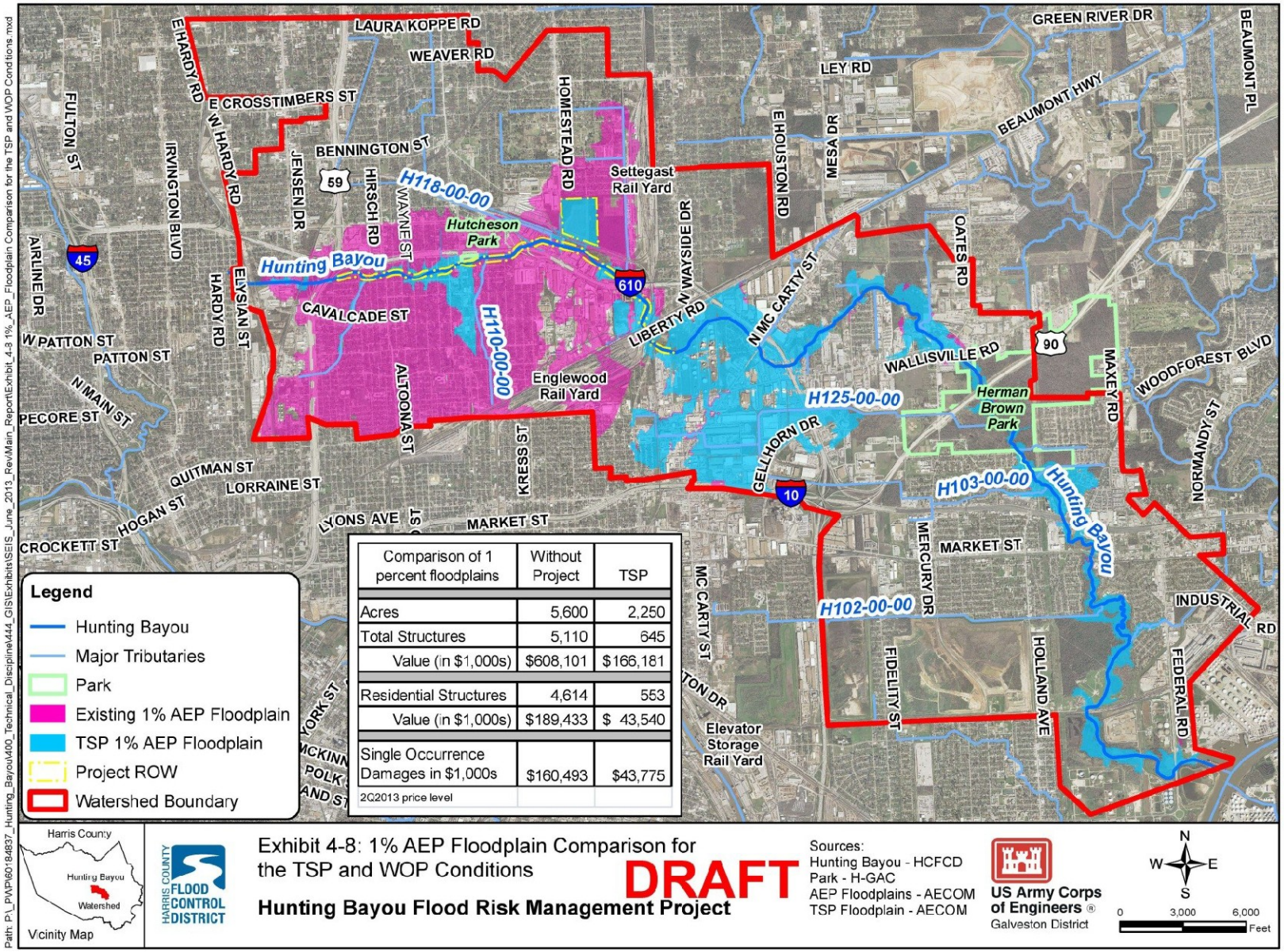
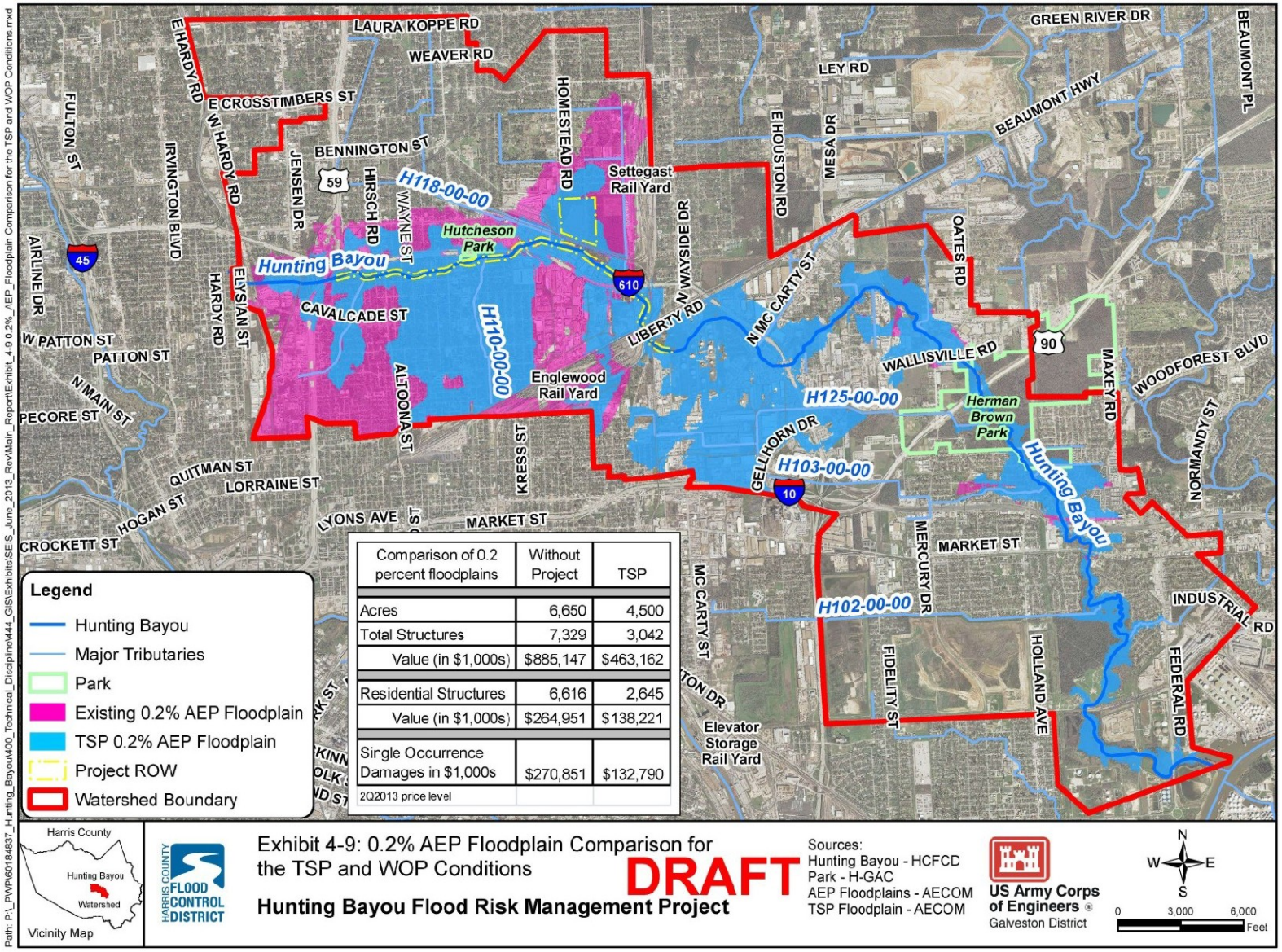


Exhibit 4-9:
0.2% AEP Floodplain Comparison for the TSP and WOP Conditions
2009 Price Level, Discount Rate = 4.375 percent



4.11.8 Expected Project Performance

The TSP is the non-federal sponsor's, HCFCD, preferred scale for the best performing alternative. This recommendation also assumes that COH's planned drainage improvements, which may include drainage impoundments to better manage increased runoff, would be effective and that adequate vacant land is available for detention and disposal to support the TSP.

Residual Risk. Even though residual risk remains in the floodplain, the non-federal sponsor, HCFCD, chooses to stop the plan formulation process at the point where the TSP has been identified. Further risk reduction would be accomplished by combining the policies and procedures described in Section 3.5.

Economics. The AAEV benefits and costs for the TSP are presented in *Table 4-23*. The TSP returns $15.4 million in AAEV benefits to $8.0 million in AAEV costs, realizing a 1.92 BCR at the 3.50 percent federal discount rate and 2Q2013 prices.

Table 4-23:
AAEV Benefits and Costs
2Q2013 Structure Inventory Update and Price Level,
3.50 and 7.0 Percent Interest Rates
($1,000s)

TSP	
Investment Costs	
Total Project Costs	$154,320
Interest During Construction (IDC)	$28,535
Uncompensated NED Losses	618
Total Investment Costs	$183,473
AAEV First Cost, 3.5 %	$7,822
Annual OMRR&R*	$169
Total AAEV Costs, 3.50 %	$7,991
AAEV Benefits, 3.50 %	$15,364
AAEV Net Benefits	$7,373
BCR	**TSP**
3.50 percent	1.92
7.0 percent	0.96

**OMRR&R = Operating, Maintaining, Replacing, Repairing and Rehabilitating*

The estimated investment cost for the TSP is approximately $183.5 million, based on the actual costs expended for completed construction and estimated costs for future construction, uncompensated NED losses and IDC. *Table 4-23* summarizes the project first costs, based on the actual costs and future estimates. The construction costs for future construction were based on January 2013 price levels. Estimates for material, equipment and labor costs for typical work in this area were used to develop the construction costs for the future phases. Real estate costs were developed based on gross appraisals as described in *Appendix 6 – Real Estate Plan*. Detailed cost estimates with quantities and descriptions based on the MCACES are provided in *Appendix 4 – Cost Estimates*. A risk analysis was performed using estimated risk factors for the major cost items, without percentage contingencies. The analysis used the Crystal Ball risk

analysis software. A 22.6 percent contingency would provide an 80 percent probability the resulting cost would not be exceeded. This contingency was applied only to the future construction items and is included in the cost summary.

Residual Flooding. With the TSP, residual flooding would be expected when the flood water rises above the bayou banks during more severe events. Residual flooding could also be expected to continue to occur as a result of high tailwater conditions where the storm sewer system is surcharged and cannot convey or freely outfall the runoff collected from the DA. The flood water is contained within the bayou banks for higher frequency events for most of the study area reach. When flood water overflows the channel banks, the flow is expected to spread to the overbank areas. Since the overbank areas are relatively flat, the flooding depth would not be expected to be significant due to the flood water spreading over a larger area. Since the rise rate and flow velocity are related to the flow area, the rise and the velocity are expected to be very low.

In isolated areas such as depressions and roadway underpasses, the flooding depth could be significant and may create access problems for vehicular traffic. The potential for loss of life in some of these isolated areas where deep water ponding could occur would be expected from drivers attempting to or accidentally passing through these areas during the more severe events that cause residual flooding. These areas would be expected to be limited mainly to more abrupt roadway or underpass grade changes adjacent to the bayou, such as along Homestead Road just north of the bayou.

Life Safety Criteria. Implementing the TSP is intended to manage flood water risks, not control or avoid them. The TSP does not have unlimited operational capacity to control extreme floods. For instance, the offline detention basin has a limited capacity to accept diverted water from the main channel. When the basin's maximum capacity has been reached, any additional channel flow is not attenuated.

Human life is rarely lost in the study area due to flooding; therefore, the Hunting Bayou watershed is considered to have a low loss-of-life risk level due to flooding. The population at risk includes residential neighborhoods, industrial facilities and a nearby railroad yard. Many in this community of elderly and economically disadvantaged are particularly vulnerable during and after a flood event.

Typical loss-of-life due to flooding incidences occurs when motorists choose to ignore warning signs or messages and drive into high flood water conditions, or due to vehicular accidents occurring at or near ditches. Because it is often difficult to see the channels and roadside ditches during a flood, a dangerous condition exists for pedestrians and motorists in the area. Overall, flood waters within the Hunting Bayou watershed rise gradually (no flash flooding conditions) due to its relatively wide and flat floodplain. However, there are some locations and during heavy rainfall (2-4" per hour) where waters rise and flow rapidly creating a life safety issue. Project implementation is expected to lower the risk frequency and magnitude associated with flooding.

The project design will not involve precedent-setting methods, use innovative materials or change prevailing practices.

Environmental Impact from the TSP and other Alternatives. The TSP avoids adverse effects when compared to the other plans requiring greater channel modifications. The TSP also minimizes the number of displacements required to construct an effective conveyance. This identifies the TSP as the environmentally preferred alternative.

Systems/Watershed Context. The Hunting Bayou watershed is a highly developed urban region which has experienced significant flooding. The plan would greatly reduce flood damages along the stream. The decision was made to forego additional nonstructural components to the channel modification/detention basin alternative because, to do so, could jeopardize the project's acceptance within the surrounding community. As noted previously, the HCFCD maintains an active voluntary nonstructural program which can contribute to a long-term strategy of residual risk reduction over the period of analysis for the Hunting Bayou watershed. The TSP complies with the federal objective to reasonably maximize NED benefits and with local floodplain management policies and practices. The TSP reduces the needed footprint within the developed area along the stream bank to be more acceptable to the surrounding community.

Environmental Operating Principles. The TSP must also be evaluated against USACE's environmental operating principles, as these are essential to USACE's risk management approach in decision-making. There are seven principles as follows, including a description of how the plan is responsive to each.

- **Foster sustainability as a way of life throughout the organization:** The non-federal sponsor, HCFCD, manages flood risk in Harris County, Texas. The many watersheds throughout the county must be managed so they perform flood damage reduction functions yet still function as healthy floodplains and stream courses. The non-federal sponsor, HCFCD, executes planning, design, construction and operation of flood risk management remedies so the natural resource base of floodplains and stream courses are not permanently impaired or damaged.

- **Proactively consider environmental consequences of all USACE activities and act accordingly:** Direct and indirect effects from the project on the natural environment were quantified using ecological modeling. Compensatory mitigation is provided for the TSP for unavoidable adverse effects to waters of the United States, including wetlands. Additionally, disposal sites for material removed from modified stream channels and detention excavation were sited to avoid or minimize impacts to wildlife and their habitat.

- **Create mutually supporting economic and environmentally sustainable solutions:** The TSP provides the nation with economic benefits while avoiding and minimizing adverse effects to the natural environment to the greatest extent practicable. Unavoidable effects to wetlands are fully mitigated by replacing wetland values so there is no net loss of wetlands.

- **Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE which may impact human and natural environments:** TSP construction and operation would comply with all applicable federal, state and local environmental laws and regulations. Natural resource agencies have also been coordinated with during the study period to assure environmental compliance associated with the TSP meets current regulatory standards. Community interests have been

coordinated with on an ongoing basis to assure impacts from the TSP are acceptable to the community and the benefits from the improvements are fully understood by the community.

- **Consider the environment in employing a risk management and systems approach throughout the lifecycles of projects and programs:** Mitigation would be provided for all unavoidable adverse effects to aquatic resources. Such mitigation and maintaining natural systems associated with floodplains and stream courses are central to the non-federal sponsor's, HCFCD, flood risk management policies.

- **Leverage scientific, economic and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner:** Stakeholders, residents, resource agencies and the general public were consulted throughout the study period in an effort to understand the project and project area's biological, physical and socioeconomic circumstances. Biological environment specialists and socioeconomic resource experts were engaged with the engineering team to develop accurate analyses of project effects. Community outreach assured citizen and resident views about project alternatives were fully appreciated.

- **Employ an open, transparent process that respects view of individuals and groups interested in USACE activities:** The views of stakeholders, the public, local residents, resource agencies and others helped identify the problems, opportunities and constraints addressed which lead to identifying multiple alternatives and their evaluation/selection in this reevaluation study. Project newsletters, community meetings and engagement with community leaders, including elected officials and leadership from faith based organizations, helped achieve clarity of message and full comprehension of citizen perspectives. Both resident and technical specialist perspectives helped formulate the TSP.

4.11.9 How the TSP is Consistent with the USACE Campaign Plan, FY13-14-18, June 203

The USACE Campaign Plan FY13-14-18, dated June 2013, provides goals, objectives, and actions for improving the USACE contribution to the nation in the areas of warfighting; civil works processes and delivery systems; risk reduction from natural events; and preparation for the future. The Hunting Bayou Flood Risk Management Project supports the Campaign Plan with a contribution to Goal 2, "Transform Civil Works," and Goal 3, "Reduce Disaster Risks".

Objective 2c of Goal 2 aims to "Improve USACE methods of delivery to produce quality engineering solutions and services on schedule." Supporting action 2.c.4. aims to "implement a customer/stakeholder engagement strategy" with an end state of establishing and maintaining "collaborative relationships with Federal, state, Tribal, and local agencies, and other stakeholders." The Hunting Bayou Flood Risk Management Project supports Goal 2. Section 211 of WRDA 1996 allows non-federal entities to engage in water resources planning and project execution by incorporating USACE policies and regulations into quality FRM products that meet budget and schedule goals. The activities undertaken by the NFS at their own risk supports the mission of the USACE by utilizing local agency resources and strengthening the relationship between the local agency and the USACE.

Objective 3.c. of Goal 3 aims to "enhance interagency disaster preparation and mitigation capabilities." Supporting action 3.c.2. aims to "enhance capacity to reduce the Nation's Flood Risk" with an end state of sustainable and resilient FRM for the Nation and communities." The Hunting Bayou Flood Risk Management Project supports Goal 3. The Hunting Bayou Flood Risk Management Project provides needed FRM to a socially vulnerable population within a highly urbanized area. The project works in concert with other local initiatives that together integrate structural engineering features, nonstructural measures, and program and policy enforcement into an overall system for sustainable and resilient flood risk management.

4.12 Cost Sharing

> "If the sponsor prefers a plan more costly than the NED plan, the NER Plan or the combined NED/NER Plan, and the increased scope of the plan is not sufficient to warrant full federal participation, ASA(CW) may grant an exception as long as the sponsor pays the difference in cost between those plans and the locally preferred plan. The LPP, in this case, must have outputs similar inkind, and equal to or greater than the outputs of the federal plan.." Planning Guidance Notebook, paragraph 2-3.f (4), ER 1105-2-100, 22 April

B60-A75 has been identified by the non-federal sponsor as the LPP and is named the TSP. As stated in ER 1105-2-100, to propose an LPP more costly than the NED Plan, an exception from ASA(CW) is required. Approval from ASA(CW) to recommend B60-A75 as the LPP was obtained in May, 2014. Accordingly, the non-federal sponsor, HCFCD, agrees that the additional cost of the LPP over the NED Plan cost is the responsibility of the non-federal sponsor. For projects recommended that are more costly than the NED Plan, cost apportionment for the federal project will be based on the NED Plan cost. As stipulated in WRDA 1996, Section 202(a), projects authorized prior to enacting WRDA 1996 (October 12, 1996) have a 25 percent non-federal/75 percent federal cost share. WRDA 1986, Section 103 (a) stipulates the maximum non-federal contribution will not exceed 50 percent of the total project cost. In this project, LERR&Ds, a non-federal responsibility, contributes significantly to the total project cost, so the federal cost share will assume a portion of LERR&D cost to meet the 50 percent non-federal cost share maximum contribution. *Table 4-24* provides the cost share for the NED Plan at a 50-50 apportionment: $67,458,365 (federal) and $67,458,365 (non-federal). The total for these shares equals the total project first costs.

Table 4-24:
Cost Apportionment of NED Plan
2Q2013 (FY 2013) Price Level

Flood Risk Management Components	Federal Cost	Non-Federal Cost	Total Cost
GRR Study Cost	$4,667,244	$4,667,244	$9,334,488
LERR&D	$0	$79,955,970	$79,955,970
--Rail Bridge Modifications [1]	$318,322		
Construction - Federal Cost Share	$54,871,036	$0	$54,871,036
Mitigation (least cost plan)	$0	$89,724	$89,724
Subtotal	$54,871,036	$80,045,694	$134,916,730
5% Cash	($6,745,836)	$6,745,836	
Subtotal	$48,125,200	$86,791,530	$134,916,730
(Percent) [2]	36%	64%	100%
50% Adjustment	$19,333,165	($19,333,165)	
NED Plan Total Project	**$67,458,365**	**$67,458,365**	**$134,916,730**

[1] Rail Bridge Modifications are federal cost-shared construction items re: Section 3, 1946 Flood Control Act

[2] Non-federal costs will be no less than 25 percent and not greater than 50 percent for the NED Plan, Section 103(a),WRDA of 1986..
NOTE: All costs shown are first costs. Contingency applied only to unconstructed costs.
The Section 902 cost limit is $1,658.589 million.

Table 4-25, provides the cost share for the TSP based on the NED Plan as displayed in *Table 4-24*. The cost apportionment is based on the NED Plan cost, as the TSP is more costly than the NED Plan. The additional non-federal sponsor's, HCFCD, contribution of $19.4 million to construct the TSP is shown in *Table 4-25* in addition to their NED Plan cost allocation.

In this project, LERR&Ds, a non-federal responsibility, contributes significantly to the total project cost, so the federal cost share will assume a portion of LERR&D cost to meet the 50 percent non-federal cost share maximum contribution as per Section 103(a), WRDA 1986. This is illustrated in the bridge costs as part of LERR&Ds in *Table 4-26*. For further information on the LERR&Ds, see *Appendix 6 – Real Estate Plan*.

Table 4-25:
Cost Apportionment of TSP
2Q2013 (FY 2013) Price Level

Flood Risk Management Components	Federal Cost	Non-Federal Cost	Total Cost
GRR Study Cost	$4,667,244	$4,667,244	$9,334,488
LERR&D	$0	$79,955,970	$79,955,970
--Rail Bridge Modifications [1]	$318,322		
Construction - Federal Cost Share	$54,871,036	$0	$54,871,036
Mitigation (least cost plan)	$0	$89,724	$89,724
Subtotal	$54,871,036	$80,045,694	$134,916,730
5% Cash	($6,745,836)	$6,745,836	
Subtotal	$48,125,200	$86,791,530	$134,916,730
(Percent) [2]	36%	64%	100%
50% Adjustment	$19,333,165	($19,333,165)	
NED Plan Total Project	**$67,458,365**	**$67,458,365**	**$134,916,730**
Additional NonFederal Cost of TSP [3]		**$19,402,898**	**$154,319,628**

[1] *Rail Bridge Modifications are federal cost-shared construction items re: Section 3, 1946 Flood Control Act*

[2] *Non-federal costs will be no less than 25 percent and not greater than 50 percent for the NED Plan, Section 103(a),WRDA of 1986.*

[3] *Cost of TSP over the cost of the NED Plan included LERRDs, Construction, and Mitigation*
NOTE: All costs shown are first costs. Contingency applied only to unconstructed costs.
The Section 902 cost limit is $1,658.589 million.

Table 4-26:
Identified Bridge Adjustments

Bridges to be Impacted (extended or replaced)			
564+09	Bridge Modification - Wayside	COH	$4,491,900
564+09	Bridge Approaches - Wayside	COH	$742,365
566+44	Rail Bridge Modification - SP ERRY*	Railroad	$42,800
566+44	Rail Bridge Approaches - SP ERRY*	Railroad	$80,798
566+99	Rail Bridge Modification - SP ERRY*	Railroad	$38,520
566+99	Rail Bridge Approaches - SP ERRY*	Railroad	$54,068
568+49	Rail Bridge Modification - SP ERRY*	Railroad	$37,450
568+49	Rail Bridge Approaches - SP ERRY*	Railroad	$6,008
599+52	Bridge Modification - Loop 610 2nd Crossing	Texas Department of Transportation (TxDOT)	$14,718,180
599+52	Bridge Approaches - Loop 610 2nd Crossing	TxDOT	$2,191,860
635+97	Bridge Modification - Homestead Road	COH	$624,960
635+97	Bridge Approaches - Homestead Road	COH	$121,500
648+92	Bridge Modification - Kelley Street Westbound	COH	$1,755,468
648+92	Bridge Approaches - Kelley Street Westbound	COH	$42,525
658+96	Bridge Modification - Loop 610 3rd Crossing	TxDOT	$4,255,680
661+53	Walkway Bridge Modification - Hutcheson	COH	$189,720
661+53	Walkway Approaches - Hutcheson	COH	$6,683
672+94	Walkway Bridge Modification - Hutcheson	COH	$189,720
672+94	Walkway Approaches - Hutcheson	COH	$4,860
692+95	Walkway Bridge Modification - Pickfair	COH	$223,200
692+95	Walkway Approaches - Pickfair	COH	$5,468
704+55	Bridge Modification - Wipprecht	COH	$1,487,070

Bridges to be Impacted (extended or replaced)			
704+55	Bridge Approaches - Wipprecht	COH	$43,740
716+69	Bridge Modification - Wayne Street	COH	$1,522,968
716+69	Bridge Approaches - Wayne Street	COH	$161,595
724+66	Bridge Modification - Hirsch Street	COH	$2,529,600
724+66	Bridge Approaches - Hirsch Street	COH	$18,360
729+22	Bridge Modification - Leffingwell Street	COH	$1,182,030
732+67	Bridge Modification - Falls Street	COH	$1,210,860
732+67	Bridge Approaches - Falls Street	COH	$105,705
739+35	Walkway Bridge Modification - Russell	COH	$149,730
739+35	Walkway Approaches - Russell	COH	$4,860

*Railroad relocation costs are considered Federal construction costs for the purposes of cost share, in accordance with Section 3, 1946 Flood Control Act.
No contingencies are shown.

4.13 Section 575 Water Resources Development Act (WRDA) 1996 Analysis

Section 575 of WRDA 96 provides: "during any evaluation of economic benefits and costs for projects… that occurs after the date of the enactment of this Act, the Secretary shall not consider flood control works constructed by non-federal interests within the drainage area of such projects prior to the date of such evaluation in the determination of conditions existing prior to construction of the project."

The WRDA 99, Section 575(b) provides that:

(b) SPECIFIC PROJECTS—The projects to which subsection (a) apply are—

(1) the project for flood control, Buffalo Bayou Basin, Texas, authorized by Section 203 of the Flood Control Act of 1954 (68 Stat. 1258);

(2) *the project for flood control, Buffalo Bayou and tributaries, Texas, authorized by section 101(a) of the Water Resources Development Act of 1990 (104 Stat. 4610);* and

(3) the project for flood control, Cypress Creek, Texas, authorized by section 3(a)(13) of the Water Resources Development Act of 1988 (102 Stat. 4014).

Section 354 of WRDA 99 amended Section 575 to remove nonstructural actions from consideration as well as "constructed works." Hunting Bayou, being a tributary of Buffalo Bayou, Texas, is affected by the analytical requirements of Section 575.

During the study period, activities had been undertaken by non-federal interests to remediate flood damages through voluntary nonstructural property acquisitions through the FEMA's Hazard Mitigation Grant Program and Pre-disaster Mitigation Program and other property acquisitions to support ROW needed for channel modification. Some property acquisitions involve improved property, which removes damageable economic assets from the floodplain. When these actions occur, they fall under the authority of Section 575, WRDA 1996 and are evaluated for their impact on project performance. The structures identified as relocations and/or ROW acquisitions were isolated, and HEC-FDA models were executed for AAEV damages in the With and WOP conditions.

To meet the intent of the Section 575 WRDA 1996 authority, only full real estate takings of parcels, not partial takings, were considered for this analysis. The operational assumption is that improvements to parcels would be acquired and either demolished or removed from the floodplain with full takings so damages prevented to those improvements could be realized. Partial takings did not offer the opportunity for removing damageable structures. Altogether, 84 full real estate takings within the Hunting Bayou economic study area qualified for Section 575, WRDA 1996 analysis during the study period.

The detention basin under construction by the non-federal sponsor, HCFCD, within the watershed was not included in the Section 575 analysis, because the basin was not yet functioning to reduce flood risk at the time of this analysis. As a result, there are no FRM economic benefits to be realized from the yet-to-be completed detention basin.

The 2013 structure inventory records were matched to the full takings, and the 84 records identified were evaluated in a HEC-FDA model run to determine their contribution to AAEV damages over the 50-year period of analysis and to determine the extent of their contribution to the TSP's inundation reduction benefits. These real estate takings are characterized in *Table 4-27 and Table 4-28* along with the results from those takings with reference to project economic performance in *Table 4-29*. *Table 4-27* displays the buyouts by primary improvement to the real estate parcel acquired.

Table 4-27:
Distribution of Section 575 Buyouts by Structure Type

Structure Type	Number	Value in $1,000s
Residential		
SFR	70	$636.19
Multi-family	6	$166.38
Commercial	8	$271.45
Total	**84**	**$1,074.02**

It is noted two-thirds (n=56) of the 84 HCFCD property acquisitions stem from the FEMA Hazard Mitigation Grant Program following Tropical Storm Allison, which occurred in 2001. Tropical Storm Allison damaged in excess of 8,000 structures within the Hunting Bayou watershed with record level rainfall. Except for one buyout acquired for floodplain preservation, the remaining non-federal sponsor's, HCFCD, buyouts were acquisitions to support channel ROW.

The structure distribution bought out by floodplain designation is shown in *Table 4-28*. While the majority of buyouts were in response to post-disaster FEMA assistance, it should also be noted that the criterion for the Hazard Mitigation Grant Program buyouts is limited to the extent of structural damage sustained and not their location in a floodplain. *Table 4-28* provides information to indicate while some acquisition properties were located well within in the floodplain and contribute to economic damage reduction, other acquisitions contribute less or no damage reduction.

Table 4-28:
Full Real Estate Takings/Acquisitions by Floodplain within the Hunting Bayou Study Area

Percent Chance Floodplain	Full Real Estate Takings/Acquisitions		
	Count, not cumulative	Percent	Cumulative Percent
20.00%	15	17.9%	17.9%
10.00%	12	14.3%	32.1%
4.00%	9	10.7%	42.9%
1.00%	12	14.3%	57.1%
0.40%	1	1.2%	58.3%
0.20%	27	32.1%	90.5%
Not in Floodplain	8	9.5%	100.0%
Total	**84**	**100.0%**	

Table 4-29 compares the With and WOP condition with all structures in place, while

Table 4-30 shows the same conditions, but with the 84 structures removed from the inventory. When comparing the two tables, removing the structures from the inventory has a negligible impact with damages decreasing in the WOP condition by 0.30 percent. The TSP's economic performance is reduced by 0.32 percent. The TSP has a 1.92 BCR; removing the structures from the inventory does not change the BCR. These results provide evidence about the lack of impact the non-federal sponsor's, HCFCD, nonstructural activities in the floodplain have on the TSP's viability.

Table 4-29:
Project Performance with All Structures in Place

Project Plan	Equivalent Annual Damages	Damages Reduced	Annual Project Cost	Annual Net Excess Benefits	BCR
	in $1,000s	in $1,000s	in $1,000s	in $1,000s	
WOP	$19,792.10	$0.00	$0.00	$0.00	
B60A75--TSP	$5,409.96	$15,363.56	$7,990.92	$7,372.63	1.92
B50A25--NED	$6,820.57	$13,952.95	$7,089.58	$6,863.37	1.97
Authorized Design	$59.35	$19,732.75	$16,724.43	$3,008.32	1.18

** Discount Rate= 3.50%, 2Q2013 (FY13) price level*

Table 4-30:
Analysis of Impact of Removing 84 Structures from Inventory

Project Plan	Damages to 84 Structure Buyouts in Project Conditions	Effect of Removing 84 Structures from Inventory				
		Equivalent Annual Damages with Structure Buyouts	Damages Reduced with Structure Buyouts	Annual Project Cost	Annual Net Excess Benefits with Structure Buyouts	BCR with Structure Buyouts
	in $1,000s	in $1,000s	in $1,000s	in $1,000s	in $1,000s	
WOP	$59.47	$19,732.63				
B60A75--TSP	$9.18	$5,400.78	$15,313.27	$7,990.92	$7,322.34	1.92
B50A25--NED	$12.16	$6,808.41	$13,905.64	$7,089.58	$6,816.06	1.96
Authorized Design	$0.11	$59.24	$19,673.39	$16,724.43	$2,948.96	1.18

** Discount Rate= 3.50%, 2Q2013 (FY13) price level*

4.14 Section 902, WRDA 1986 Analysis

The Hunting Bayou 1990 Authorized Plan is part of the Buffalo Bayou and Tributaries, Texas authorization found in Section 101(a)(21) of WRDA 1990. Because the authorization includes Buffalo Bayou's main stem and its tributaries, the Section 902 calculation incorporates all the tributaries included in the authorization. The USACE Section 902 Analysis Certified Tool, 2010 was used for the calculation and followed the guidance in paragraph G-15.a. of ER 1105-2-100, 30 June 2004.

Section 211, WRDA 1996 (Public Law 104-303) signed into law October 12, 1996 authorized non-federal interests to undertake major FRM projects with federal funding assistance (subject to federal funding availability) or credit for the non-federal interest for its portion of the work subject to Secretary of the Army approval. Section 211(f)(7) authorized the non-federal sponsor, HCFCD, to develop a FRM alternative to the 1990 Authorized Plan for Hunting Bayou. The non-federal sponsor, HCFCD, started implementing the alternative to the 1990 Authorized Plan to reduce future flood damage as soon as possible, and is doing so at its own risk. Because Hunting Bayou was added to the 211(f) authorization, the non-federal sponsor, HCFCD, may be reimbursed for the efforts taken to reduce flood damages in the Hunting Bayou watershed as approved by the Secretary of the Army. The costs expended by the non-federal sponsor, HCFCD, to date have been included in the 902 project cost limit computation.

Results from the 902 analysis show the FY 13 $1,513.116 million authorized cost of Buffalo Bayou and Tributaries inflated through construction is less than the $1,658.589 million maximum Section 902 cost limit. The Project Cost Increase Fact Sheet is included in *Appendix 5,* Attachment 1.

5.0 FORESEEABLE EFFECTS FROM THE PROPOSED ACTION AND ALTERNATIVES

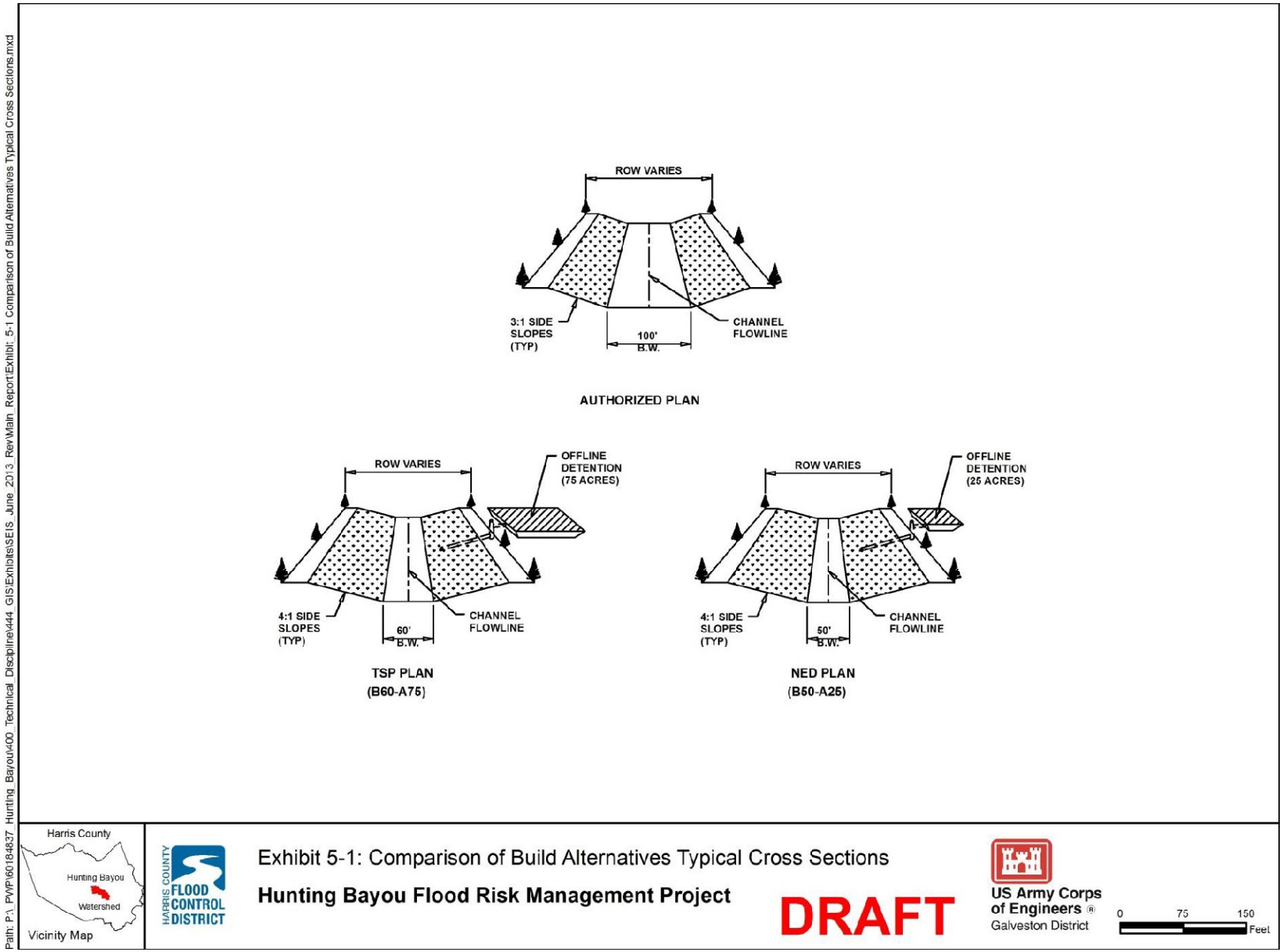
This study describes the anticipated direct and indirect impacts on physical, biological and socioeconomic resources within the upper Hunting Bayou watershed from four alternatives – NED Plan Scale B60-A75 (TSP), NED Plan Scale (B50-A25), the 1990 Authorized Plan and the No Action Alternative. Direct impacts are those which can be attributed to construction and O&M of the proposed plan or continuing the existing activities under the No Action Alternative. Indirect effects are those secondary environmental impacts attributed to implementing the proposed plan or to continuing the existing activities under the No Action Alternative. A typical cross section of each alternative is shown in *Exhibit 5-1*.

5.1 Plan Activities

5.1.1 Tentatively Selected Plan (TSP) – B60-A75

- Purchase, acquire or control 115 acres of property along Hunting Bayou and the 75-acre offline detention basin for the TSP. Disposal site requirements would include an additional 119 acres. This would total 309 acres.
- Widen and deepen Hunting Bayou and construct an earthen, grass-lined, trapezoidal channel with a 60-ft bottom width and 4:1 side slopes ratio extending from the upstream end of Hunting Bayou at US 59 to 0.3 miles downstream from ERRY. In general terms, the channel width would double to approximately 300-ft-wide along some reaches of the 3.8-mile project length.
- Excavate the 75-acre offline detention basin to depths which may extend 22 to 24 ft below ground surface (bgs).
- Displace populations from 58 SFRs and 8 multi-family residences in areas with high minority and low-income residents living along the upper Hunting Bayou reach in the Kashmere Gardens and Pleasantville Super neighborhoods, the Liberty Garden development and other residential developments.
- Modify bridges and replace 17 bridges consisting of 10 roadway bridges, 3 railroad bridges and 4 pedestrian bridges, as needed for security or public protection. Fencing would be installed at public access points.
- Construct a widened concrete-lined channel through ERRY.
- Relocate or replace underground utilities (pipelines, water lines, electrical lines, sanitary sewer lines, etc.).
- Relocate or reconstruct some streets or construct within existing street ROWs.
- Acquire commercial or public structures.
- Purchase compensatory wetland credits at the Greens Bayou Wetlands Mitigation Bank (GBWMB) to mitigate 4.37 acres of unavoidable impacts to aquatic resources.
- Excavate subsurface soils and urban fill material during channel and stormwater detention basin construction.

Exhibit 5-1:
Comparison of Build Alternatives Typical Cross Sections



Construction activities are expected to occur for 7 years, from 2014 or 2015 through 2022. OMRR&R is expected to occur through the 50-year period of analysis. The direct and indirect effects from the proposed action would be generated by the following, generally within the TSP ROW.

- Clear and grade surface and channel side slopes (site preparation) and remove surface cover prior to construction activities.
- Excavate and dredge Hunting Bayou upper channel reach. Trench and backfill areas for utility relocations. Dewater as needed during construction. Control and maintain construction laydown areas. Control surface water runoff while preparing the land to achieve water quality protection goals in accordance with water quality permits.
- Use bulldozers, draglines and other earth-moving equipment contracted by the non-federal sponsor, HCFCD, to construct channel, side slopes, detention basin, maintenance access areas, access or service roads and drainage ditches.
- Demolish and remove residential, commercial or industrial structures within the floodplain. Test materials to properly dispose solid waste generated by demolition activities.
- Construct earthen maintenance access areas with parallel access roads (if needed) at the detention basin. Install water or flow control structures and gates, foundations or supports, and install box culverts beneath.
- Demolish, abandon, install or reroute/extend utility lines or utility towers (water lines, petroleum pipelines, sanitary sewer lines, electrical lines, etc.).
- Traffic control during bridge construction may require totally closing certain bridges and detours to other roads.
- Abandon or reroute streets and roads in the area proposed for channel widening.
- Ship and truck construction materials to the site. Stockpile materials and excavated soils. Machine or fabricate materials. Handle construction and demolition waste and related by-products. Handle and manage special and hazardous wastes.
- Implement traffic control measures during construction to continue uninterrupted neighborhood access by police, fire, EMS, transit and school bus services to minimize disturbance to area residents.
- Perform soil stability testing and engineering analyses during preconstruction engineering design (PED).
- Store and stockpile construction-related materials and equipment (e.g., excavated soil, steel pipes, concrete, piping and fencing, steel supports and beams, and related roadway or building supplies).
- Install slope protection measures (stone riprap) and backslope swales and drains to control erosion in the channel and prevent slope failures.

- Demolish, reconstruct and elevate road and pedestrian bridges along the channel to meet COH floodplain management requirements (replace and install at a minimum height above BFE).

- Maintain stormwater detention basin as needed to achieve the existing WSELs designed function and maintenance.

- Store and manage dredged material removed from the Hunting Bayou channel using as much material as possible as fill for other projects. Dispose residual dredged material at upland disposal sites.

- Provide sanitary and solid waste management, stormwater and pollution prevention planning, and water and wastewater disposal. Control construction noise and dust during construction activities.

- Relocate a Homestead Road area sanitary sewer line, and install lift station to redirect flows to the area WWTP.

- Ship construction materials to the site. Manage construction and demolition waste, and special and hazardous wastes.

- Provide site security and controlled access. Install fencing at roadway and bridge ROWs as needed.

- Clean up and restore site to minimize unavoidable effects to aquatic and other resources, including erosion protection in compliance with applicable federal and state regulations and guidelines and specific requirements of necessary construction permits.

- O&M activities are to include mowing the ROW and debris removal.

5.1.2 NED Plan Scale B50-A25

Features of this alternative would be similar to the TSP, except for the following differences.

- Purchase, acquire or control 113 acres of property along Hunting Bayou and the 25-acre offline detention basin. Disposal site requirements would include an additional 57.7 acres. This would total 195.7 acres.

- Widen and deepen Hunting Bayou and construct an earthen, grass-lined, trapezoidal channel with a 50-ft bottom width and 4:1 side slopes ratio extending from Hunting Bayou's upstream end at US 59 to 0.3 miles downstream from ERRY. In general terms, the channel width would increase to approximately 50-ft-wide along some reaches of the 3.8-mile project length.

- Excavate the 25-acre offline detention basin to depths which may extend 22 to 24 ft bgs.

- Displace populations from 57 SFRs and 8 multi-family residences in areas with high minority and low-income residents living along the upper Hunting Bayou reach in the Kashmere Gardens and Pleasantville neighborhoods, the Liberty Garden development and other residential developments.

- All other features and required activities described for the TSP would also pertain to B50-A25.

5.1.3 1990 Authorized Plan

This alternative's features are described in the Buffalo Bayou and Tributaries Feasibility Report and EIS, USACE 1988 and are summarized as follows.

- Total project length is 14.8 miles extending from the mouth of Hunting Bayou at the confluence with Buffalo Bayou (Houston Ship Channel) to US 59.
- Channel bottom width would vary from 50 ft in the upper and parts of the middle segments to 100 ft in parts of the middle and lower segments.
- A total of 198 acres of additional ROW would be acquired, and 385 acres of disposal area capacity would be required on multiple sites within 5 miles of the stream channel segments. Existing ROW to be acquired would total 288 acres.
- Approximately 125 residential family units and 15 commercial businesses would be displaced resulting from the ROW acquisition.
- Wetland impacts were not identified or quantified during the period of analysis for the 1990 Authorized Plan using the same procedures applied to the TSP and other plan scales. Wetland and related aquatic resource impacts from the 1990 Authorized Plan are estimated to be greater than the other build alternatives due to the increased cross section proposed for the lower stream segment. The only quantified wetland impacts that the Authorized Plan would cause would be those common to all build alternatives which are the 2.372 acres in the upper bayou segment along the stream bottom.
- During the period of analysis, an estimated 66 acres of riparian vegetation and 30 acres of upland forest would be removed for channel construction requiring compensation measures based on calculated annual average habitat units removed (96 AAHU removed).

Channel construction (riparian tree removal, potential wetland effects) would impact small portions of Hermann Brown Park. The exact wetland acreage impact was not quantified in the 1988 Report.

5.1.4 No Action Alternative

The No Action Alternative is defined as no action by the federal government to implement the project detailed in this Draft GRR/EA; however, no action means local government entities would continue to implement actions of their own to reduce flood risk during the period of analysis. Basic assumptions regarding the most-likely future WOP condition stem from assuming these activities and policies would continue and likely expand in an attempt to meet public need.

5.2 Physical Resources

Evaluating potential impacts to the physical setting and physiographic resources considered whether the proposed action or an alternative would cause any of the following conditions:

- Soil or sediment erosion, loss of topsoil, excavation of subsurface soils
- Bank failure or slope channel changes

Impacts to the physical setting were assessed based on map and field resource data. The primary information about physical resources including geology and soils was compiled using regional geology maps, Harris County Soil Survey Reports, Natural Resources Conservation Service (NRCS) soil data and available area studies from research or government resources as available. The environmental consequences discussed below address the potential impacts from the proposed alternatives on topography and soil quality. Certain effects within the physical setting of the TSP, NED Plan B50-A25 and the 1990 Authorized Plan are related to other resource concerns, specifically impacts from dust emissions and soil erosion. These effects are also discussed in the Climate Change and Air Quality sections in this chapter.

5.2.1 Topography

Topographic effects include the potential for land surface disturbance and alteration. The study area for direct and indirect impacts encompasses the TSP ROW and the mapped floodplain area. The topography cumulative effects study area is the same as the direct/indirect study area. For the TSP, 905,882 total cubic yards of material would be permanently excavated to construct the proposed channel, with 1,506,798 cubic yards of material being permanently excavated to construct the offline detention basin. The offline detention basin's depth could be 22 to 24 ft bgs. B50-A25 would excavate approximately 20 percent to 30 percent less material in the channel and over 400,000 cubic yards less material for the detention basin. The 1990 Authorized Plan would excavate approximately 4.4 million cubic yards of material for channel construction but not require any detention basins. The 1990 Authorized Plan cross section for the upper segment is similar to B50-A25 without detention. Middle and lower segments would be modified to 50 ft and 100 ft widths, respectively, creating the need for multiple disposal sites.

The No Action Alternative would maintain the status quo and provide scheduled channel repair/maintenance as required to keep the bayou functioning as a stream course. Vegetation and material which would degrade channel flow capacity would periodically be removed.

For the TSP and NED Plan B50-A25 area topography within the proposed channel ROW, detention area and disposal sites would be permanently altered to construct the widened/deepened channel, 22-ft deep 75-acre offline detention basin (25-acre basin for the B50-A25) and upland disposal areas. The TSP and B50-A25 would include modifying the existing channel and excavating some areas currently at natural ground level to construct the channel and detention areas. Elevation changes would vary depending on the specific location within the affected upper stream segment. The proposed channel bottom elevation would generally average about 3 ft lower than the existing channel bottom. Within the Hunting Bayou channel ROW, the TSP would change the topography so the ROW would widen up to 300 ft at the widest point, and could be as much as 24 ft deeper than the existing land surface elevation. ROW requirements for B50-A25 would be somewhat less. Riprap or rock would be installed for either the TSP or B50-25 to minimize the potential for erosion or sedimentation along channel bends and at areas proposed for stabilization (see Engineering Report).

The 1990 Authorized Plan would require more ROW beyond the existing channel for the entire bayou length, and channel depths would increase.

The No Action Alternative would maintain the channel status quo, except for required maintenance.

Except for the proposed channel and detention areas, the area topography would not change over the existing conditions with the exception of the provisional upland disposal sites for dredged and fill material. The potential disposal sites' topography for the three build alternatives would be permanently changed from existing conditions. The upland disposal sites for the TSP would consist of stockpiled materials which would be elevated relative to the surrounding land. Potential disposal properties identified as Disposal Sites 4, 5a and 6 would receive approximately 12 ft of fill material maximum. The material would be deposited according to approved disposal plans in controlled lifts in compliance with permit provisions (to manage dust, noise and surface water runoff); thus permanently changing the local topography. The proposed disposal area adjacent to the UPRR would receive 8 ft maximum fill, also permanently changing the topography at the location. The B50-A25 disposal site requirement and fill depths would be somewhat less than the TSP, as the excavated material amounts would be less. The 1990 Authorized Plan would require multiple disposal sites totaling 385 acres to accommodate the 4.4 million cubic yards of excavated material. It was estimated approximately 15 percent of the excavated material could be sold commercially for fill (1988 BB&T FR and EIS).

No Action Alternative

Under the No Action Alternative, there would be continued O&M for the existing Hunting Bayou flood channel; thus no direct, indirect or cumulative effect on topography would be expected. Flood risk would be consistent with baseline conditions, and no reduction in the existing floodplain elevation would be expected. Area topography controls drainage and, in the upper watershed, severe effects from flooding are identified within topographic low areas bounded generally by major road or railroad infrastructure which control surface water flow such as foundations and abutments consistent with the surrounding urban environment. Federal emergency flood response and nonstructural local measures for FRM would continue to occur. No anticipated direct, indirect or cumulative effects on topography would be expected for the No Action Alternative.

5.2.2 Geology and Soils

Surface geology within the project area consists predominantly of Quaternary Age relict alluvial deposits which formed Hunting Bayou. Shallow sediments include clays and silty clays interbedded with discontinuous layers of silts and sands. Build alternative construction and O&M would not be expected to have a direct or permanent effect on regional geology. Environmental effects from all build alternatives associated with geology and soils include topographic change in the project area. The potential exists for geologic conditions or hazards to influence design, construction or operation, soil stability and cohesion. There is also the potential for sedimentation or erosion to occur based on soils and channel stability.

The total area permanently disturbed by the TSP and to a lesser extent by NED Plan B50-A25 within the Hunting Bayou ROW would be 313 and 300 acres respectively. The 1990 Authorized Plan would disturb 198 acres of additional ROW for channel construction and 385 acres for excavated material disposal.

Area geology influences surface and subsurface soil deposition. Faults are present in the project vicinity, but in Hunting Bayou's upper reach, they are mapped as normal or growth faults which

exhibit a linear pattern with minimal mapped displacement on the downthrown side. Prime farmland soils are mapped in Hunting Bayou's lower reach, but are not present in the upper watershed and are not addressed further.

Based on geotechnical investigations, soils along the main channel are suitable for the proposed side slopes, except for a 1,250-ft reach along ERRY with previously identified slope stability and erosion problems. The 1,250-ft reach is currently concrete-lined to provide stability through several existing railroad bridge crossings in proximity to one another. The open channel is enclosed, lined and low flows are conveyed through relatively large diameter culverts. Since the culverts in the channel do not completely enclose the channel, storm flows pass through the culverts and over the top of the culverts in the open channel section. The proposed channel improvements would replace the existing concrete-lined section with an open channel concrete-lined section through ERRY.

Construction, excavation, demolition and relocation activities for the TSP would result in the existing surface and subsurface soils being permanently removed and relocated from the channel ROW and the detention basin area to the upland disposal areas.

Effects to and influences of geology and soils have been and would continue to be incorporated into design considerations to minimize potential adverse effects to the area geology. This includes effects caused by sedimentation or erosion and effects on varying soil capabilities on channel slopes and within the channel bottom.

The channel ROW may include maintenance access areas which may be mounded, graded, mowed and maintained; thus also permanently effecting to a minimal extent local topography. In all cases, grading would occur to restore area topography to the extent possible after construction; however it is anticipated permanent changes to topography would occur within the channel and detention basin and at the upland disposal sites. No indirect or cumulative effects of geology or soils associated with the TSP are anticipated.

No Action Alternative

Under the No Action Alternative, there would be continued O&M of the existing Hunting Bayou flood channel; no direct or indirect effect to soils and geology would be expected. Flood risk would be consistent with baseline conditions, and no reduction in floodplain areas would occur. Federal emergency flood response and nonstructural local measures for FRM would continue to occur. No indirect effects of geology or soils associated with the No Action Alternative are anticipated.

5.2.3 Groundwater and Subsidence

All build alternatives would encounter shallow groundwater conditions in the Hunting Bayou project area which may affect excavation or trenching, and may cause the need for dewatering during construction. No adverse indirect or cumulative effects from groundwater or subsidence associated with these alternatives are anticipated, as these conditions would be addressed through proper engineering design as described in *Appendix 2 – Hydrology and Hydraulics*.

Shallow groundwater quality, quantity and recharge rates are expected to be temporarily affected during the build alternative's construction. Excavation cuts made into water-bearing zones would result in groundwater discharge, which would require dewatering. Appropriate groundwater

management for the generated waste would be required. No direct or indirect changes or impacts to groundwater aquifers used for public drinking water supply are anticipated.

No Action Alternative

Under the No Action Alternative, O&M would be continued for the existing Hunting Bayou flood channel; no direct effect on groundwater or subsidence would be expected due to implementing TPS. Under the No Action Alternative, local and federal emergency flood response and implementing nonstructural local measures for FRM would need to continue. Long-term direct and adverse indirect or cumulative effects of the No Action Alternative are anticipated as described by *Appendix 2 – Hydrology and Hydraulics* and *Appendix 5 – Economics Analysis.*

5.3 Hydrology

Hunting Bayou's main channel is an earthen channel which extends approximately 15 miles from its headwaters west of US 59 to the confluence with Buffalo Bayou at HSC. The Hunting Bayou watershed drains an area calculated to be approximately 30 square miles. The average slope in the watershed is 0.0007 feet/feet and the upper watershed floodplain is wide and relatively shallow. Water flow sources in the bayou include precipitation and human activities. Water reaching streams or bayous via surface runoff eventually discharges into Galveston Bay or the Gulf of Mexico from the Buffalo Bayou watershed, including Hunting Bayou, and evaporates to perpetuate the hydrological cycle.

Environmental effects associated with study area's hydrologic resources include Hunting Bayou surface water resources and water quality and socioeconomic issues. The area of direct and indirect effects for hydrology encompasses the 1 percent AEP (100-year) and the 0.2 percent AEP (500-year) floodplains. In the intent of FRM, Hunting Bayou has been channelized from its upstream boundary to its downstream limit since the 1940s. Downstream channelization efforts have not been maintained, since early efforts were conducted and the lower Hunting Bayou has returned to a natural condition. The upstream reach has provided urban FRM in combination with the street and stormwater infrastructure in efforts to manage flood damages. The upper Hunting Bayou watershed drainage areas encompass approximately 12 square miles.

Current FRM efforts are inadequate, inefficient and costly in terms of human health, damages incurred and the environment. Developed by reevaluating the 1990 Authorized Plan, all build alternatives provide improved flood water conveyance for over 6,000 acres of the upper Hunting Bayou watershed (described in more detail by *Appendix 2 – Hydrology and Hydraulics* and *Appendix 5 – Economic Analysis*).

Indirect effects from each build alternative would be long-term and beneficial (except for B50-A25), and would occur within the upper and middle Hunting Bayou watersheds within an area totaling 23 square miles.

Implementing the TSP or B50-A25 alternative would reduce the 0.1 percent AEP floodplain area in the bayou's upper segment from 5,060 acres in the study area to 2,250 acres. Ordinarily, the hydrology of some special aquatic sites such as wetlands would be affected by such a change, because floodplain wetlands would likely change in species composition and size. Because the upper segment's natural hydrology has been altered by urban development and associated drainage structures, existing pockets or fragments of wetlands within the upper segment

floodplain are not supported by periodic flooding. The greater likelihood is these areas are more frequently flooded by less frequent storm events due to the existing drainage systems' operations. The only contiguous wetland/upland complex in the project area in the floodplain is associated with the 75-acre detention site (25 acres for B50-A25), and it is being accounted for in the mitigation plan. No other special aquatic site in the upper segment, outside the bayou channel, would be affected by the reduction in floodplain acreage.

The situation is different for the upper, middle and lower segments with respect to the 1990 Authorized Plan. This plan provides for 25-year structural flood risk reduction. According to the 1988 study, this alternative would reduce the 100-year floodplain from 5,334 acres (estimated at that time) to 760 acres. Areas in the middle and lower segments which are less developed and could contain special aquatic sites (wetlands) could be inundated for less time during major flood events. This could potentially reduce the size and composition of some wetlands vegetation communities.

No Action Alternative

During an intense rainfall event, Hunting Bayou's existing conditions do not provide adequate flood protection, nor does the bayou serve as an adequate outfall source for the local drainage system. Under the No Action Alternative, there would be continued O&M for the existing Hunting Bayou flood channel and as a result, there would be negative direct, indirect and cumulative effect on area hydrology. As discussed in the previous subsection, the cumulative effects of subsidence including within the Hunting Bayou watershed would continue and potentially expand to residential areas which would experience increased flood risks associated with the No Action Alternative.

5.4 Water Quality

For surface water resources, potential direct impacts from the TSP generally would include changes to the surface water flow regime and water quality within the upper Hunting Bayou watershed.

After completing the TSP and B50-A25 alternatives, Hunting Bayou's overall water quality would be expected to return to baseline conditions. Baseline water quality for Hunting Bayou is poor, and described as impaired under Section 303(d) of the CWA. Water quality is characterized by low dissolved oxygen (DO) concentrations, the presence of chlordane and polychlorinated biphenyls in fish tissue, the presence of excessive levels of bacteria and *E. coli*, dieldrin, and other pesticides, dioxins, and high concentrations of nitrate, ammonia nitrogen and fecal coliform bacteria.

Hunting Bayou in the upper reach is an urban, rectified channel for which day-to-day perennial flow only courses through a small perennial channel within its banks. The channel modifications associated with either the TSP or B50-A25 will involve widening the portion of the bottom of the bank's full channel outside the perennial channel and not the perennial channel itself. The deepening involved will lower the perennial channel's elevation, but not change its perennial geometry (either depth or width). The project proposes to put the same perennial channel geometry back into the modified channel. Therefore, the same daily flow (i.e., base flow) will be contained in the same sized perennial channel, and result in the same preconstruction flow depths and velocities, not deeper water column or strata. DO problems more related to water quality versus stratification are not expected to be exacerbated by the proposed deepening. Neither the

TSP nor B50-A25 would alter the quality of runoff or shallow groundwater seepage which constitutes the base flow.

The 1990 Authorized Plan is expected to increase water temperature and reduce DO caused by the enlarged surface areas due to channel widening along with reduced base flow velocity. Diurnal fluctuations in DO would be amplified in the bayou's riprapped reaches due to increased algal growth. No change in salinity patterns for the lower segment is expected, though the tidal zone will be extended 0.5 miles upstream (BB&T Feasibility Report and FEIS, USACE 1988).

Excavation activities associated with the TSP and B50-A25 channel improvements would not be expected to result in a high concentration of contaminants for the long-term, although short-duration, localized sediment disturbance may occur in the construction area and immediately downstream. Should highly polluted water be encountered during construction, measures would be implemented to prevent downstream movement of contaminated water while the contamination and volume are evaluated. The potentially contaminated water would likely originate from perched water tables which have a limited volume. Pumping contaminated water to tanker trucks and then treating at an industrial wastewater facility has been used in the past when such circumstances have been encountered (Hardy Toll Road/IH 610 construction, 1987, AECOM; West Sam Houston Tollway depressed section south of IH 10, 1995, AECOM).

The 1990 Authorized Plan would generate short-term turbidity in the channel during construction. It would face similar potential constraints in the upper segment as the other build alternatives, though there is a decreased likelihood of encountering pollution in the middle and lower segments as these areas are less populated.

During non-storm events, water in the bayou generally consists of storm sewer, municipal and industrial WWTP discharges. The grass-lined channel would help maintain the sediment and pollutant removal benefits of grass-lined conveyances (swales, channels, etc.) especially under normal low flows. It is expected the proposed channel modifications in the upper segment would result in a perennial channel on the widened channel bottom to maintain water flow.

As with other elements constructed within surface water bodies, short-term temporary increases in suspended sediment concentrations, turbidity and sediment deposition would occur from project-related disturbance. Short-term temporary increases in suspended sediment concentrations, turbidity and sediment deposition would be minimized by implementing construction water control (e.g., cofferdams), erosion control measures (e.g., silt fences, check dams) and other stormwater best management practices. During PED, developing the Stormwater Pollution Prevention Plan (SWPPP) would ensure appropriate control of potential water quality effects from construction, such as uncontrolled erosion and sediment runoff from improper material storage/stockpiling, excavated material hauling and equipment use. O&M operations are not expected to have a long-term effect on water quality.

Hunting Bayou's water quality is limited as a result of E. coli bacteria and other pollutants common to urban areas. The bayou is subject to a Total Maximum Daly Load (TMDL) implementation plan in compliance with CWA Section 303(d) to reduce bacteria through regulatory and voluntary mechanisms (HGAC 2012). The types of mechanisms contemplated include educating citizens on the impact of pet waste on surface water quality and the potential for measures which would slow the movement of pollutants into the bayou. Such measures would not materially affect implementing or operating any build alternative. The existence of a

proposed storm water detention facility as part of the TSP would likely be consistent with TMDL compliance measures.

Hunting Bayou being subject to TMDL plan implementation is not seen as an impediment to receiving a state water quality certification under CWA Section 401, as the TSP will introduce structural elements such as the detention basin which will improve bayou water quality in the upper reach.

The potential for localized soil erosion resulting from discharging surface water during construction is anticipated to be low to moderate and temporary. No indirect effects on water quality associated with the TSP are anticipated.

The 1990 Authorized Plan also has a 404(b)(1) evaluation included in the 1988 Report which establishes compliance with CWA.

No Action Alternative

Drought conditions have been ongoing in the Houston area since 2010. Hunting Bayou's water flows and water quality relatively depend on normal rainfall conditions. Wastewater effluent in the upper Hunting Bayou reach may augment and maintain the minimum stream flows.

Under the No Action Alternative, no build alternatives would be constructed and federal, state and local FRM or flood response measures and strategies would need to be implemented to meet demand for FRM. Local and federal emergency flood response and nonstructural local measures would need to continue and potentially expand to incorporate provisions for the possible increases in subsidence, and lack of proper hydrologic functioning in the existing Hunting Bayou flood management system.

Indirect effects from the No Action Alternative would be long-term, adverse, and would occur within the upper and middle Hunting Bayou watersheds in an area totaling 23 square miles.

5.5 Floodplains

In accordance with E.O. 11988 Floodplain Management requirements (see Section 5.21.11), as part of their public interest review, projects should avoid to the extent practicable, long- and short-term significant adverse impacts associated with occupying and modifying floodplains and the direct and indirect support of floodplain development whenever there is a practicable alternative. *Exhibit 3-2* shows the location for the Hunting Bayou watershed's 1 percent and 0.2 percent AEP floodplains based on FEMA mapping. The 1 percent AEP floodplain, also known as a Special Flood Hazard Area on a FEMA Flood Insurance Rate Map (FIRM or floodplain map), is an area at risk for flooding from a bayou, creek or other waterway overflowing during a 1 percent AEP (100-year) flood. Statistically, structures in a 1 percent AEP floodplain have a minimum of a 26 percent chance of flooding during a 30-year period and a minimum 1 percent chance of flooding in any given year. As an example, for flat slopes in areas adjoining a floodplain, 3- to 4-inch increases in ponding may result in standing water expanding laterally ±500 ft for less than a day. *Exhibit 3-3* shows the location for the 10 percent, 4 percent, 1 percent and 0.2 percent AEP floodplains under existing conditions. The 0.2 percent AEP floodplain affects approximately 6,500 acres within the watershed.

Exhibit 4-5 through *Exhibit 4-8* geographically compare the "with" and "WOP" conditions for the 10 percent, 4 percent, 1 percent and 0.2 percent AEP floodplains within the watershed. In keeping with common floodplain management practices, the design for Hunting Bayou channel and other project elements associated with the TSP and B50-25 were developed to meet the requirements specified in ER 1105-2-100 and ER1105-2-101 risk analysis for flood damage reduction. Inundated areas corresponding to the calculated floodplains for the "without" project scenario are as follows:

- 10 percent AEP floodplain – approximately 3,050 acres (4.8 square miles)
- 1 percent AEP floodplain – approximately 5,600 acres (8.8 square miles)
- 0.2 percent AEP floodplain – approximately 6,600 acres (10.3 square miles)

After implementing the TSP or NED Plan B50-A25, the 1 percent AEP (100-year) floodplain would be approximately 2,250 acres (3.5 square miles). The 1990 Authorized Plan would also reduce the overall extent of the 1 percent AEP floodplain from an estimated 5,334 acres in 1988 to 760 acres.

No Action Alternative

Under the No Action Alternative, no build alternatives would be constructed; and federal, state and local FRM or flood response measures and strategies would need to be implemented to meet demand for FRM. Local and federal emergency flood response and nonstructural local measures would need to continue and potentially expand.

Indirect effects from the No Action Alternative would be long-term, adverse and would occur within the upper and middle Hunting Bayou watersheds in an area totaling 23 square miles.

5.6 Wetlands and Waters

The TSP and B50-A25 impacts to wetlands and waters were identified by overlaying the surveyed wetlands and wetlands shown by the National Wetland Inventory maps over graphic illustrations depicting the TSP and B50-A25 ROW. Wetland impacts were characterized as the direct loss of wetlands due to placing dredge or fill material, and as type conversion impacts relating to altering or converting wetlands function due to removing vegetation. These type conversion impacts could be temporary (e.g., where an emergent or scrub-shrub [woody vegetation less than 20 ft tall] wetland is disturbed and allowed to regenerate) or permanent (e.g., a wetland forest is cleared and allowed to regenerate as an emergent or scrub-shrub wetlands). The acreages for wetland areas affected by the TSP (and by extension B50-A25) and related infrastructures were calculated using GIS analyses.

5.6.1 Waters

An investigation for waters was performed on the TSP and B50-A25 ROW. The site review identified waters which would be affected by the project's construction and O&M. During this work, natural drainage features and aquatic resources were identified. The influence area for wetland resources included these alternative's proposed ROW for associated infrastructure (i.e., stormwater detention basin, upland disposal sites, conveyance channel, utility ROWs, access or maintenance areas, and to be acquired residential areas so structures within the AEP floodplain could be demolished).

During construction for the TSP or NED Plan B50-A25, approximately 6.9 acres of the bayou stream channel would be excavated. Hunting Bayou's low-flow channel, a perennial stream, is approximately 20,100 ft long and 15 ft wide. Approximately 905,882 cubic yards of earthen material would be excavated to construct the proposed TSP channel, and approximately 505,885 cubic yards for B50-A25.

The 1990 Authorized Plan would excavate approximately 4.4 million cubic yards of material, which will impact wetlands. Wetlands identified in the 1988 study indicated potential effects to lower segment backwater swamps, mudflats and shallow water areas which could contain saltmarsh communities. No acreages or areas were estimated in the 1988 study.

No Action Alternative

Under the No Action Alternative, there would be no direct or indirect impact or change to the waters or wetlands identified within the proposed build alternatives ROWs.

5.6.2 Wetlands

Wetlands outside the TSP or B50-A25 alignment which may depend on hydrology from surface water flow would not be anticipated to be affected. While not quantified in the 1988 study, floodplain reductions associated with the 1990 Authorized Plan could affect some wetland communities in the middle and lower bayou segments. As mentioned previously, the inundation period in these areas would be reduced, potentially causing a 'switching' of very wet to less wet vegetation.

Activities involving dredging sediment from waters including wetlands or placing fill in wetlands, would be considered to have a permanent adverse impact. Dredged material is defined as material which is dredged or excavated from waters including wetlands. Activities involving removing or converting wetland vegetation could affect wetland resources. A change in wetland function which would occur by converting wetlands type (i.e., forested wetlands conversion to emergent wetlands) would also be considered an adverse permanent impact. The wetlands function and value assessments and proposed compensatory mitigation are discussed in *Appendix 1*, Attachment D.

The U.S. Fish & Wildlife Service (USFWS) provided a Planning Aid Letter regarding "wildlife resource impacts" from the TSP (January 2007), which would also apply to B50-A25. USFWS reconfirmed the substance of this guidance in 2013. The Planning Aid Letter's focus is the 75-acre site proposed for stormwater detention for the TSP. USFWS observed the tract is 'relatively small, isolated, and fragmented' which diminishes this site's wildlife value. However, the site was seen as a possible repository for resources necessary to rejuvenate a small native prairie ecotype. Even so, USFWS recognized the site's limited size and isolation may make preservation infeasible and recommended compensation at a 2:1 ratio. Wetland impacts were considered as part of the mitigation alternatives. The USFWS request to mitigate for coastal prairie effects is also being fully considered by the non-federal sponsor, HCFCD.

The mitigation plan described in *Appendix 1*, Attachment D is the lowest cost of the five mitigation alternatives considered (*Appendix 1*, Attachment D). The mitigation alternatives were rigorously evaluated in differentiating between acres of wetlands and AAHUs. Because mitigation would be achieved by purchasing mitigation bank credits, successful mitigation is assured.

The TSP would unavoidably directly and permanently impact approximately 4.372 acres of forested and scrub-shrub wetlands as part of the excavation activities, which include channel deepening and widening, developing the offline detention basin and constructing disposal sites. B50-A25 would impact 2.372 acres of wetlands. The permanently impacted wetlands resources by type and location are summarized below.

- 1.682 acres of forested wetlands unavoidably impacted at the stormwater detention basin and within the Hunting Bayou channel (avoided by B50-A25)
- 0.318 acres of scrub-shrub wetlands unavoidably impacted at the stormwater detention basin (avoided by B50-A25)
- 2.372 acres of emergent wetlands unavoidably impacted by all build alternatives within the Hunting Bayou channel and at Disposal Site 4

Approximately 1.18 acres of fringe wetlands in the upper segment would be directly and adversely, but not permanently, affected by any build alternative's proposed construction within the Hunting Bayou channel; however, these fringe wetlands would be expected to regenerate through natural or assisted processes (planting and regrowth). The fringe wetland vegetation results from recruiting common hydrophytic vegetation along the edges of the perennial channel within the grass-lined main channel bottom. Because the proposed deepening will not lower the water depth within the perennial channel, the same water's edge exposure which resulted in the fringe wetland vegetation growth will be present. Compensatory mitigation would include purchasing credit for forested and emergent wetlands from the GBWMB as calculated by the Habitat Suitability Index (HSI) scores developed through performing a HEP analysis. *Appendix 1*, Attachment E contains a Section 404(b)(1) Evaluation and the TCEQ Tier II Water Quality Questionnaire and Alternatives Analysis Checklist completed for the TSP.

5.6.2.1 Mitigation and Monitoring

The fringe wetlands observed within the channel banks during 2007 field investigations result from natural recruitment of native and non-native emergent vegetation along the edge of a perennial channel constructed during the previous Hunting Bayou modifications. Emergent wetland plants currently growing within the channel bottom and along the perennial channel would be expected to naturally re-vegetate after construction. Fringe wetlands are therefore expected to recover after construction and are not included as part of the Wetland Mitigation Plan (*Appendix 1*, Attachment D).

The non-federal sponsor, HCFCD, would monitor conditions after construction, and if less than 70 percent of the original fringe wetlands have not regenerated, the non-federal sponsor, HCFCD, would plant 1 acre of emergent wetlands plant species along the perennial channel fringe expecting the remaining 0.2 acre loss would re-vegetate naturally from planted vegetation.

Detailed design for the wetland mitigation plan would occur during the project's final design phase. The mitigation plan would ensure the functions/values of the impacted wetlands would be replaced accordingly.

No Action Alternative

Under the No Action Alternative, no construction activities would occur in or near wetlands, and there would be no impact or change in baseline conditions related to these resources.

5.7 Air Quality

This section provides a generalized discussion about the air quality impacts associated with the TSP, B50-A25, Authorized Plan and No Action Alternative relative to the inventory of air emissions for the HGB Nonattainment Area. The air contaminants considered are those covered by the NAAQS including nitrogen oxide (NO_x) and volatile organic compound (VOC).

5.7.1 Direct Air Quality Impacts from the Tentatively Selected Plan (TSP)

The air quality impact evaluation associated with the TSP and B50-A25 was based on identifying expected air contaminants and estimated emission rates for this project alternative. The emission sources evaluated include land-based mobile sources which would be used during construction activities, including front end loaders, dozers, trucks, backhoes and other predominately diesel powered construction equipment. Air contaminant emissions associated with this equipment would be primarily combustion products from fuel burned in the engines powering this equipment. The movement or disturbance of soil and other construction materials would also result in PM emissions to the air.

Emissions from the construction-related activities associated with the TSP and B50-A25 would include NO_x and VOC. Air emissions would result from construction activities and vehicular traffic associated with on-road construction equipment and support vehicles. This alternative is expected to result in an increase in direct and indirect emissions to the HGB Nonattainment Area during the construction period. However, the construction activities associated with this alternative would be considered one-time activities, i.e., the construction activities would not continue past the date of completion, thus they are considered short-term impacts. *Table 5-1* summarizes the total estimated emissions in tons resulting from using construction equipment for the TSP and B50-A25.

The results in *Table 5-1* demonstrate NO_x and VOC emissions would not exceed the current *de minimis* threshold of 25 tons per year from constructing the TSP and B50-A25. As a result, project emissions from the TSP and B50-A25 would not require a General Conformity Determination, would be considered to conform to the HGB SIP, and would require no further analysis. A copy of these findings would be submitted to TCEQ for review and concurrence.

Table 5-1:
Total Estimated NO_x and VOC Construction Emissions for the TSP and B50-A25

Year	Emissions (tons per year)	
	NO_x	VOC
2015	15.94	0.86
2016	19.51	1.11
2017	1.69	0.10
2018	1.09	0.07
2019	8.90	0.59
2020	8.63	0.64
2021	8.32	0.61
2022*	5.76	0.43

**One-half year of construction*

The potential impacts from PM emissions would be minimized by using dust control techniques such as covering or treating disturbed areas with dust suppression techniques, sprinkling and other dust abatement controls, as appropriate.

Air contaminant emissions would also result from activities related to periodically maintaining the project area including activities such as mowing and sediment/debris removal from the channel bottom and detention basins. The emission sources during maintenance may include construction equipment, with air contaminant emissions associated with this equipment primarily combustion products from fuel burned in the engines powering this equipment. Moving or disturbing soil and other construction materials would also result in PM emissions to the air. These activities associated with maintenance activities would be conducted on a periodic basis, and therefore would result in periodic short-term impacts of relatively short duration at different locations along the existing earthen channel. These emissions would be very minor in magnitude compared to the whole of other typical urban sources (cars, trucks, etc.) of these emission types. Implementing standard construction BMPs would mitigate potential impacts.

The 1990 Authorized Plan emissions associated with excavating and disposing 4.4 million cubic yards of material plus related actions would exceed the temporary air quality effects of the other build alternatives associated with construction. These emissions were not quantified in the 1988 Report.

5.7.2 Greenhouse Gas Emissions and Climate Change

Greenhouse gas (GHG) emissions from all build alternatives will result from construction activities and from vehicular traffic associated with on-road construction equipment and support vehicles. The principal greenhouse gases entering the atmosphere as a result of human activities include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and fluorinated gases (UT Press 2011; EPA 2012c). GHG contribution from the build alternatives will be temporary and only occur during construction, as the alternatives will result in no permanent emission source, and will not have any indirect influence on other sources such as cars, trucks or other fossil fuel-consuming sources.

Climate change due to GHG is a global and regional-scale issue, and locally, the largest contributions are from on-road mobile sources (cars, trucks) and power plant stationary sources.

CO_2 is the largest GHG component emitted by these sources. The GHG emitted from constructing the build alternatives will be insignificant compared to regional emissions. Consider the maximum yearly NO_x emissions estimated for the TSP or B50-A25 construction constitute only 0.04 to 0.11 percent of the on-road source emissions and only 0.02 to 0.05 percent of all source emissions contained in the proposed revision to the HGB area SIP for the modeled years 2006 and 2018 respectively. The 1990 Authorized Plan emissions, while much larger than these, would still be less than 1 percent of total emissions.

Build alternative emissions will occur primarily from combustion of diesel by construction equipment and heavy duty diesel vehicles used to haul excavated soil. The ratio of average NO_x emissions per mass of fuel consumed between heavy duty diesel vehicles (which constitute the majority of build alternative emissions) compared to gasoline light-duty trucks and passenger vehicles (which constitute the majority of on-road GHG sources) ranges from 9.06 to 12.43 (USEPA 2008a and b). The average CO_2 emissions ratio of diesel compared to gasoline is approximately 1.14 (USEPA 2005). Because the ratio comparing average NO_x emissions of diesel to gasoline sources is greater than the ratio between these sources for CO_2, if TSP and B50-A25 NO_x emissions constitute an insignificant percentage of regional emissions, TSP and B50-A25 CO_2 emissions will constitute an even smaller percentage of regional emissions. Therefore, build alternative emissions will not contribute significantly to GHG emissions.

In accordance with EC 1165-2-212, the effects of Relative Sea Level Rise (RSLR) on the project have been evaluated. A discussion about the evaluation and how RSLR was accounted for in hydraulic modeling is provided in *Appendix 2 – Hydrology and Hydraulics*, which concludes RSLR effects are anticipated in Hunting Bayou's lower reach.

No Action Alternative

Under the No Action Alternative, O&M would be continued for the existing Hunting Bayou flood channel, and an alternative FRM plan developed by reevaluating the 1990 Authorized Project would not occur for the Hunting Bayou watershed. Implementing the No Action Alternative would result in no change from baseline to the area's air quality.

5.8 Sound Environment

Implementing any build alternative evaluated for Hunting Bayou would result in deepening and widening the existing channel, excavating detention areas (except for the 1990 Authorized Plan) and replacing new bridge crossings; demolishing existing buildings within the project ROW; relocating utility/pipelines; and disposing excavated materials. Short-term impacts on sound levels within the community during the construction related activities would include sound from construction equipment/vehicles and delivery vehicles traveling to and from the proposed construction site. Construction related equipment sound levels generally range from 76 dB for hoist operations and 85 dB for backhoe operations to a maximum 100 dB for pneumatic hammers.

Sound levels related to the proposed construction activities at a given receptor would vary widely, depending on the phase of construction, demolition, land clearing and excavations, and other tasks. During the construction period, some increased sound levels within neighborhoods adjacent to the Hunting Bayou channel/detention areas would be anticipated. To minimize the potential impacts from construction related sound to surrounding areas, the contractor would be

required to limit the construction, demolition and excavation associated with the proposed action to daylight hours, when occasional loud sounds are more tolerable.

Project plans and specifications would also include an environmental clause stating the contractor should make reasonable efforts to abate noise in the construction area. Extended disruption of normal activities is not considered likely, due to the relatively short-term exposure periods anticipated on any one receiver during the potential construction phases. No direct or indirect permanent effects on the noise environment or continuation of disruptive, intrusive or disturbing sounds would be anticipated due to implementing any build alternative.

Residential land uses adjacent to the bayou and other noise sensitive receptors such as schools, libraries and churches within a block of the bayou will be affected by construction noise from the build alternatives (*Section 2.6.1.2*). Earth moving equipment, graders, trucks hauling excavated material and other construction related traffic will be in operation during daylight hours. Bridge removal and constructing replacement bridges and roadways will also contribute to increased day time sound in neighborhoods affected by the build alternatives. The TSP and B50-A25, restricted to the upper bayou segment areas, will contribute increased sound levels to residential areas, Hutcheson Park and to one school (St. Francis of Assisi) during the construction day. Due to service schedules, churches in the project areas will likely not experience construction noise during evening and weekend services.

The 1990 Authorized Plan, which affects all three bayou segments, will contribute noise during the construction period to at least six additional residential neighborhoods vs. the other build alternatives and to an additional park land use: Herman Brown Park.

No Action Alternative

Under the No Action Alternative, there would be continued O&M of the existing Hunting Bayou flood channel, and an alternative FRM plan developed by reevaluating the 1990 Authorized Plan would not occur for the Hunting Bayou watershed.

Implementing the No Action Alternative would result in no construction-related sound impacts to the areas surrounding the Hunting Bayou channel or proposed detention areas. The noise environment would be consistent with existing conditions and reflect an urban area of Houston.

5.9 Socioeconomic Resources

5.9.1 Land Use

Constructing any build alternative would require the non-federal sponsor, HCFCD, to acquire land to maintain the system ROW. At least 17 bridges (roadway, street and pedestrian) would be replaced or removed as part of the TSP, B60-A75, and the NED Plan, B50-A25. The 1990 Authorized Plan would remove and replace approximately 30 bridges.

The predominantly privately-owned land along the upper Hunting Bayou channel would be converted to public use from private ownership, would lose direct value, while potentially improving the value of properties within the 0.2 percent AEP floodplain. Local taxing entities would lose a total of $91,000 in property taxes resulting from the proposed land use conversion associated with project ROW acquisitions. Hunting Bayou water quality does not support recreational uses. Long-term adverse effects on recreation would not be expected. While not

estimated in the 1988 Report, private land owned in the lower segment would also be converted to public use as would the multiple disposal areas required for channel excavation.

Appendix 6 – Real Estate Plan summarizes the geographic layout for the property parcels which would be traversed by the TSP and the NED Plan and those which would be acquired for project ROW. Tabulated summaries found in *Appendix 6 – Real Estate Plan* provide information on the value, size of each property by parcel number, the parcel acres to be taken by the TSP, and the percent of each parcel which would be acquired within the proposed ROW. The total acreage acquired for the channel and offline detention area is 134 acres. The total property acquisition for the disposal areas is approximately 123 acres for the TSP. The NED Plan real estate requirements would be similar for ROW acquisition. The 1988 Report identified most of the real estate requirements for the 1990 Authorized Plan.

An analysis of induced damages revealed all of the NED Plan scales which reasonably maximize net excess benefits induce damages primarily downstream in the middle stream segment between cross-sections 285+13 and 565+44. The least cost NED Plan, B50-A25, ranks highest overall in induced damages. The AAEV of the induced damages is $201,000 or $4.7 million in present value equivalents at 3.5 percent interest. B60-A75, the TSP, induces AAEV damages of $26,000 or $619,000 in present worth equivalents at 3.5 percent. The 1990 Authorized Plan does not induce damages downstream by design.

The Memorandum, "Federal Emergency Management Agency (FEMA)/U.S. Army Corps of Engineers (USACE) Joint Actions on Planning for Flood Risk Management Projects," signed in June 2012, addresses the requirement to perform mitigation when proposed USACE flood-risk reduction projects increase the BFE (1 percent annual chance). NFIP regulations, found in 44 CFR 65.12, require revisions to FIRMs to reflect BFE and/or floodway changes caused by encroachments permitted by an NFIP participating community. Once the area subject to map revision has been defined, the community must certify to the Federal Flood Insurance Administrator that no structures are impacted by the increase to the BFE in order to maintain the community's participation in the NFIP. Mitigation for all structures impacted is a necessary cost for the local community in association with project implementation and realizing federal project benefits.

If B50-A25 or any other NED Plan scale that induced damages by raising the BFE was to be implemented, NFIP regulations would require the non-federal sponsor, HCFCD, to mitigate the induced damages within the 1 percent AEP flood hazard area. Buyout is the least cost alternative for mitigating to FEMA/NFIP requirements for B50-A25. Buyout for B50-A25 would involve acquiring 171 residential and commercial structures on 131 property parcels valued at $34 million in Hunting Bayou's middle stream segment. Approximately 205 acres of privately held land would be impacted.

The TSP does not induce damages at the 1 percent or more frequent AEP event. Therefore there are no FEMA/NFIP mitigation requirements to implement the TSP. Since the 1990 Authorized Design is a full channelization of the bayou and mitigates for downstream impacts with its design, there are no FEMA/NFIP mitigation requirements for the 1990 Authorized Plan.

The TSP construction and O&M would permanently convert approximately 300 acres of land described as residential, commercial, industrial, open, farm/ranch, forest or other land use to public water utility use. The percent change in land use in a parcel-by-parcel basis and total for

the TSP are summarized in *Appendix 6 – Real Estate Plan*. B50-A25 would convert about 250 acres with an additional 205 acres for FEMA/NFIP mitigation for 455 acres total converted to public use. About 385 acres of land would be converted to public use by the 1990 Authorized Plan.

There would be land use changes for all build alternatives in the upper reach, as the build alternatives would require acquiring single and multi-family residential properties, businesses and an unnamed neighborhood recreational area. The unnamed recreation area has a trail, bench and barbeque pit which would be replaced in the new overbank in this segment. Based on the H-GAC 2007 land use map, prior to most property acquisitions, approximately 13 acres of existing single and multi-family residential areas would be converted to channel ROW. Approximately 5 acres of commercial property would be converted to channel ROW. Land use in the area of the proposed offline detention areas and potential Disposal Sites 4, 5a, 6 and UPRR were either classified as industrial, farm/ranch, vacant or undetermined, but were primarily undeveloped and would be expected to stay the same. The 1990 Authorized Plan would require acquisitions in the middle and lower reaches, plus acquiring multiple disposal sites.

Existing pipelines/utility crossings located between US 59 to the HSC would be replaced/relocated due to deepening and widening the channel as part of all build alternatives. This would consist of replacing or relocating 100 pipeline/utility crossings in the upper reach. If the 1990 Authorized Plan is implemented, the middle and lower reaches would require approximately 40 to 50 additional pipeline relocations (1988 Report, Engineering Appendix, p. 5-144 passim). During the final design phase, coordination with pipeline/utility line companies and personnel would occur to develop procedures to minimize any potential construction related impacts. As a result, no service disruption is anticipated to occur, so long-term permanent adverse impacts to the environment would not occur.

No Action Alternative

Under the No Action Alternative, federal, state and local FRM or flood response measures and strategies would need to be implemented to meet demand for FRM.

5.9.2 Visual and Aesthetics

Visual resources are defined as natural and man-made features which constitute the aesthetic qualities of an area.

In general, the potential changes in the visual quality and hence aesthetics of the project area for all build alternatives would depend on the presence of sensitive or valued visual resources and how these are viewed from various, large-scale vantage points (roads, backyards, hike and bike trails, neighborhood parks). Overall, the project can be visually characterized as an active urban environment, with the majority of the views consisting of residential, commercial and industrial land uses in the upper segment and more natural environment views in the middle and lower segments.

The upper segment project area is approximately 90 percent developed, although there are small open spaces and neighborhood parks. The visual character in the upper segment project area is residential, and transitions toward commercial/industrial as one moves from US 59 east toward the rail freight yard.

All build alternatives would cause some limited visual change to the surrounding area in the upper segment's overall visual character. The construction activity view would be temporary, and the bayou would soon appear similar to pre-construction views. New bridge structures would constitute a new visual addition to the landscape, but would eventually blend with existing urban views. Detention and disposal sites are designed to blend as much as possible with existing surrounding landscape features. To improve the visual appearance, the detention and disposal sites would be vegetated after completing the project. Trees and shrubs would also be planted along the proposed channel ROW up to an approximate density of 100 trees per acre. Grassed areas would be regularly mowed and maintained. This would increase project's aesthetic qualities and wildlife conditions.

The 1990 Authorized Plan would impact views in the middle and lower segments as mature riparian vegetation is removed to modify the channel. Re-plantings would be proposed so construction effects would gradually disappear, and views in these segments would return to preconstruction conditions.

No Action Alternative

Under the No Action Alternative, few changes to the existing visual landscape would occur.

5.9.3 Population and Demographics

The TSP requires 58 SFR (57 for B50-A25) and 8 multi-family displacements due to ROW acquisition. The distinction is made between property acquisitions which are transacted on a parcel-by-parcel basis and involve a change in property ownership. The concept of displacements is associated with real estate transactions which require relocating residents or businesses to other dwellings and structures. Multi-family displacements may require a single property transaction, yet can displace several families.

Table 5-2 shows properties affected by implementing the NED Plan, the TSP or the 1990 Authorized Plan under current conditions. The 1990 Authorized Plan would require displacing 125 residential units and 15 commercial businesses directly impacting an estimated 316 residents.

The TSP would require 70 displacements impacting an estimated 167 persons. Of the 70 displacements, 66 are residential and 4 are nonresidential.

Implementing the NED Plan B50-A25 would require 240 displacements, of which 171 would occur in the middle stream reach to comply with FEMA/NFIP regulations. Of these displacements, 86 are residential structures housing an estimated 218 residents. In total, buyout and relocation due to implementing the NED Plan B50-A25 would directly impact approximately 380 residents along Hunting Bayou.

Table 5-3 demonstrates properties impacted by implementing the TSP have already been acquired and the residents relocated. Owners and occupants of these properties are compensated monetarily and given relocation assistance.

Table 5-2:
Displacements* by Plan for Project Construction (Not structure acquisitions)

Plan	Reason	Single Family Residential	Multifamily Residential (4 units/ea)	Commercial	Religious	Industrial	Total	Residents
B50-A25	ROW	57	8	2	1	1	69	164
	Rise in BFE^1	86		85			171	218
B60-A75	ROW	58	8	2	1	1	70	167
Authorized Design	ROW	115	10	15	0	0	140	316

^1 FEMA requires certification that no structures are impacted by rise in BFE due to project implementation. Buyout is lease cost option for FEMA mitigation.

Table 5-3:
Displacements Due to TSP Implementation

Property Type	Not Yet Acquired	Already Acquired	Total
Commercial	1	1	2
Religious	1	0	1
SFR	9	49	58
Multi-FR (4 units/ea.)	4	4	8
Industrial	0	1	1

The overall watershed population would not be substantially altered from implementing the TSP, nor would it be expected to affect the population's overall racial/ethnic distribution or other demographic factors. Residential and business displacements are discussed in additional detail below.

No Action Alternative

The No Action Alternative would not require residential relocations other than those which may occur due to the continued implementation of local and federal emergency flood response and nonstructural local measures for FRM. The effect from the No Action Alternative is the unabated potential for area-wide flooding with associated long-term, adverse and severe effects caused by human health injuries, damages and long-term detrimental effects on social and community values. The population's overall racial/ethnic distribution or other demographic factors would not be expected to be affected by implementing the No Action Alternative.

5.9.4 Economic Activity

Under current conditions, 4,614 residential, 438 commercial and 58 public/institutional structures are within the 1.0 percent AEP (100-year) floodplain. The TSP would reduce the number of structures within the 1.0 percent AEP (100-year) floodplain by 87 percent as shown in *Table 5-4*.

Table 5-4:
Comparison for Number of Structures at Risk from a 1.0 Percent AEP (100-Year) Event, 2Q2013 Structure Inventory Update

Type of Structure	Number of Structures Within 1.0 Percent Floodplain			
	No Action Alternative	B60-A75 (TSP)	B50-A25 (NED)	1990 Authorized Plan
Residential	4,614	553	942	17
Commercial	438	87	139	0
Public/Institutional	58	5	8	0
Total	**5,110**	**645**	**1,089**	**17**

Under existing conditions, the total average annual equivalent value of flood damages within the 0.2 percent AEP floodplain over the 50-year period of analysis is expected to be approximately $19.8 million. The TSP would result in a positive economic benefit to the area by reducing expected annual damages in the 0.2 percent floodplain by 73 percent.

Long-term economic effects from the TSP would include removing approximately 436 acres of taxable property for property acquisitions (including the proposed detention and disposal sites) from the tax rolls of local government entities and school districts.

The total estimated appraised value for the taxable property acquisition (including the proposed detention and disposal sites) is $2.2 million. Thus approximately $56,310 in annual school and property (county, city and school) tax revenue is lost based on a combined 2012 tax rate of $2.52 per $100 taxable value (Harris County Appraisal District [HCAD] 2012).

This loss of taxable property is expected to be offset by the decrease in costs associated with flood events, which is estimated to be reduced by $14.4 million AAEV over the next 50 years. The costs for deploying emergency response personnel (fire department, police, etc.) would also be reduced.

Two business relocations would be required due to implementing the TSP. These two businesses, IH 610 Beauty Supply and a vacated auto repair facility, are on the southwest corner of the IH 610 and Lockwood intersection, on the bayou's north side. The non-federal sponsor's, HCFCD, acquisition and relocation assistance program would provide assistance to affected residences and businesses. Residential relocations are discussed in further detail in *Section 5.9.6.*

The NED Plan, B50-A25 would reduce the number of structures within the 1.0 percent AEP (100-year) floodplain by 79 percent as shown in *Table 5-4.* The NED Plan would result in a positive economic benefit to the area by reducing expected annual damages in the 0.2 percent floodplain by 66 percent.

Long-term economic effects from the NED Plan would include removing approximately 600 acres of taxable property for property acquisitions (including the proposed detention and disposal sites and FEMA/NFIP mitigation) and removing taxable property from the tax rolls of local government entities and school districts.

The total estimated appraised value for the taxable property acquisition (including the proposed detention and disposal sites and FEMA/NFIP mitigation) associated with the NED Plan is $32 million. Thus approximately $800,000 in annual school and property (county, city and

school) tax revenue is lost based on a combined 2012 tax rate of $2.52 per $100 taxable value (HCAD 2012). This loss of taxable property is expected to be offset somewhat by the decrease in costs associated with flood events. The costs for deploying emergency response personnel (fire department, police, etc.) would also be reduced. The non-federal sponsor's, HCFCD, acquisition and relocation assistance program would provide assistance to affected residences and businesses. Residential relocations are discussed in further detail in *Section 5.9.6*.

The Authorized Design would reduce the number of structures within the 1 percent AEP by 99.7 percent, virtually eliminating any residual damage from a 1 percent AEP event. The NED Plan would result in a positive economic benefit to the area by reducing expected annual damages in the 0.2 percent floodplain by 99 percent. Acreage required for channel ROW for the 1990 Authorized Plan equal 432 acres; and disposal acreage required equals 385 acres for a total of over 800 acres. Impacts to losses of taxable property to local taxing entities is estimated to be about equal to what is estimated for the NED Plan, B50-A25 since 200 acres of ROW required is located in Herman Brown Park, a public park with no taxable value.

No Action Alternative

Under the No Action Alternative, no nonstructural or structural plan(s) would be implemented, and no federal funds for implementing FRM measures would be expended; however, federal expenditures would continue to subsidize the flood insurance program and to assist in flood recovery operations. The total number of structures subjected to risk of a 1 percent AEP event would not be reduced, which would result in no FRM. The estimated $19.8 million in annual flood damages over the next 50 years would not be reduced. The No Action Alternative would not require any residential or business relocation or acquisitions and would not result in the loss of taxable property from the tax rolls. Flooding would continue, and emergency access during flooding events would remain limited due to the number of structures within the floodplain.

5.9.5 Population and Income

Some 95 percent of the population within the watershed is classified as minority, and 30 percent is classified as low income. Correspondingly, approximately 95 percent of the population within the 96 Census blocks located directly adjacent to Hunting Bayou project is classified as minority.

Within Harris County and COH, 82 and 78 percent of the population, respectively, speak English "very well." Approximately 78 percent of the population living within the planning area speak English "very well." For all the census tracts within the study area, 75 percent of the population speak English "very well." Approximately 25 percent of the population within the study area speaks English less than "very well," which qualifies as Limited English Proficient (LEP) (EO 13166), and would require specific outreach measures to successfully communicate flood hazard information and information associated with flood risk management plans for the area. Forty census tracts in the study area have LEP populations or percentages exceeding the "safe harbor" threshold (i.e., they would need documents translated). Census Tract 2120 has the highest LEP population percentage in the study area, exceeding the watershed percentage by 15 percent. This population would also qualify as among the more vulnerable at risk for flooding. Within the seven adjacent Census tracts, for all build alternatives, 28.7 percent are classified as low income (*Appendix 1*, Attachment G). Although higher, the percent minority population within the 96 blocks where population displacement is expected is consistent with, or proportionate to, the percent minority and low income population within the overall watershed.

The location of Census tracts and blocks adjacent to the TSP is included in *Appendix 1,* Attachment A.

In addition to the information provided below, *Appendix 5 – Economics Analysis* discusses vulnerable populations at risk for flooding in the Hunting Bayou watershed. The economic analysis identified the population within the Hunting Bayou study area to be socially vulnerable.

With respect to flood hazards, vulnerable populations are those persons who lack the personal or economic resources to cope with or effectively respond to a flood threat, and therefore are at a higher risk to suffer adverse consequences from a flood event. Socially vulnerable populations including younger and older persons as well as minority and low-income are more likely to be vulnerable to a flood threat because they may lack resources to respond independently to secure their safety.

Institutional or governmental assistance is more likely to be required to aid these populations during emergency evacuations and post-disaster recovery. Other social characteristics indicate social vulnerability such as gender or health, but this analysis is confined to age, ethnicity and poverty.

5.9.6 Relocations

The non-federal sponsor, HCFCD, met with members of Land Assemblage Redevelopment Authority (LARA), COH Planning Department and Harris County Habitat for Humanity to assess opportunities for affordable housing for residents who must be relocated and want to stay in their communities. To date, several homeowners who are voluntarily relocating have received additional assistance from the LARA program and COH Planning Department in conjunction with the non-federal sponsor, HCFCD, relocation benefits. These are part of a series of meetings held with residents who would be offered relocation assistance. This focused outreach involved providing detailed information to residential communities and neighborhoods concerning the project's benefits and describing the relocation process. Door-to-door outreach efforts to disseminate similar information were also conducted. Faith-based organizations and community leaders were included in all outreach activity so residents would have multiple opportunities to learn about the project, its benefits and the requirements for project implementation.

In the long-term, the entire community including minority and low income populations would benefit from implementing the TSP. While individual minority and low income persons may be affected by implementing the B60-A75 NED plan scale, it cannot be shown the TSP would cause disproportionately high and adverse human health or environmental effects on minority or low income populations.

As discussed in the memorandum in *Appendix 1*, Attachment G, public outreach targeted specifically to minority and low income residents has consistently been initiated and maintained by the non-federal sponsor, HCFCD, since the project was started in 1998. The information presented at the meetings has progressed from general to specific study information, including: 1) study purpose, goals and objectives; 2) conceptual remediation alternatives considered; and 3) several phases of final sets of alternatives examined. This has culminated in many public meetings presenting the TSP, which was developed in large part due to input from the local community.

Focused effort to solicit public comments was made at the public scoping meeting held on June 11, 1998 and at six public information meetings held between September 1998 and April 2003. The meetings were announced in local newspapers, and/or meeting notices were mailed to elected officials, government agencies, local organizations, civic groups, the media, businesses and interested citizens. The announcements for the four public information meetings held in October 2000 (two meetings), March 2003 and April 2003 were provided in mailed project newsletters and flyers to neighborhood groups. USACE and the non-federal sponsor, HCFCD, also maintain a mailing list of public meeting attendees and other interested parties to be contacted prior to future public meetings and/or announcements.

USACE and the non-federal sponsor, HCFCD, have attempted to address all issues of concern expressed at the scoping meeting and public information meetings in developing this document. Other outreach activities included newsletters to watershed residents, regular updates to locally elected officials, civic associations, Super Neighborhood groups, non-profit organizations, local housing assistance programs and churches, and one-on-one meetings with affected property owners, as discussed in detail in *Appendix 1*, Attachment G. Follow-up meetings, eliciting community viewpoints and incorporating community recommendations indicate a fair treatment and meaning study.

Implementing the NED Plan scale, B50-A25, would necessitate displacing an estimated 382 persons due to compliance requirements of FEMA for the NFIP. This magnitude of displacements would be unacceptable to the surrounding community. The 1990 Authorized Plan acquisition/displacement requirements would exceed the community's threshold for tolerating changes to the bayou. Its implementation would be controversial from social/community and environmental impact perspectives.

5.9.7 Compliance with E.O. 13045

Under existing conditions, 10 schools within the existing 1 percent AEP floodplain are within the Hunting Bayou watershed. After implementing the build alternatives, the number of schools within the 1 percent AEP floodplain would be reduced to one—Kashmere Gardens Elementary. The remaining 9 schools would flood less frequently after implementing the TSP. This would result in a long-term direct benefit to the respective school districts and the students attending those schools. The TSP would not disproportionately affect children's health or safety. People of all ages would benefit from the proposed improvements.

No Action Alternative

Under the No Action Alternative, the build alternatives would not be constructed; and federal, state and local FRM or flood response measures and strategies would need to be implemented to meet demand for FRM. The effect from the No Action Alternative is the unabated potential for area-wide flooding with associated long-term, adverse and severe effects caused by human health injuries, damages and long-term detrimental effects on social and community values.

5.9.8 Housing

The TSP would require 58 SFR (57 for B50-A25), 2 multi-family/apartments (4 units each) and 2 business/commercial acquisitions, and one religious facility for ROW acquisition. The total cost for the property acquisition (residential, commercial and other), not including relocation assistance funds, is discussed in *Appendix 6 – Real Estate Plan*.

The non-federal sponsor, HCFCD, would provide assistance in locating replacement housing for displaced residents through an available independent real estate broker. Due the limited number of commercial and residential relocations, no constraints are anticipated regarding relocating people to decent, safe and sanitary replacement housing. Within the watershed, several vacant lots and available commercial properties are available for relocated uses.

The NED Plan scale B50-A25 would require 151 residential displacements; 65 for ROW acquisition and 86 for FEMA compliance.

The 1990 Authorized Plan would require displacing 125 residential family units.

No Action Alternative

The No Action Alternative would not require any residential, commercial or industrial relocations or property acquisition.

5.9.9 Public Facilities

Under existing conditions, 58 public structures are within the existing 1.0 percent AEP (100-year) floodplain within the Hunting Bayou watershed. Implementing the TSP would reduce the risk of a 1 percent AEP event to 53 public structures. The NED Plan would reduce the risk of a 1 percent AEP event to 50 public structures. Implementing the 1990 Authorized Plan would reduce risk of a 1 percent AEP event from all 58 public structures.

No Action Alternative

Implementing the No Action Alternative would not reduce the number of public structures at risk from a 1.0 percent AEP (100-year) event.

5.10 Transportation and Infrastructure

For the TSP and B50-A25, most of the existing bridge crossings along the TSP's length would have to be replaced or extended due to deepening and widening the channel. This would consist of replacing 10 roadway bridges, 3 railroad bridges and 4 pedestrian bridges. Roadways bridges which would be replaced or extended are as follows: Wayside Drive, IH 610 (2nd Crossing), Homestead Road (extending both access roads), Kelley Street (Westbound), IH 610 (3rd Crossing), Wipprecht Street, Wayne Street, Hirsch Road, Leffingwell Street and Falls Street. In addition, the termini of existing roads and streets may be abandoned along the channel in some limited areas. All new roadway and railroad bridges would be designed to pass the 1.0 percent AEP (100-year) floodplain. Short-term, adverse traffic-related impacts would occur in the proposed bridge replacement or extension areas.

Coordination with COH and TxDOT would occur during detailed design and construction to develop procedures to minimize potential impacts. A Traffic Control Plan would need to be implemented to minimize and manage effects to traffic, roads and infrastructure in the project area. The non-federal sponsor, HCFCD, has implemented other FRM projects involving multiple bridge modifications including those for Brays Bayou and Sims Bayou, and would use similar measures for traffic accommodation.

Individual bridge replacements would be expected to take between 3 to 5 months each, but could take as little as 1 month if accelerated bridge construction techniques are feasible and used.

Extensions for larger crossings could last between 6 to 9 months. For the smaller roadway bridge crossings, some roads within residential areas would be anticipated to be closed to allow for the proposed bridge replacements. Traffic would be rerouted to other roadways in the area during this construction activity. For larger roadway bridges (such as the IH 610 crossings), only parts of the roadway are anticipated to be closed. Traffic would be rerouted through remaining open lanes to either frontage roadways or to constructed bypass lanes, depending on the appropriate measures determined in the traffic control plan. Slower traffic movement through these areas would be anticipated.

Of the 17 planned bridge modifications, 10 carry public traffic, and 7 are used along access roads for rail yards, serve as railroad crossings or are pedestrian bridges or walkways across Hunting Bayou. Six of the public traffic roads are owned by COH and four are owned or controlled by TxDOT. The bridge replacements are scheduled to occur throughout the 7-year planning level construction schedule, and would be staggered and phased to minimize neighborhood access disruption and traffic impedance. Once the new bridges are constructed, traffic patterns would return to normal. The specific construction procedure for the railroad bridge replacements would be determined through coordination with railroad personnel.

Access to local businesses and residential properties would be maintained during the bridge reconstruction process. Signage would be posted in areas where temporary closings or rerouting would occur. METRO currently operates bus routes in the project area. Plans would be implemented for transit dependent neighborhoods in the project area. It is possible school bus routes could be impacted during the construction process, and re-routing could cause temporary delays for local emergency responders (police protection, fire protection and EMS). Emergency responders and local school districts would receive notification and accommodations prior to roadway closings. With this information, emergency responders and schools could plan routes in advance to minimize delays.

Utilities crossing Hunting Bayou or which would otherwise be within the TSP or B50-A25 required widening will require replacement/relocation. This may result in temporary service outages during replacement/relocation, but will be minimized by using wet connection/wet tap construction for water and sewer as practicable. Wet connection/wet tapping uses special sleeve and valve connections, which allow contained connections to pressurized lines; thus uninterrupted service. The cost for these connection types was included in cost estimates. Utility relocation/replacement is a dedicated subtask in the TSP Construction Schedule in *Appendix 4 – Cost Estimates*. It is phased to occur towards the beginning of each of the 5 construction contracts before other dependent subtasks (e.g., excavation), and has been explicitly accounted for in the schedule timeline to ensure timely and coordinated execution to minimize delays. Each construction contract affects a different TSP or B50-A25 stream segment or the offline basin and is sequentially phased so utility relocation/replacement is staggered through the anticipated 7-year construction schedule. Outage notification and procedures regularly employed by the utility companies/owners for the facility being replaced would be employed to ensure users are notified and can plan accordingly. No substantial adverse service outages are expected.

The 1990 Authorized Plan would require replacing the bridges and infrastructure just described and an additional 13 bridges (30 total for all segments) and 40 to 50 additional pipeline relocations.

No Action Alternative

Implementing the No Action Alternative would result in no impacts to any bridge crossings along Hunting Bayou.

5.11 Hazardous Materials

The upper segment has 36 properties or facilities in regulated state or federally-maintained reporting or solid, hazardous, closed or historical management databases within 1,000 ft of the build alternatives. These facilities include permitted PST sites, LPST sites, areas where voluntary cleanup is occurring, facilities which transport or handle various quantities of hazardous wastes or hazardous/toxic chemicals, areas with reported spills or releases to the environment, and other sites being tracked for environmental regulatory compliance status. In areas with proposed construction, chemical constituents may be present as they may have been released to the environment or may have migrated and impacted shallow groundwater, surface water and surface or subsurface soils. Underground pipelines containing petroleum and other products may have also released chemical constituents to the environment. In areas where excavation or subsurface disturbance is planned, regulated and non-regulated and pipeline and other releases to the environment may be exposed causing a potential health and safety threat to construction workers and the public (including residents and visitors).

During the PED phase, potential construction areas would be investigated and provisions made to avoid known or potential areas affected by chemical and other releases. As always, local, federal and state requirements/regulations for compliance with HTRW management would occur. In some areas, specific sampling and laboratory analyses may be conducted for properties which potentially pose a long-term liability to implementing the TSP or B50-A25. Investigations for acquired properties would help characterize environmental conditions and may be necessary to classify soils and demolition wastes being removed from acquired properties prior to disposal. Spill Prevention, Control and Countermeasure Plans (if needed) and construction specifications would describe HTRW management during construction and O&M.

Constructing new FRM improvements, demolishing existing structures and relocating/replacing utilities/pipelines may generate minor amounts of hazardous or toxic waste. Demolition and excavation work may encounter structures containing asbestos and lead-based paint including soils which may contain lead-based paint. Demolishing structures containing asbestos requires specific procedures and permit requirements, which would also abate any potential for environmental impacts.

Disposing any asbestos wastes encountered when demolishing any acquired structures would be conducted as directed by the Clean Air Action National Emission Standards for Hazardous Air Pollutants (40 CFR 61.40 through 157). Removing and disposing any materials and soils determined to contain lead-based paint above regulatory action levels would be conducted in accordance with applicable regulations (Toxic Substances Control Act, Titles I and IV, and the Occupational Safety and Health Act). Materials and soils sampling and analysis would be required as part of the acquisition process to identify potential hazardous materials including asbestos, which would need to be managed during project implementation.

While replacing pipelines and operating construction equipment, the potential would exist for spills. During construction, the TPDES permit requires the contractor/responsible party to immediately report any regulated hazardous substance spills equal to or exceeding the

Reportable Quantity levels listed in 40 CFR 110, 117, and 302 to the National Response Center. The responsible party would also be required to submit a written description of the spill to the EPA Regional Office; would be responsible for any required clean up; and would be required to modify the site pollution prevention plan to document these steps. Compliance would be required with all applicable federal, state and local laws and regulations related to accidental hazardous substance spills and protecting surface water and groundwater (33 USC 1251 *et seq.*; 42 USC 9601 *et seq.*; 42 USC 6901 *et seq.*).

Homestead Road and Kirkpatrick landfills are in the immediate vicinity of the build alternatives ROW. Prior to beginning construction activity, geotechnical testing would be conducted to determine the landfills' boundaries and extent, and to characterize the wastes present within the landfills. Leachate could potentially be present at the landfill base. Excavation deep enough to reach the landfill base could cause existing leachate to migrate from the site, particularly if any liner present has been intercepted. Excavating existing soils could potentially increase groundwater flow rates or change groundwater gradients in the area. The excavations would expose wastes, directly increasing the potential for generating contaminated surface runoff during rainfall events which would flow directly to the channel.

Areas affected by construction would be revegetated with turf grasses which will be maintained by mowing. Trees and shrubs will also be planted at an approximate 100 trees per acre density. No direct, adverse or long-term effects from the build alternative would be anticipated. All HTRW site cleanups in the project area will be the non-federal sponsor's, HCFCD, responsibility. Maintenance costs will not be cost-shared.

Due to limited development, the bayou's middle and lower segments (associated with the Authorized Plan) do not have the same risk of encountering HTRW sites as the upper bayou segment. However, the Authorized Plan will encounter more pipelines which would have to be relocated and could be determined to have released product. A pre-construction survey and assessment of pipeline ROWs would help identify any areas of environmental concern.

No Action Alternative

Implementing the No Action Alternative would result in no construction activity along the channel, and would not alter the existing conditions for sites of environmental concern currently within the project corridor.

5.12 Cultural Resources

Archeological surveys and cultural resource assessments have been performed for the Hunting Bayou project. *Appendix 1* – Attachment F provides copies of cultural resources reports and coordination with the THC.

As indicated in the correspondence shown in *Appendix 1*, Attachment F, most of the upper bayou segment has little potential for significant prehistoric or historic material due to previous disturbance, distance from water or clay soils. Along the bayou's length, most of the soils in the area are highly clayey, and much of the drainage has been significantly disturbed. All areas have had archeological and historical surveys for the presence of cultural resources, except possibly some of the proposed dredged material and fill material placement areas. However, during the PED phase, potential construction areas which may not have been subject to cultural resource

investigations would be investigated in accordance with applicable regulations and an ROEC would be achieved.

Based on the cultural resource investigations conducted, one area between a Hunting Bayou trail/park and a pipeline corridor along Hirsch Road would require further subsurface investigation. This area is east of US 59 and along the south side of IH 610 East. Although the soils in this area are relatively clayey, some loam areas were visible on the surface at the time of the survey. It could not be determined whether these were naturally occurring. The Post Survey Level of Probability was indicated to be medium low for this area. This area is located within the TSP and B50-A25 boundaries.

On December 13, 2001, an ROW layout for the TSP (by extension B50-A25) and a brief plan description were provided to the State Historic Preservation Officer (SHPO) for their review prior to a proposed resource agency meeting. As a result of that transmittal, additional correspondence was received from SHPO during January 2002 requiring additional information be provided concerning the residences, apartments and businesses to be relocated as part of the TSP (by extension B50-A25) (see SHPO THC letter dated December 13, 2001, postmarked January 14, 2002). Subsequent coordination with SHPO (see Greenstone Geoscience letter dated January 17, 2002 in *Appendix 1*, Attachment F) determined their concern regarding residences, apartments and businesses was for those structures built before 1956.

Consistent with THC's recommendations, Greenstone Geoscience conducted an additional archeological survey and historical reconnaissance under Texas Antiquities Permit No. 2842 during 2002. The documentation and findings from the survey and reconnaissance are contained in the draft report titled: *Archeological Survey and Historical Reconnaissance of Hunting Bayou and Surrounding Area, Harris County, Texas* (Greenstone Geoscience 2002b). The study's conclusions indicated neither the archeological (subsurface) survey nor the historical reconnaissance found any evidence of historically or archeologically significant materials or structures within the TSP or B50-A25 project area. No building within the project area met the consideration criteria for placement on NRHP, nor did any area meet these criteria as a district. No prehistoric material was recovered during this work phase, nor was any surface suitable for prehistoric occupation uncovered. The report indicates this project could proceed with no further investigation. However, any significant change in the proposed plan which included areas not previously considered would require further cultural resource investigation to be undertaken. Copies of this study were provided to SHPO for review and comment. SHPO indicated its concurrence with the findings and recommendations contained in the June 2002 archeological survey and historical reconnaissance in correspondence dated July 22, 2002 (see THC correspondence in *Appendix 1*, Attachment F). If any archeological or historical remains are uncovered during construction activities, construction would cease and SHPO would be notified.

An updated survey and evaluation of affected bridges and structures was conducted in February 2008 to determine NRHP eligibility. The survey and reconnaissance documentation and findings are in the report titled: *Reconnaissance-Level Historic Resources Survey, Hunting Bayou Federal Flood Control Project, Houston, Harris County, Texas* (Hardy Heck Moore, Inc.). The study concluded no historical engineering structures would be impacted; therefore, none of the 17 bridges are identified for inclusion. Bridge survey reports are available upon request. SHPO indicated its concurrence with the findings in correspondence dated April 9, 2008 (see THC Correspondence in *Appendix 1,* Attachment F).

Due to the length of time elapsed since the last historical reconnaissance survey, THC suggested reevaluating the project area for historical resources in 2010. A Phase I History/Architectural survey was submitted to THC. THC concurred with the conclusion in this report that the structures in the survey area did not retain enough integrity to be eligible for inclusion in NRHP individually or as a historical district.

THC noted one exception, which was the M.W. Sinai Grande Lodge A.F. and A.M. building at 5002 Wipprecht Street. THC indicated this structure is eligible under Criterion A for Social History and Ethnic heritage, because it is a long-term fraternal organization and is an important institution in the Kashmere Gardens community. THC concurred with the recommendation the TSP (by extension B50-A25) would not affect the structure itself, but would potentially affect the chain-link fence surrounding the property and remove less than one-third of the property facing Hunting Bayou (see *Appendix 6 – Real Estate Plan*). The structure itself would not be demolished, and the TSP (by extension B50-A25) would not impact the building's eligibility or integrity; therefore, THC made the termination determination "No Historic Properties Affected: Project May Proceed." For all action alternatives, an INADVERTENT FINDS legal provision would be made part of all undertaking requirements and be included with site development specifications. If, during construction activities, archeological or historical remains are uncovered, construction would immediately cease and SHPO would be notified. Through coordination with SHPO and implementing protective covenants and required mitigation agreements, no impacts to archeological resources would result from implementing the TSP (by extension B50-A25) (see Cultural Resources Report and THC Letters, *Appendix 1*, Attachment F).

The 1990 Authorized Plan, especially in the middle and lower segments, would require additional evaluation. As reflected in the 1988 study, 10 prehistoric sites have been recorded along bayou banks. Characterized as stratified midden sites, in 1988 they were considered to be potentially eligible for NHRP. No sites were determined to be in the proposed disposal areas (USACE 1988).

No Action Alternative

Implementing the No Action Alternative would result in no construction activity along the channel and would not alter the existing cultural resource environment in the TSP (by extension B50-A25) vicinity.

5.13 Biological Resources

5.13.1 Vegetation

5.13.1.1 Upland Vegetation

Constructing the TSP or B50-A25 would result in removing the existing terrestrial and aquatic vegetation (including wetland vegetation) within the proposed channel ROW, detention areas and potential disposal sites. Within the existing ROW, the predominant vegetation is grass and other herbaceous plants growing on the earthen channel's tops and banks. Woody vegetation within the ROW consists of small fragments of woodlots or narrow bands of trees and shrubs growing along ROW edges. Relatively few large mature trees would be affected by the project within the proposed channel ROW. Vegetation within the adjacent urban areas primarily consists of ornamental grasses, shrubs and trees.

Following the TSP or B50-A25's construction, grasses such as Bermuda grass and foxtail millet (*Setaria italica*) would be planted in these areas. Trees and shrubs would also be planted consistent with the existing tree cover. Planting native tree species along the top of banks would increase the project's aesthetic qualities and wildlife conditions. Emergent wetland plants currently growing within the pilot channel bottom and predominantly along the channel edges would also be expected to be impacted, and would return to the channel and channel edges after the project is completed. *Appendix 1,* Attachment D summarizes the acreage of habitat types found within the upper segment ROW which would be permanently adversely impacted by the TSP or B50-A25. Implementing the compensatory wetland mitigation plan (presented in *Appendix 1,* Attachment D) would enhance vegetation diversity within the proposed inline detention basin.

Vegetation within the detention area is a mixture of second growth forest and openings dominated by grasses and other herbaceous plants. This vegetation would be removed during the excavation activities to create the detention area. Following construction activities, turf grasses and limited amounts of trees would be planted within the detention area. Planting trees along the top of the detention basin would also offset some of the tree losses due to excavation activities. Constructing the offline detention basin would require removing the regionally rare orchid, which has no state or federal protection. Clusters found in 2009 near this area have been relocated to Mercer Arboretum.

Except for the UPRR Disposal Site, most of the potential disposal sites have previously been cleared or disturbed and have received fill. Volunteer herbaceous vegetation primarily occurs in these areas. The non-federal sponsor, HCFCD, has an agreement with UPRR for the maximum fill volume to dispose at the UPRR Disposal Site. Approximately 21 acres of the 78 acres of secondary growth upland mixed hardwoods on the UPRR Disposal Site would be impacted when this site is used. For any of the proposed disposal sites used, the existing vegetation would be removed. Following disposal activities, these areas would be made aesthetically pleasing by planting grasses, trees and shrubs. Opportunities for developing wildlife habitat would also be considered for these areas where feasible. Planting trees and shrubs in these previously cleared areas would be anticipated to compensate for the vegetation removed while constructing the detention area.

All seeding and planting associated with re-vegetating the project areas affected by construction are for site preparation and restoration, and would be eligible for cost-sharing consistent with guidance in ER 1165-2-400, Recreation Planning, Development, and Management.

All plantings would include various native vegetation endemic to the area which would comply with the intent of E.O. 13112 Invasive Species. E.O. 13112 was issued to prevent introducing invasive species and provide for their control.

Development along Hunting Bayou's upper segment has resulted in limited open space for project features, thereby making impacts to upland habitats such as forest, scrub shrub and prairie grasses unavoidable by the TSP or B50-A25. The existing upland habitat is fragmented and isolated, and is gradually being overgrown by invasive species. However, the existing upland vegetation does provide limited habitat for birds and smaller wildlife species.

The open herbaceous areas with remnant upland coastal prairie species are in the process of woody species invasion from the upland forest and scrub-shrub in the offline detention basin.

Although coastal prairie itself would be considered to be a significant resources, as evidenced by the June 2008 FWCAR and January 11, 207 Planning Aid Letter, the small open areas present at the offline detention basin site no longer constitute coastal prairie habitat. The small open areas are fragmented habitat patches which has implications for their utilization by a variety of animals. Fragmentation, the division of formerly contiguous areas of natural or semi-natural habitat into smaller isolated patches, affects the ability of habitats to support populations of constituent species. This is because the ecological characteristics of small fragments of a habitat are different from those of larger areas, principally owing to so-called 'edge effects' and to the inability of small areas to support viable populations of species that have large territories or home ranges. For these reasons, small fragments of a habitat almost invariably support fewer species than large areas. Further, a reduction in the area of a habitat patch can decrease its suitability for animals to a disproportionately greater degree than the actual reduction in area. The numbers of a species are likely to decline if its habitat is reduced; fragmentation effects imply that the value of the remaining habitat also is diminished.

Mitigation for the loss of these open herbaceous areas is not warranted as they do not support viable numbers of animal species common to prairie habitats and because of the encroachments mentioned earlier, are already on a path leading to their disappearance.

Approximately 4.37 acres of unavoidable impacts to the wetlands are within the upper segment ROW, exclusive of the 1.18 acres of fringe wetlands. The HEP HSI modeling demonstrated the project and disposal required would have net losses of 0.570 Average Annual Habitat Units (AAHUs) of emergent wetland and 0.699 AAHUs of forested wetlands (no scrub-shrub AAHUs impacted). The mitigation analysis demonstrated the justified mitigation plan would consist of purchasing 4.33 forested wetland credits (acres) and 0.83 emergent wetland credits in Subdivision B of the GBWMB to directly replace these losses. Wetland exhibits are shown in *Appendix 1*, Attachment A.

The 1990 Authorized Plan would remove approximately 66 acres of riparian vegetation and 30 acres of upland forest according the 1988 Study. Channel enlargement would reduce habitat diversity and adversely affect species diversity and abundance. Wetlands should be unaffected or minimally affected, since these are located beyond the ROW limits. Aesthetic plantings within the channel ROW were proposed for the 19 road crossings and at public access areas in channel ROW reaches (USACE 1988)

No Action Alternative

Under the No Action Alternative, the channel ROW would remain predominantly vegetated with grass and other herbaceous plants growing on the current earthen channel's tops and banks. The vegetation within the channel ROW would continue to be maintained by periodic mowing. Within the offline basin, the invasive species would continue to grow, and woody species would continue to invade the remaining open herbaceous areas.

5.13.2 Wildlife and Aquatic Organisms

5.13.2.1 Terrestrial Wildlife

The terrestrial wildlife area of direct influence for the TSP and B50-A25 includes the construction areas within the proposed ROW. Areas most affected would be along the banks of the upper Hunting Bayou channel, disposal areas and the stormwater detention basin. The 1990

Authorized Plan would affect these areas plus riparian areas along the middle and lower segments.

The construction impacts on wildlife associated with all build alternatives can be divided into short-term effects resulting from physical disturbance during construction and long-term effects resulting from habitat modification and change to riparian vegetation. The net effect on local wildlife from short-term construction effects may be relatively minor. A general discussion about the construction and facility operation impacts on wildlife follows.

In general, the greatest potential impact to wildlife would result primarily from habitat loss, particularly riparian and fragmentation of habitat. The ROW would be cleared, and channel side slopes along Hunting Bayou would be constructed and maintained. These channel side slopes would be relatively long linear surface features in more densely populated Harris County and Houston areas. Fencing would be needed at street, road and pedestrian bridges. These security fences would pose a permanent, long-term adverse effect to wildlife migration and movement.

Wildlife in the immediate area would experience a loss of browse or forage habitat due to clearing woodland and brush within the project ROW. Herbaceous vegetation regrowth in the ROW following construction would benefit species which forage and live in open habitats.

The increased, though temporary, noise and activity levels during construction and routine maintenance may potentially disturb breeding or other activities of species inhabiting the areas adjacent to the ROW. Other construction impacts to wildlife would be short-term dust and gaseous emissions from construction equipment. Periodically mowing the ROW, while producing temporary negative impacts to wildlife, improves the habitat for ecotonal or edge species due to the increased production of perennial forbs and grasses.

Using stormwater pollution prevention best management practices would be required prior to construction to limit the amount of water turbidity. Following construction, it would be anticipated a similar assemblage of aquatic and terrestrial animals would re-inhabit the areas disturbed by construction.

No Action Alternative

No change to the wildlife would occur under the No Action Alternative. The project area would remain similar to existing conditions. The watershed's heavily urbanized condition would continue to provide insufficient habitat for large mammals, and generally low quality habitat for other terrestrial and aquatic organisms. Small mammals, reptiles, amphibians and birds found within the watershed are those able to use an urbanized area or are commensal with humans. No impacts to fish or mussel species inhabiting the existing area, their preferred habitats or to the lower Hunting Bayou watershed. No long-term, direct effects would be expected to occur.

5.13.2.2 Threatened and Endangered (T&E) Species

The FWCAR included numerous USFWS recommendations. The USFWS suggested the non-federal sponsor, HCFCD, consult with federal and state agencies while developing a mitigation plan. The USFWS also suggested an invasive species plan be developed for the mitigation site and planting native vegetation along the channel and in proposed detention basins. The FWCAR stated concrete-lined channels should be eliminated where possible, and to use drift

fences to help reduce soil and/or plant material from entering and accumulating in the channel (*Appendix 1*, Attachment C).

In compliance with the ESA, federal and state agencies were contacted to determine the potential for the proposed action to impact threatened or endangered species. Qualified biologists, including local flora expert Dr. Larry Brown, have conducted flora and fauna surveys including presence and absence surveys for T&E species for the TSP and B50-A25. No listed species were documented during the surveys. The 1988 Study also determined no threatened or endangered species were in the bayou's middle or lower segments which could be impacted by the 1990 Authorized Plan.

The Bald and Golden Eagle Protection Act (16 USC 668-668d) protects two eagle species. The bald eagle was chosen as a U.S. national emblem in 1782, and was provided federal protection in 1940 (Bald Eagle Protection Act). This act was expanded in 1962 to include the golden eagle. The act currently prohibits anyone without a permit from 'taking' these eagles where the term 'eagle' includes the bird itself, its nest, eggs or any part thereof (including feathers) or molesting or disturbing the birds. Anyone who takes, purchases, barters, sells, offers to sell, transports, exports or imports at any time or any manner any bald or golden eagle is subject to criminal penalties.

The USFWS has indicated no threatened or endangered species under its jurisdiction are likely to occur within the areas proposed for improvement (USFWS 1998). The National Marine Fisheries Service (NMFS) provided a list of T&E species under its jurisdiction (NMFS 1998). This list included marine mammals and turtles.

Based on studies conducted within the project area, there are no known documented rare, threatened, and endangered plants, animal, invertebrates or exemplary natural communities located in the immediate vicinity of the TSP or B50-A25 construction.

While the bald eagle is currently de-listed as threatened or endangered, its potential presence in areas surrounding upper Galveston Bay or along waterways such as Hunting Bayou cannot be discounted. Bayou areas in the middle and lower segments provide extensive habitat which can be used as foraging areas and desirable nest trees for this species. For the 1990 Authorized Plan, pre-construction surveys of habitat near the bayou water course would need to be conducted to establish no nesting eagles are in areas to be affected by construction. Coordination with USFWS and TPWD would be required should eagle nest trees be identified in areas scheduled for clearing or for nearby construction.

5.13.2.3 Birds

The area for birds directly influenced by the build alternatives includes all alternative ROWs and project elements such as the Hunting Bayou channel, proposed disposal areas and the 75-acre stormwater detention basin.

Based on a study conducted by Blair (1950), National Land Cover Database data (2006), site visits and aerial photography, the regional ecosystem (Austroriparian Biotic Province) was reviewed for the common bird species likely inhabiting the TSP and B50-A25 area. Common bird species occurring within the TSP and B50-A25 area are likely to be blue jay, flycatcher, northern cardinal, cooper's hawk, northern mockingbird and mourning dove.

Hunting Bayou is within the North American Flyway, and neo-tropical migrants annually pass over the project area. Avian wildlife would lose approximately 72 acres of wooded areas after the development of the stormwater detention basin. Approximately 3.5 acres of grasslands and wetlands would be impacted. In the long-term, the TSP and B50-A25 may potentially benefit herons, coots, geese, ducks and other birds which forage or inhabit aquatic areas. The overall loss of wooded areas and grassland would have a negligible effect on migratory and residential bird species. Large areas of requisite habitat for these species, which have varied habitat requirements, exist in adjacent watersheds. Major areas containing important habitat for these species will continue to exist in Hunting Bayou's middle and lower reaches.

The TSP and B50-A25 would reduce habitat for resident and migratory bird species in approximately equal amounts or area, and be restricted to areas in the bayou's upper stream segment. Greater impacts to avifaunal habitat are predicted for the 1990 Authorized Plan which removes 66 acres of riparian vegetation along the bayou in the middle and lower bayou segments. Herman Brown Park and natural areas adjacent to the bayou south of Market Street in the lower segment have the greatest potential to contain areas where various bird species including colonial water birds and song birds may establish rookeries. Because these areas are desirable for migratory songbird foraging and resting areas, special care will have to be taken to avoid construction during active migration periods and periods when various species may be in nesting or rookery areas.

Wooded areas such as parklands which exist in all three bayou segments may contain hard mast tree species and understory species which provide berries important to most bird types. For example, migratory song birds eat fruits and berries prior to and after migration periods. The wooded areas located in Herman Brown Park in the middle bayou segment and the undisturbed areas of the bayou lower segment contain most of the habitat used by resident and migrant bird species.

5.13.3 Aquatic Organisms

Due to Hunting Bayou's urban, rectified nature in the project reach, it has very little in-stream structure serving as fish habitat, such as riffles, pools, undercut banks or in-stream coarse woody debris. The overbanks lack natural riparian cover and consist primarily of urban landscaping and sparse, ornamental tree growth typical of residential backyards. Other than this, only very scattered, bankside volunteer tree growth with common bankside species such as black willow is occasionally observed. A physical stream habitat assessment performed for Section 401 State Water Quality Certification compliance using the TCEQ's method from Chapter 9 of the TCEQ's Surface Water Quality Monitoring Procedures, Volume 2, which assessed quality based on major stream geomorphology characteristics, corroborated this, with only 3 riffle-pool structures identified in the project reach, little in-stream structure that wasn't urban debris-based, and limited to intermediate physical stream habitat quality. Intermediate scoring mainly resulted from the largest pool dimensions, channel sinuosity and the flow in the perennial channel. As explained above, the same perennial channel will be reconstructed and will provide the same base flow depths. Channel sinuosity is not being decreased with the proposed modifications. The largest pools were associated with stormwater outfall scour. Because of this and because little in-stream structure or natural riparian cover exists, the modified channel would not substantially alter habitat fish habitat from what is present. Due to these reasons, Habitat Suitability Index (HSI) fish models were not used during the study.

5.13.4 Reduction and Mitigation for Potential Impacts

In accordance with the Migratory Bird Treaty Act (MBTA) to protect migratory bird species, clearing the ROW in the bird habitat vicinity may need to be restricted to the time period outside the bird nesting season (February 15 to September 1). The only remaining contiguous riparian areas in the upper reach are on Hunting Bayou's north bank between Homestead Road and Kirkpatrick Boulevard. These wooded areas can accommodate migratory songbirds as they move through the Houston area during seasonal migrations. This wooded habitat provides cover and various food sources for these species. Due to the proximity of the bayou water course, colonial water birds may potentially gather and nest in the denser understory areas of this habitat. Surveying the area during neo-tropical songbirds and other species seasonal migrations and observing presence/absence of colonial water bird nesting would be reasonable prior to construction activities. Areas actively being used by avifaunal species should be avoided if possible. Active rookeries should be avoided entirely during the nesting season. Regulated construction activities may include removing nests or nest structures, tree felling, vegetation clearing, trampling and maintenance. If nesting pairs of migratory birds are observed, construction activities in those areas would be rescheduled if possible to avoid impacts. Similar measures for avoiding impact would be implemented for the middle and lower bayou segments if the 1990 Authorized Plan were implemented.

No Action Alternative

No changes to T&E species within the watershed would occur due to implementing the No Action Alternative.

5.14 Relationship between Short-Term Use of Man's Environment and Maintaining and Enhancing Long-Term Productivity

NEPA requires considering the relationship between short-term environment uses and long-term productivity associated with the proposed action. Short-term commitments would include labor, capital and fossil fuels resulting directly from any construction activities and indirectly from providing services to the various project areas during construction and O&M. Over the long term, the proposed FRM project would provide for reduced flood damages within the upper Hunting Bayou watershed.

This evaluation involves considering whether an action is sacrificing a resource value which may benefit the environment in the long-term, or some short-term value to the non-federal sponsor, HCFCD, or the public. The short-term environment uses associated with operating the proposed FRM measures and the long-term impairment of environmental resources as they have been analyzed in this Draft GRR/EA are defined as follows. Short-term refers to the time period encompassing the TSP and B50-A25 (2072) life span and the time period encompassing the subsequent restoration and rehabilitation activities. Long-term refers to the time period following restoration and rehabilitation activities, during which consequent impacts from the proposed action may still effect the environment. The proposed short-term uses for the environment associated with the proposed action are developing approximately 313 acres, using approximately 114 acres of habitat, and the direct loss of vegetation, wildlife habitat, perennial streams and wetlands resources. The projected period before natural conditions return to an approximate baseline condition within the study area is expected to exceed several decades after completing restoration activities.

Wetlands and streams restored following equipment removal and rehabilitation efforts would recover to the baseline condition. Within several years after construction, re-grading and re-vegetation would occur and the area would be restored.

5.14.1 Unavoidable Adverse Impacts

5.14.1.1 Physical Resources

Within the channel ROW for all build alternatives, the general topography would be modified to reflect a larger and deeper channel section. For the build alternatives, this would consist of an earthen trapezoidal channel with 4:1 side slopes, except for the existing concrete channel through ERRY, which is to remain concrete due to erosion protection concerns. The TSP and B50-A25 would include modifying the existing channel and excavating some areas currently at natural ground level to construct the channels and detention areas. Elevation changes would vary depending on the specific location within the TSP and B50-A25 area.

A total of 905,882 cubic yards of earthen material would be excavated to construct the TSP channel, with 1,506,798 cubic yards of material being excavated to construct the offline detention area. The B50-A25 excavations would be 20 to 30 percent less than these. The offline detention basins' depth for the TSP and B50-A25 could be 22 to 24 ft below ground surface. The 1990 Authorized Plan requires that 4,389,000 cubic yards of material be excavated for its channel construction.

Implementing the improvements for all build alternatives would result in minor, short-term impacts to water quality. A temporary increase in turbidity levels due to increased sediment suspension from excavation or demolition activities would also be experienced during construction. Existing DO concentrations are already typically depressed during the summer. Water temperature increases, which can result from removing aquatic shade and change to a different channel lining, can further depress DO concentrations. Because the project would maintain the current grass-lined channel configuration and the existing aquatic shade provided by bankside trees is already sporadic, significant water temperature elevation is not expected. The grass-lined channel would provide sediment and pollutant removal, especially during low flow periods.

For all build alternatives, impacts to air quality during construction activities are not anticipated to produce significant increases in O_3 precursor (NO_x and VOCs) emissions; however, since the area is in non-attainment for O_3, an applicability analysis to the CAA's General Conformity Rule was performed. The anticipated NO_x and VOC emissions which would result from the proposed plans would be below the emissions (*de minimis*) levels specified in 40 CFR 93.153(b)(1) for non-attainment areas; therefore, the proposed action would not be considered regionally significant for General Conformity. As a result, a formal conformity determination would not be required consistent with the conditions of 40 CFR 93.153(c)(1), and the proposed action would be considered to be in compliance with the SIP for the area. Over the long-term, impacts to air quality would be generally consistent with existing conditions.

For all build alternatives, short-term impacts on community sound levels would occur due to excavation/construction activities and from construction/delivery vehicles traveling to and from the construction sites. To minimize the potential impacts, construction activities would be limited to daylight hours when occasional loud sounds are more tolerable, unless future revisions to the SIP for the area restrict daylight construction activities to reduce O_3 levels. Project plans

and specifications would also include an environmental clause the contractor shall affect all reasonable measures to abate noise in construction areas including: maintaining equipment muffler systems, haul road routing, establishing noise attenuation techniques, etc. Once completed, sound levels would be anticipated to be similar to existing conditions.

For the TSP and B50-A25, 100 pipeline/utility line crossings along the project reach would need to be relocated. Coordination with pipeline/utility line personnel would occur during detailed design and construction to develop procedures to minimize any potential construction related impacts.

The 1990 Authorized Plan would require these relocations plus as many as 50 more pipeline /utility line relocations in the middle and lower segments.

No Action Alternative

There would be no new impacts on the area's physical resources if the No Action Alternative was implemented.

5.14.1.2 Biological Resources

Constructing the TSP and B50-A25 would result in removing the existing vegetation within the proposed channel ROW, detention areas and potential disposal sites. For the channel ROW and detention areas, the existing vegetation would be replaced with turf grasses which would routinely be mowed and maintained. Trees and shrubs would also be planted. This would increase the project's aesthetic qualities and wildlife conditions. It would be anticipated most wildlife would avoid the area during construction.

The TSP would impact approximately 3.67 acres of emergent wetlands, forested wetlands, scrub shrub wetlands and 1.18 acres of fringe wetlands (fringe wetlands area also impacted by B50-A25) along the proposed channel ROW and within the proposed offline detention area. Another 0.70 acre of emergent wetlands may be impacted if all potential disposal sites are used for either plan scale. The 4.37 acres of palustrine wetlands which would be impacted would be replaced through mitigation within the channel and detention areas. The 1.18 acres of fringe wetlands along the perennial channel margin would be expected to reestablish. All proposed disposal sites used would be made aesthetically pleasing by planting grasses and native trees and shrubs. Opportunities for developing wildlife habitat would also be considered for these areas where feasible.

The 1990 Authorized Plan would not require detention areas, though it would require 385 acres over multiple disposal sites which contain upland habitat but no wetlands. Some wetlands would be affected in the middle and lower segments as a consequence of channel construction including the fringe wetlands in the upper segment channel.

No Action Alternative

There would be no new impacts on the area's biological resources if the No Action Alternative was implemented.

5.14.1.3 Socioeconomic Resources

Long-term economic effects from B50-A25 would include removing approximately 242 acres of taxable property for property acquisitions (including the proposed detention and disposal sites) from the tax rolls of local government entities and school districts. This property's total value is approximately $3.6 million, for a total loss of approximately $91,342 in annual school, property (county and city), hospital and other local tax revenues, based on a combined 2012 tax rate of $2.52 per $100 taxable value (HCAD 2013). This taxable property loss is expected to be offset by the annual decrease in costs due to flood damages, which is estimated at $14.4 million annually over 50 years.

The TSP would require 58 SFR (57 for B50-A25) and 8 multi-family residential (i.e., individual apartment units) relocations. Two business relocations would be required due to implementing the TSP. These two businesses are the 610 Beauty Supply and an automobile repair facility which may no longer be in active operation. The NED Plan scale B50-A25 would require relocating 57 SFR and 8 multi-family residential units for ROW acquisition and another 86 residential displacements due to FEMA compliance requirements for the NFIP. A total of 89 nonresidential displacements would be required for NED Plan scale B50-A25 implementation.

The 1990 Authorized Plan would require 125 residential and 15 nonresidential displacements for project implementation.

Under the TSP and B50-A25, an unnamed recreational area would be disturbed, although the recreational amenities would be replaced on the overbank to Hunting Bayou channel.

For the TSP and B50-A25, 13 roadway bridges and 4 pedestrian bridges would have to be replaced. Short-term, traffic-related impacts would occur in the proposed bridge replacement areas. Coordination with COH, TxDOT and railroad personnel would occur during detailed design and construction to develop procedures to minimize potential impacts. All new roadway and railroad bridges would be constructed with their base 18 inches above the 1 percent AEP floodplain water surface elevation.

The 1990 Authorized Plan would require 30 additional bridge removal/replacements and relocating some roadway bridges.

No Action Alternative

There would be no new impacts to the area's socioeconomic resources if the No Action Alternative was implemented. The No Action Alternative would result in no nonstructural or structural plan(s) being implemented, and would require no federal fund expenditure to implement FRM measures; however, federal expenditures would continue to subsidize the flood insurance program and assist in flood recovery operations. With the occurrence of the existing 1.0 percent (100-year) flood, 4,465 structures would continue to be subjected to the risk associated with a 1 percent AEP event. Annual flood damages are estimated at $19.8 million.

5.15 Irreversible and Irretrievable Resource Commitments

Irreversible commitments are those which cannot be reversed, except perhaps in the extreme long-term. The classic instance is when a species becomes extinct; this is an irreversible loss. Irretrievable commitments are those which are lost for a time, i.e., if an interstate is constructed

through a forest, the ROW timber productivity is lost for as long as the highway remains. The highway construction signals an irretrievable loss in exchange for the highway's benefits.

Construction and long-term maintenance for the proposed FRM project would require committing various resources including labor, capital, energy, biological resources, building materials and land resources. Short-term labor, capital and fossil fuel commitments would result directly from constructing the proposed improvements and indirectly from providing services to the various sites during construction. Long-term resource commitments would result directly from maintaining the project and indirectly from providing water, sewage, electricity, gas and solid waste services for proposed recreational facilities. Building materials would also be long-term commitments. All these losses would be considered irretrievable.

Duration for the land resources commitment would depend on the ultimate reuse and life for the facilities and property. Since the proposed preferred land use is for long-term FRM improvements for the watershed, the land resources commitment is long-term, an irretrievable loss.

5.16 Possible Conflicts between the Proposed Action and the Objectives of Federal, Regional, State and Local Land Use Plans, Policies and Controls for the Area Concerned

All build alternatives are consistent with local private sector and all levels of government plans, programs and policies regarding land use in the watershed.

5.17 Energy Requirements and Conservation Potential for Various Alternatives and Mitigation Measures

Energy in the form of various fossil fuels would be required during any construction, operation and maintenance for the proposed FRM improvements. At this time, prior to developing the final detailed design plans and specifications, it would be difficult to determine the specific energy requirements required to construct any of the build alternatives. However, construction in general can be divided into various phases: ground clearing, site grading, excavation/construction, filling and finishing. Each phase would require varying energy input levels. Diesel fuel would generally be the main type of energy source required during any construction activities. Prudent energy conservation practices such as minimizing equipment idling would be incorporated into this project wherever possible during construction activities. Maintenance activities would be anticipated to be consistent with the activities currently occurring within the channel ROW, with maintenance equipment generally being fueled by gasoline. All maintenance activities would be conducted in compliance with the approved HGB Clean Air Plan. Energy requirements for the proposed action would have no impact on U.S. or greater Houston area's energy requirements.

5.18 Natural or Depletable Resource Requirements and Conservation Potential for Various Alternatives and Mitigation Measures

No significant natural resource based construction, operation or maintenance materials or resources are planned to be used to implement any build alternative. Water use, erosion control materials, rock or riprap would be used during construction and maintenance activities. However, the material amounts or quantities would not be expected to adversely affect their supply or availability.

5.19 Urban Quality, Historic and Cultural Resources and the Built Environment Design Including the Reuse and Conservation Potential for Various Alternatives and Mitigation Measures

Implementing the TSP or B50-A25 is expected to enhance the urban environment's overall quality, because it would reduce flood risk to 5,100 existing structures within the pre-project 1 percent AEP floodplain. Over time, there is a potential for some of these structures to qualify as historic. No impacts are anticipated to prehistoric resources resulting from implementing the TSP or B50-A25. The potential for impacts in the middle and lower segments exist for the 1990 Authorized Plan.

5.20 Construction Best Management Practices

Stormwater management and erosion control measures would be implemented to reduce potential impacts from construction-related activities consistent with the TPDES General Permit requirements for Construction Activities. This would include preparing and implementing a SWPPP.

During the construction period, the contractor would be required to limit construction, demolition or any excavation associated with the proposed action to daylight hours to minimize potential sound level impacts. Project plans and specifications would also include an environmental clause stating the contractor should make all reasonable efforts to abate noise in the construction area.

After constructing the proposed plan, turf grasses would be planted, along with native trees and shrubs at an approximate 100 trees per acre density. This would increase the project's aesthetic qualities, replace current tree growth along the channel and maintain conditions for some wildlife.

Aquatic resources unavoidably affected by implementing the TSP or B50-A25 would be compensated by purchasing credits at GBWMB.

During any bridge-related construction activities, traffic may be re-routed to other roadways, to frontage roads or to constructed bypass lanes to minimize potential effects related to traffic congestion or delays in travel time.

Under the TSP or B50-A25, an unnamed recreation area would be impacted, but replacement facilities are planned on Hunting Bayou channel's new overbank area. Other park facilities would remain available to the local community under the TSP, B50-A25 or the No Action Alternative.

5.21 Consistency with State and Federal Regulations

This GRR/EA has been prepared to meet the requirements of all applicable environmental laws and regulations. The document has been prepared in accordance with the Council on Environmental Quality NEPA regulations (40 CFR 1500-1508) and USACE Engineer Regulation (ER) 200-2-2 (Environmental Quality: Policy and Procedures for Implementing NEPA, 33 CFR 230). USACE will follow provisions for all applicable laws, regulations and policies related to the proposed action, including those for which applicability, review and enforcement are their responsibility. The non-federal sponsor, HCFCD, may be required to secure local municipal permits as part of a Land, Easements, Rights of Way, Relocation and

Disposal Areas requirement. These permit types could include general construction permit, notification of construction in ROW, 48-hour pre-construction notice and a development permit. This sub-section briefly summarizes federal environmental laws, regulations and coordination requirements applicable to this GRR/EA.

5.21.1 Clean Air Act (CAA) (42 USC 7401 et seq)

The CAA, as amended, protects and enhances the nation's air resources. PM and other air pollutants resulting from any construction activities would have a short-term air quality impact on the immediate vicinity, but no permanent or long-term impacts to regional air quality related to implementing the TSP or B50-A25 are anticipated to occur. However, since the Houston-Galveston area is in non-attainment for O_3, proposed federal actions must show conformity before they can be implemented, thus an applicability analysis was performed to determine if a formal conformity determination would be required. As discussed in *Section 5.7*, estimated annual emissions from construction activities are expected to be below the established *de minimis* levels for the area, and less than a 10 percent increase in the emission inventories for the entire non-attainment area. Therefore, the proposed action would not be considered regionally significant for General Conformity. As a result, a formal conformity determination would not be required consistent with 40 CFR 93.153(c)(1) conditions, and the proposed action would be considered to comply with SIP for the area. Over the long-term, impacts to air quality would be generally consistent with existing conditions.

5.21.2 Clean Water Act (CWA) (33 USC 1251 et seq) and E.O. 1190 Protection of Wetlands

CWA, as amended, regulates discharges to the waters of the U.S. Compliance with applicable CWA provisions would be accomplished by coordinating with the appropriate resource agencies, submitting permit applications, if required, and responding to agency review. CWA Section 404 regulates the discharge for dredged or fill material. CWA Section 404(b)(1) Environmental Evaluation has been performed for the TSP and B50-A25, and is included in *Appendix 1*, Attachment E. The 404(b)(1) evaluation for the 1990 Authorized Plan is in the 1988 Report. Any non-point pollution sources associated with the TSP or B50-A25 action would comply with TPDES permit requirements. A mitigation plan has also been prepared, and is presented in *Appendix 1,* Attachment D to help meet CWA Section 404 goals. CWA Section 401 gives states the authority to grant, deny or condition certification for federal permits or licenses (e.g., CWA Section 404 permits) which may result in a discharge to waters of the U.S. Based on the Memorandum of Agreement (MOA) between TCEQ and USACE which established procedures for streamlining TCEQ's CWA Section 401 review process, a TCEQ Tier II Questionnaire and Alternatives Analysis Checklist was completed and is presented in *Appendix 1,* Attachment C to meet CWA Section 401 permit requirements.

E.O. 11990 Protection of Wetlands directs agencies to take actions to minimize wetlands destruction, loss or degradation, and to preserve and enhance the natural and beneficial values of wetlands on federal property. As indicated above, a CWA Section 404(b)(1) Environmental Evaluation and a proposed wetland mitigation plan have also been prepared for the project, and are included in *Appendix 1*, Attachment D.

5.21.3 Rivers and Harbors Act of 1899 (33 USC 401 et seq)

Section 10 in the Rivers and Harbors Act prohibits unauthorized obstruction or alteration for any navigable water of the U.S. The TSP and B50-A25 do not include improvements within navigable waters.

5.21.4 Fish and Wildlife Coordination Act (FWCAR) (16 USC 661 et seq.) and Endangered Species Act (ESA) (16 USC 1531, et seq.)

FWCAR directs federal agencies to consult with USFWS, NMFS and state agencies before authorizing alterations to water bodies. This Act's purpose is to ensure wildlife conservation receives equal consideration. The non-federal sponsor, HCFCD, coordinated with USFWS to prepare the required FWCAR (included in *Appendix 1*, Attachment C), and coordinated the responses to that report with USFWS and TPWD (see correspondence contained in *Appendix 1*, Attachment C). These agencies will also be provided the opportunity to comment and submit recommendations on this draft GRR/EA. These agencies' views will be fully considered when preparing the final GRR/EA. A final FWCAR and Planning Aid Letter were received during 2007-2008 and were fully considered in preparing this GRR/EA. The FWCAR was updated in 2013 and the non-federal sponsor, HCFCD, received concurrence from USFWS on the update. The 1990 Authorized Plan was coordinated with USFWS, NMFS and state agencies in the 1988 time period.

USFWS has determined no threatened or endangered species under its jurisdiction are likely to occur within the project area as defined in this GRR/EA. No threatened or endangered aquatic organisms included in a list of aquatic species provided by the NMFS are likely to be found in areas proposed for construction or would be indirectly affected by construction.

5.21.5 E.O. 13186 Responsibilities of Federal Agencies to Protect Migratory Birds and the Migratory Bird Treaty Act (MBTA)

5.21.5.1 Migratory Bird Treaty Act (MBTA) of 1918

This law basically covers most bird species. Because all build alternatives will impact varying amounts of avifaunal habitat, construction activities should include pre-construction surveys of affected habitat to avoid adverse effects to active rookeries or areas where bird species are concentrated during migrations. Coordinating with USFWS may be prudent in developing habitat surveys and identifying those periods during the year where construction is least likely to affect bird species. Some circumstances may require permits from the Department of Interior prior to construction. Among other activities, an unauthorized take of migratory birds is prohibited in the same way an unauthorized take or impact (defined according to specific actions and behaviors) is prohibited for threatened or endangered species. E.O 13186 requires federal activities to consider the potential effects from their actions on migratory birds including, but not limited to cranes, ducks, geese, shorebirds, hawks and songbirds. The TSP and B50-A25's effects on migratory birds have been assessed in this GRR/EA, and no adverse impacts in the study area are expected to these species or their habitat. Construction contracts will include instructions to avoid impacts from construction-related activity to migratory birds and their nests. Note: the Migratory Bird Conservation Act (16 USC 715-715d, 715e, 715f-715r; 45 Atat. 1222) establishes a Migratory Bird Conservation Commission to approve land or water areas for acquisition as reservations for migratory birds, and is not applicable to the TSP or B50-A25.

5.21.5.2 Bald and Golden Eagles Protection Act

The potential for eagle habitat has been assessed. The greatest potential for these species to occur (primarily the bald eagle) is in the middle and lower bayou segments (Herman Brown Park and in areas south of Market Street toward Buffalo Bayou). Construction contracts for any build alternative will include provisions for preconstruction surveys for these species and their nesting areas.

5.21.6 Magnuson Stevens Fishery Conservation and Management Act

Congress enacted amendments to this Act in 1996, which established procedures for identifying EFH and required interagency coordination to further conservation for federally managed fisheries. Provisions in the regulations implementing the Act require consultation for any proposed action which could adversely affect EFH. No effects to estuarine or marine resources or their supporting habitats would occur as a result of the TSP or B50 A25. The 1990 Authorized Plan has the potential to affect estuarine species in the lower bayou segment.

5.21.7 Coastal Zone Management

The Coastal Zone Management Act of 1972, as amended, provides for the effective management, beneficial use, protection and development for resources in the nation's coastal zone. The Coastal Zone Management Act directs federal agencies proposing activities or development projects, within or outside the coastal zone, which could affect any land or water use or natural resource of the coastal zone, to assure those activities or projects are consistent, to the maximum extent practicable, with the approved state programs.

The coastal zone's northernmost boundary within Harris County is IH 10 East. The portions of Hunting Bayou which would be directly and indirectly affected by the proposed construction are north of IH 10 East, outside the coastal zone. Portions of the 1990 Authorized Plan are in the coastal zone, and would have to be reviewed consistent with the Texas Coastal Zone Management Plan.

5.21.8 Section 106 in the National Historic Preservation Act (NHPA) (16 USC 470(f))

NHPA directs federal agencies, prior to approving the federal funds expenditure or prior to issuing any license, as the case may be, to take into account the effect of the undertaking on any district, site, building, structure or object included in or eligible for inclusion in NRHP. As discussed in *Section 2.9* and *Section 5.12*, the archeological survey and cultural resources assessment performed along Hunting Bayou indicated most of the TSP and B50-A25 area has little potential for significant prehistoric or historic material due to previous disturbance, distance from water or clay soils. The THC coordination concerning the M.W. Sinai Grande Lodge A.F and A.M. building (*Section 5.12*) has concluded there would be no impact to this structure, and the TSP and B50-A25 features in the neighboring vicinity would not affect the building's eligibility to the NRHP. The Commission has issued a 'no effect' determination concerning potential impacts to the structure from the TSP or B50-A65. Other surveys for proposed residential and business acquisitions and bridge structures to be removed also concluded no properties, sites or structures potentially eligible to the NRHP would be affected by the TSP and B50-A25. The 1990 Authorized Plan would have to be evaluated for prehistoric resources potentially located in the middle and lower segments.

5.21.9 Federal Aviation Administration (FAA) – Hazardous Wildlife Attractants On or Near Airports

USACE signed a MOA with the FAA (FAA, 2003) to adopt coordination procedures to ensure USACE project features such as wetland mitigation or ecosystem restoration habitat which may attract wildlife that poses aircraft-flight strike hazards, minimize such risks. The TSP and B50-A25 will likely have wetland mitigation features within the project ROW. The MOA references siting criteria contained in FAA Advisory Circular 150/5200-33 to help screen and identify projects which may require more consideration and coordination with the FAA due to the flight safety hazard aquatic sites may pose. The recommended separation distance between the airport and the attractant (mitigation feature, etc.) varies between 5,000 feet and 6 miles depending on the type of aircraft served and attractant, and typically applies to the edge of the airport's air operations area. The FAA provides an on-line self-screening tool to determine if projects warrant further review by the FAA with the siting criteria, using a 7-mile threshold screening distance. The airport listing and coordinate data obtained from this application was used in conjunction with TSP and B50-A25 geospatial data to find if any airports were located within 7 miles of the project ROW. No airports were located within the 7-mile search radius. Therefore, no further coordination or review of any build alternative is warranted to comply with the FAA MOA.

5.21.10 Harris Galveston Subsidence District Regulatory Plan

The Harris Galveston Subsidence District regulates groundwater withdrawal in their area of jurisdiction, which includes the study area and areas encompassing Harris and Galveston counties. Implementing any build alternative would not affect groundwater use in the study area.

5.21.11 E.O. 11988 Floodplain Management

EO 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall 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 flood plains in carrying out its responsibilities." This section provides the information that decision documents recommending flood and coastal storm risk management actions should display to demonstrate compliance with EO 11988 and to adequately evaluate public safety.

The Water Resources Council Floodplain Management Guidelines for implementing EO 11988 require an 8-step process for agency decision-making on projects that have potential impacts to or within the floodplain. The 8 steps reflect the decision-making process required in EO Section 2(a). The information required for compliance with EO 11988 is summarized below.

Step 1. Describe the existing floodplain management activities; including NFIP related actions and requirements.

Section 3.5 describes the future WOP condition within the Hunting Bayou watershed. The WOP condition assumes no action by the federal government to implement the project; however, this assumption does not imply local government entities would not implement actions of their own during the period of analysis to reduce flood risk. Basic assumptions regarding the most-likely

future WOP condition stem from expecting existing policies, procedures and programs to continue over time.

Section 3.5.1 describes ongoing local practices, policies and programs that manage local flood risk. As part of their agency's mission, the non-federal sponsor, HCFCD, has adopted policies and practices stipulating that new residential, commercial, industrial or other land development must include measures to assure no adverse impact to the surrounding area's WSELs. Due to these requirements, developers must either retain increased runoff associated with changes in land use on-site or purchase storage volume in regional detention facilities which retain runoff to equal or match pre-development levels. Other policies and programs which support or reinforce floodplain management activities are discussed in *Section 3.5.1* and include the following.

- The non-federal sponsor, HCFCD, participates in and supports FEMA-granted relocations to evacuate or retreat from flood prone areas where structural measures are uneconomical or not practical. The non-federal sponsor, HCFCD, also maintains a voluntary buyout program which emulates FEMA guidelines. Local communities also participate in flood hazard mitigation through FEMA grants.

- Harris County and the cities of Houston, Galena Park and Jacinto City joined NFIP in the 1970s, and comply with floodplain regulations to elevate new construction at or above the BFE.

- COH policy requires new construction and substantial reconstruction with first-floor elevations within the 1 percent floodplain to be built at a minimum of 12 inches above the BFE.

- Harris County and COH participate in NFIP's community rating system, which is a voluntary program for NFIP participating communities. COH is the largest city in the nation to achieve a Class 5 rating.

- Harris County maintains a real time flood warning system which covers the entire county by monitoring approximately 133 stream gauges strategically placed along Harris County bayous and their tributaries. The information collected and processed by the flood warning system is used by local, state and national agencies to help issue flood watches and warnings. Diverse warning outlets communicating the same or similar messages repetitively to the population increase the probability warnings would be noticed and heeded.

- As part of the Project Partnership Agreement (PPA) execution for the Hunting Bayou federal project, the non-federal sponsor, HCFCD, will develop a Floodplain Management Plan within one year of signing the PPA.

Step 2. Determine if the proposed action would be in the base floodplain. If the proposed action is in the base floodplain, identify and evaluate practicable alternatives to locating the action in the base floodplain.

The characteristics and performance of the TSP are discussed in *Section 4* and *Section 8*. The proposed TSP consists of 3.8 miles of channel modification for Hunting Bayou's upper stream segment from the vicinity of US 59 to 0.3 miles downstream from ERRY. The channel modification consists of a 60-ft-wide channel bottom with trapezoidal grass-lined 4:1 side slopes. An offline detention basin, in the vicinity of Homestead Road, will be excavated to depths of 22

ft and encompass 75 acres. Bridge modifications and replacing 17 bridges will be required and consist of 10 roadway bridges, 3 railroad bridges and 4 pedestrian bridges, as needed for security or public safety.

The proposed project is in the base floodplain. *Section 3* presents the plan formulation process. There are no practicable alternatives to project location within the base floodplain, because the Hunting Bayou federal study is an FRM study with a study objective of reducing flood risk due to riverine flooding to a socially vulnerable population along Hunting Bayou. Therefore, all practicable alternatives, which included 2 nonstructural alternatives, reevaluating the Authorized Plan and the economically optimized alternative, are located in the base floodplain. All FRM actions impact the floodplain by reducing its extent and by reducing damages resulting from flood events. All impacts associated with the recommended plan for implementation, the TSP, will occur within the Hunting Bayou floodplain.

Step 3. If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.

Public involvement activities are described in *Section 7*. This study follows the public review process in compliance with NEPA. The NEPA compliance level of analysis is an environmental assessment whose anticipated finding of no significant impact will be made available to the public. Potentially affected populations along the bayou have been communicated with about flood risk management options over the course of the study period as documented in *Section 7*.

Step 4. State whether the proposed action would induce development in the base floodplain.

Section 4 discusses the impacts from the proposed TSP on the surrounding area. Due to local policies, practices and programs for FRM within Harris County and the cities of Houston, Jacinto City and Galena Park, no induced development is expected to occur in the base floodplain from project implementation. All new construction and substantial reconstruction are required to be built 12 inches above the BFE in compliance with local ordinances within COH's jurisdiction and to at least the BFE within the remaining area.

Step 5. Identify the impacts in the base floodplain of the proposed action and any induced development.

Section 8 discusses the impacts from the proposed TSP. The proposed TSP will reduce the base floodplain size from 5,600 acres to 2,250 acres. About 4,465 structures would have reduced risk from the 1 percent AEP floodplain with 645 structures remaining in the residual 1 percent AEP floodplain. Over 10,000 persons are expected to experience reduced risk from a 1 percent event by implementing the TSP. Damages from a 1 percent AEP event are expected to be reduced by 73 percent, from $160 million to $44 million. *Table 5-5* presents the impacts from the TSP, the NED Plan and the 1990 Authorized Plan under current conditions. No induced damages are expected by implementing the TSP at the 1 percent AEP. No induced development within the base floodplain is expected to occur with project implementation.

Table 5-5:
Project Performance for NED Plan Scales B50-A25 (TSP) and B60-A75 (NED Plan) and the 1990 Authorized Plan
3.5 Percent Interest Rate, 2(Q)13 Price Levels, 2013 Conditions

Performance Variables	No Action	NED Plan Scales		1990 Authorized Design
	WOP	TSP B60-A75	NED B50-A25	
Structures with Reduced Risk over No Action				
from 0.2 percent flood event	0	4,287	3,331	7,062
from 1 percent flood event	0	4,465	4,021	5,093
Residential Structures with Reduced Risk over No Action				
from 0.2 percent flood event	0	3,971	3,110	6,376
from 1 percent flood event	0	4,061	3,672	4,597
Population with Reduced Risk over No Action				
from 0.2 percent flood event	0	10,047	7,868	16,131
from 1 percent flood event	0	10,274	9,290	11,630
Single Occurrence Damages (in $1,000s)				
from 0.2 percent flood event	$270,851	$132,790	$168,251	$13,104
from 1 percent flood event	$160,493	$43,775	$53,069	$828
AAEV Benefits in $1,000s	N/A	$15,364	$13,953	$19,733
AAEV Net Excess Benefits[^1] in $1,000s	N/A	$7,373	$6,863	$3,008

[^1] *under current conditions*

Step 6. Describe measures available to minimize adverse impacts on natural and beneficial floodplain values

The proposed TSP has no significant adverse impact to the natural and beneficial flood plain values. The flood plain is highly urbanized with disturbed and mowed channels. No wetlands are in the area where floodplain is reduced. Implementing FRM measures in the upper bayou segment would avoid the need to impact the middle and lower segments which have riparian forests and adjacent upland habitat. The upper segment plan scales effectively avoid impact to floodplain resources in these other bayou segments.

Step 7. Describe the effect of the above topics on any reevaluation of alternatives and on the final plan selection.

The nonfederal sponsor, HCFCD, prefers to implement B60-A75, the TSP, because it reasonably maximizes net excess benefits without inducing damages downstream at the 1 percent AEP event and meets EO 11988 requirements as demonstrated. B60-A75 also best meets the study objectives by reducing flood damages within the watershed to a greater extent than the identified NED Plan, B50-A25, while also minimizing to the greatest extent practicable adverse impacts to the surrounding neighborhoods and natural environment. B60-A75 has been named the TSP due to its FRM and economic performance which avoid large-scale population displacement and disrupting the natural environment.

Step 8. Findings and Explanation

The TSP complies with EO 11988. With present local drainage conditions in the watershed, the TSP would provide flood risk reduction from a flood ranging between 2 and 4 percent AEP frequency in the upper stream segment.

Public engagement activity has been an essential part of the federal planning process and is discussed in detail in *Section 7.0*. The general public favors FRM activities within the Hunting Bayou watershed which respect their cultural values and community cohesion.

5.21.11.1 Critical Action Floodplain

The critical action floodplain is the area subject to inundation from a 0.2 percent AEP flood event. As of 2013, an estimated 7,329 structures (6,616 residences) are within in the Hunting Bayou 0.2 percent AEP (500-year) floodplain. The existing flood risk in the Hunting Bayou watershed directly impacts the life, health and safety of people who live and work in the homes, businesses and schools in the Hunting Bayou 0.2 percent AEP floodplain. Many in this community of elderly and economically disadvantaged are particularly vulnerable during and after a flood event. Because it is often difficult to see the channels and roadside ditches during a flood, a dangerous condition exists for pedestrians and motorists in the area. While most floods are an inconvenience to most people, the population in the project area is more likely to lack the ability and resources to easily, quickly or completely rebound after a flood event.

In addition to the local community, the existing flood risk can also impact the life, health and safety of many of the 4.1 million people who live in Harris County. Infrastructure within the 0.2 percent floodplain includes LBJ General Hospital, the state's busiest Level III trauma center, which serves patients and their families living in and beyond the Hunting Bayou watershed. Two major railroad yards are within the Hunting Bayou project area, and many businesses depend on these and community support facilities to transport goods to regional and interstate destinations. Other infrastructures include public schools, churches, day care facilities, pharmacies and grocery stores. Regionally significant infrastructure such as electrical transmission and oil and gas product pipelines also traverse the Hunting Bayou project area and broader watershed.

Access to freeways, major transportation routes and connections to hurricane evacuation corridors such as IH 610, US 59 and IH 10, and emergency response for medical transportation, police and fire officials have been and likely will be significantly hindered during a major flood event. When sections of these facilities in the Hunting Bayou watershed are affected by flooding, the inter-regional transportation system is compromised. When intense rainfall accompanying Gulf storms floods freeways used for hurricane evacuation, consequences can be significant as coastal residents evacuate low lying areas for higher ground. Freeways slowed or stopped by flooding can strand evacuees and subject them to greater risks posed by an advancing tropical flood event.

Table 5-5 summarizes impacts from the TSP to residents and assets within the 0.2 percent AEP floodplain. The TSP would reduce the 0.2 percent floodplain from 6,650 acres to 4,500 acres. Approximately 10,000 persons and about 4,300 structures would experience reduced risk from the occurrence of a 0.2 percent AEP event by implementing the TSP.

5.21.12 Documenting Additional Public Safety Considerations

5.21.12.1 Vulnerabilities

Section 4.11.7.2 discusses the population in the residual floodplain of the TSP. The population impacted by a 0.2 percent AEP flood is expected to be reduced by 60 percent by implementing the TSP. The TSP residual 0.2 percent AEP floodplain is projected to contain, 6,700 persons living in 2,600 residences. The population living within the TSP's residual floodplain remains at risk for flooding and shares the same social and economic characteristics that indicate high vulnerability to hazards. The residual population is 95 percent minority and, like the population within the "most likely" future WOP 0.2 percent AEP floodplain, the residual population contains proportionately more younger and older persons than Harris County in general. Also over 30 percent of the population within the residual floodplain lives below the poverty level, a characteristic shared with the 0.2 percent WOP floodplain population.

5.21.12.2 Residual Risk

Section 4.11.8 discusses residual flooding and residual risk with implementation of the TSP. With present local drainage conditions in the watershed, the TSP would provide flood risk reduction from a flood ranging between 2 and 4 percent AEP frequency in the upper stream segment.

With the TSP, residual flooding would be expected when flood water rises above the bayou banks during more severe events. Residual flooding could also be expected to continue to occur as a result of high tailwater conditions where the storm sewer system is surcharged and cannot convey or freely outfall the runoff collected from the drainage area. Flood water is contained within the bayou banks for higher frequency events for most of the study area reach. When flood water overflows the channel banks, the flow is expected to spread to the overbank areas. Since the overbank areas are relatively flat, the flooding depth would not be expected to be significant due to the spread of the flood water over a larger area. Since the rise rate and flow velocity are related to the flow area, the rise and the velocity are expected to be very low.

In isolated areas, such as depressions and roadway underpasses, the flooding depth could be significant and may create access problems for vehicular traffic. The potential for loss of life in some of these isolated areas where deep water ponding could occur would be expected from drivers attempting to or accidentally passing through these areas during the more severe events that cause residual flooding. These areas would be expected to be limited mainly to more abrupt roadway or underpass grade changes adjacent to the bayou, such as along Homestead Road just north of the bayou.

By implementing the TSP, LBJ Hospital will have reduced risk from the 0.2 percent AEP flood event.

5.21.12.3 Managing Residual Risk

Implementing the TSP is intended to manage flood water risks, not control or avoid them. The TSP does not have unlimited operational capacity to control extreme floods. For instance, the offline detention basin has a limited capacity to accept diverted water from the main channel. When the basin's maximum capacity has been reached, any additional channel flow is not attenuated.

Human life is rarely lost in the study area due to flooding; therefore, the Hunting Bayou watershed is considered to have a low loss-of-life risk level due to flooding.

Typical loss-of-life due to flooding incidences occurs when motorists choose to ignore warning signs or messages and drive into high flood water conditions, or due to vehicular accidents occurring at or near ditches. Because it is often difficult to see the channels and roadside ditches during a flood, a dangerous condition exists for pedestrians and motorists in the area.

As noted previously, the HCFCD maintains an active FRM policy that contributes to a long-term strategy of residual risk reduction for the Hunting Bayou watershed. Local communities also actively participate in FRM through their own initiatives and in conjunction with the NFIP.

5.21.13 Farmland Protection Policy Act of 1981 and Council on Environmental Quality Memorandum Concerning Prime and Unique Farmlands

The purpose for the Farmland Protection Policy Act and the Memorandum is to minimize the extent to which federal programs contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. No prime or unique farmlands are located in any bayou segment project area.

5.21.14 E.O. 12898 Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations and E.O. 13045 Protection of Children from Environmental Health Risks and Safety Risks.

These EOs mandate federal agencies identify disproportionately high and adverse human health or environmental effects on minority and low-income populations and children. Conducted as part of the NEPA process, publishing the Notice of Intent for the project, the public scoping meeting and publishing the notice announcing the availability of this GRR/EA help to ensure the public, including minority and low-income communities, has access to public information relating to human health or environmental planning, regulation and enforcement. Also as described in *Section 5.9.5* and *Section 5.9.6*, long-term systematic public outreach efforts have been maintained by the non-federal sponsor, HCFCD, since early planning. In the long-term, the entire community including minority and low-income populations would benefit from implementing any build alternative. While individual minority and low-income persons may be affected by implementing these alternatives, it cannot be shown any build alternative would cause disproportionate adverse impacts to minority or low-income populations.

No Action Alternative

No disproportionate adverse impacts to minority or low-income populations would occur due to implementing the No Action Alternative.

5.21.15 E.O. 13113 Invasive Species and USACE Policy

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

In accordance with this E.O., 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 re-

vegetate disturbed areas, and soil disturbance would be minimized, to the extent practical, to ensure invasive species do not further propagate in the study area.

Recent USACE policy in the CECW-ZA memorandum titled "U.S. Army Corps of Engineers Invasive Species Policy," dated June 2, 2009, requires civil works planning studies to address invasive species in analyzing project impacts, and to collaborate with federal, state and local agencies in developing the analysis. As discussed in *Section 2.8.4* and *Section 5.13.1*, many invasive and non-native plant and animal species have already established themselves in the study area through human introduction such as urban landscaping or through volunteer growth or recruitment from non-native species introduced into the general Houston area. Non-native grasses are already established within the channel's project reach as part of the adjacent residential, recreational and prior channel erosion control landscaping. Therefore, any replanted erosion control grasses would not be expected to expand into any undisturbed natural areas.

The vegetation in the undeveloped offline detention basin tract already includes non-native and invasive trees, shrubs and vines, in addition to the native woody vegetation and limited native grasses. Constructing the offline basin will remove this vegetation and replace it with limited native tree plantings and grass species appropriate for the basin's eventual recreational. This may include non-native turf grasses already widely used in the area, depending on the ultimate recreational use. The offline detention basin will occupy approximately half of a currently undeveloped tract which is isolated on all sides by urban development. The other half of the tract will eventually contain intermodal transport facilities built by UPRR to expand existing facilities located east of the tract. UPRR may leave some remnant woody vegetation in place. However, expanding any grasses from the basin into the remnant vegetation would be limited by the heavy shading provided by the woody vegetation canopy, and in any case would be limited to the tract boundaries. Therefore, no expansion of turf grasses into undisturbed natural areas would be expected to occur.

With respect to other impacts the TSP or B50-A25 may have on aquatic invasive animal species, Hunting Bayou is a tributary of Buffalo Bayou, a stream which has already been impacted by the aquatic invasive species discussed in *Section 2.8.4*. The TSP and B50-A25 will not involve creating any new hydraulic connection to another water body. Therefore, the TSP and B50-A25 will not introduce nor propagate any non-native or invasive aquatic animal species to any new water body. The TSP and B50-A25 will involve widening and deepening the channel bottom, which would remove the current fringe wetland vegetation at the perennial channel margin. This vegetation includes dominant native and non-native species discussed in *Section 2.8.4*. This vegetation developed due to natural recruitment following previous modification to the current grass-lined channel. Therefore, this vegetation would be expected to return along the perennial channel margin after implementing the TSP or B50-A25, and would be anticipated to be composed of native and non-native species. Monitoring and mitigation in case substantial natural recruitment does not occur is discussed in *Section 5.6.2.1*, and will involve replanting with native emergent species only.

Implementing the TSP or B50-A25 will result in open vegetation areas which may be susceptible to colonization by invasive species if not maintained. However, all open grassy areas will be maintained and mowed per current non-federal sponsor, HCFCD, maintenance procedures. All tree and shrub plantings will likewise be maintained for a period following initial planting to ensure invasive plants do not overtake the plantings until they have become established. In

general, the proposed project will not result in propagating non-native or invasive species into new areas not already impacted by them.

Similar measures to provide counter measures for invasive species would be implemented for the 1990 Authorized Plan.

5.21.16 E.O. 13166 Limited English Proficiency (LEP)

E.O. 13166 requires federal agencies to implement a system by which LEP persons can meaningfully access the (federal) agency's services and make such persons aware of any financial services provided by the agency they may access. Planning for the Hunting Bayou project included efforts to communicate widespread, non-discriminatory, timely and vital information relating to project proposals and outreach initiatives which informed affected persons about relocation programs through which land owners would be fairly compensated. Public involvement activities as described in *Section 7.1* and information contained included efforts to make project plans and related information easily accessible to LEP persons. Foreign language translators (English to Spanish) and sign language translators were made available at public meetings. Printed publications included Spanish to English translations. In most cases, contact persons were available to assist the public in accessing and understanding information presented at project plan meetings.

Vulnerable populations typically lack the personal or economic resources to cope with or effectively respond to a flood threat, and therefore are at a higher risk to suffer adverse consequences from a flood event. As the LEP community is generally subsumed into the broader minority community, which comprises 95 percent of the watershed population, and is not specifically concentrated in one location, FRM benefits provided to LEP population generally mirrors the FRM benefits provided to the remainder of the watershed population. Benefits are expected to include less frequent flooding and lower water surface elevations, which will reduce the health, economic, and social consequences of flood events on vulnerable communities. Anticipated adverse impacts to LEP populations are primarily limited to population displacement. However, population displacement for LEP populations is expected to be consistent with, or proportionate to, that of the general population displaced by the project.

5.22 Mitigating Ecological Resources

Appendix 1, Attachment D contains the detailed Mitigation Plan and Cost Effectiveness/Incremental Cost Analysis (CE/ICA) which implemented the mitigation planning steps outlined in ER 1105-2100 Planning Guidance Notebook (PGN). The planning and steps are summarized as follows.

5.22.1 Inventory and Categorize Ecological Resources

Ecological resources were inventoried and summarized in *Section 2*. The TSP and B50-A25 impacts: 1) aquatic resources including palustrine forested, emergent and scrub-shrub wetlands and fringe wetlands, and Hunting Bayou; and 2) upland habitats including mixed hardwood forest, scrub-shrub and remnant prairie. Any build alternative's impacts to Hunting Bayou are temporary, as the same grass-lined stream channel structure with the same perennial channel will be constructed. Therefore, the same perennial in-stream habitat would be available for aquatic fauna. Similarly, fringe wetlands are a consequence of volunteer growth on the margins of the perennial channel, and would be expected to return following construction as explained

previously. The upland mixed hardwoods and upland scrub-shrub are secondary growth with substantial numbers of invasive species; are typical of commonplace volunteer succession in this area; and do not represent unique vegetation assemblages; therefore, they would not be considered significant. The Palustrine wetlands are included in the mitigation alternatives.

5.22.2 Determine Significant Net Losses

USACE policy in Civil Works-Planning and Policy Division (CECW-P) Memorandum "Policy Guidance on Certification of Ecosystem Output Models," dated August 2008 requires certified models to be used in determining mitigation outputs to offset ecological resource losses, and lists certified models available. USFWS HSI models were the most appropriate for the palustrine wetlands, as Regional Guidebooks for the Hydrogeomorphic Approach applicable to this region have not been developed. Four species were selected in consultation with resource agencies based on their applicability to the cover type of the wetlands and the applicability to the Texas Gulf Coast region as described in the USFWS model documentation. Applicability considers whether the species is endemic to this region. The species were barred owl (*Strix varia*), mink (*Mustela vison*), swamp rabbit (*Sylvilagus aquaticus*), and snapping turtle (*Chelydra serpentina*). The models were composited for each cover type as follows, considering the applicability and habitat suitability described in the model literature.

- Palustrine Forested Wetland model – A composite HSI consisting of the barred owl and mink
- Palustrine Emergent Wetland model – A composite HSI consisting of the swamp rabbit and mink
- Palustrine Scrub-Shrub Wetland model – A composite HSI consisting of the snapping turtle and mink

These models were applied according to the USFWS Ecological Service Manual 102 for implementing the HEP to determine significant net losses in terms of AAHU for each cover type (or resource category). Changes in the model parameters were determined using assumptions based in literature described in *Appendix 1*, Attachment D to determine how the HSI would change over time. The timeframe for analysis to determine net impacts was chosen in accordance with USFWS ESM 102 to be from the 2009 baseline conditions of the collected data to 2072, the end of the TSP or B50-A25 period of analysis. In compliance with PGN, the beneficial effects without TSP or B50-A25 mitigation to these wetland types were considered. However, because the basin bottom would be graded to drain dry and receive regular mowing, wetlands would not be expected to develop in the basin bottom in the absence of mitigation features being constructed. Net impacts were determined by the difference in WOP AAHUs and With Project, No Mitigation AAHUs as summarized in *Table 5-6* (see next page).

Scrub-shrub wetlands resulted in a zero score, because the mink and snapping turtle models require continuous standing water for at least 3 months for the model to score more than zero, and the only scrub-shrub wetland impacted by the project did not meet that condition.

Table 5-6:
Summary for Net Impact on AAHUs by the TSP

Patch ID	Cover Type	Acres	AAHUs		
			WOP from HSI	With Project from HSI	Net Project Impact from HSI
Project Only	Emergent Wetland	**1.672**	**0.546**	**0.055**	**-0.491**
	Forested Wetland	1.682	0.729	0.030	-0.699
	Scrub-Shrub Wetland	0.318	0.000	0.000	0.000
	Forested + Scrub-Shrub Wetland	**2.001**	**0.729**	**0.030**	**-0.699**
Disposal	Emergent Wetland	**0.700**	**0.081**	**0.002**	**-0.079**
	Forested Wetland	0.000	0.000	0.000	0.000
	Scrub-Shrub Wetland	0.000	0.000	0.000	0.000
	Forested + Scrub-Shrub Wetland	**0.000**	**0.000**	0.000	0.000
Project Disposal Total	Emergent Wetland	**2.372**	**0.627**	**0.056**	**-0.570**
	Forested Wetland	1.682	0.729	0.030	-0.699
	Scrub-Shrub Wetland	0.318	0.000	0.000	0.000
	Forested + Scrub-Shrub Wetland	**2.001**	**0.729**	0.030	-0.699

5.22.3 Define Mitigation Planning Objectives

The primary mitigation planning objectives were to replace the 0.570 AAHU of emergent wetland and 0.699 AAHU of forested wetland losses which would occur from constructing the TSP or B50-A25. Other objectives are to avoid impacts to two wetlands bordering Disposal Sites 5a and 6 by configuring soil placement around them.

5.22.4 Determine Unit of Measurement

The unit of measurement is driven by using the HSI models and is the AAHU.

5.22.5 Identify and Assess Potential Mitigation Strategies

Because the upper watershed is highly urbanized, lands suitable for mitigation measures are practically limited to those being acquired for the TSP or B50-A25. Other private lands are already developed and would require residential and commercial acquisitions counter to the study objective to minimize impacts to the community. Suitable land in the middle watershed is limited to Herman Brown Park, which is already in conservation. Undeveloped lands in the lower watershed are either Port of Houston land dedicated to future uses (e.g., dredge disposal) or already targeted for conservation, or COH East Water Purification Plant reserve land. Therefore, the mitigation measures considered were creating onsite wetlands within the TSP or B50-A25 and purchasing credits from GBWMB. Hunting Bayou is within the USGS Hydrologic Unit Code hydrologic division of the GBWMB, and is therefore the applicable bank.

5.22.6 Define and Estimate Costs for Mitigation Plan Increments

Measures were conceived to provide emergent wetland or forested wetland mitigation. The mitigation measures were sized to at least offset the project impacts from 0.570 AAHU of

emergent wetland or 0.699 AAHU of forested wetland. Onsite creation was conceived for the two suitable locations available to site mitigation features, the offline detention basin and a small existing excavated feature owned by the non-federal sponsor, HCFCD, at the confluence of Tributary H110-00-00 and Hunting Bayou. Measures for mitigation banking would be purchasing available credits from Subdivision B of the GBWMB.

The HSI models were used to analyze the mitigation measure outputs including at GBWMB, and size the measures according to the two following size increments: 1) offsetting the project impacts 0.570 AAHU of emergent wetland or 0.699 AAHU of forested wetland and 2) offsetting the acres of wetland impacts. The analysis of measures indicated the not enough acreage was available at the H110 site to offset forested wetland impacts, and therefore, was combined with forested wetland creation at the offline detention basin. The offline detention basin is large enough to provide sufficient acreage for all increments. The resultant measures were combined to form the following alternatives.

- Alternative 1 – H110-00-00/Hunting Bayou Confluence and Offline Forested Wetland Creation plus Offline Emergent Wetland Creation, equal to 1.269 AAHUs
- Alternative 2 – Offline Forested Wetland Creation plus Offline Emergent Wetland Creation, equal to 1.269 AAHUs
- Alternative 3 – GBWMB Subdivision B Forested and Emergent Wetland Credits, equal to 1.269 AAHUs
- Alternative 4 – 2.00 acres total of H110-00-00/Hunting Bayou Confluence and Offline Forested Wetland Creation plus 2.37 acres of Offline Emergent Wetland Creation, equal to 2.63 AAHUs
- Alternative 5 – 2.00 Acres of Offline Forested Wetland Creation, plus 2.37 Acres of Offline Emergent Wetland Creation, equal to 2.77 AAHUs
- Alternative 6 – 2.00 Acres of Forested and 2.37 Acres of Emergent Wetland Credits in GBWMB Subdivision B Forested equal to 1.95 AAHUs

Alternative 6 did not fully offset forested wetland impacts and was eliminated from the analysis. Costs for the remaining alternatives were estimated based on non-federal sponsor's, HCFCD, wetland construction costs, and included long-term monitoring for success criteria. The costs are fully described in the Mitigation Plan and CE/ICA.

5.22.7 Display Incremental Costs

The USACE Institute for Water Resources (IWR) Planning Suite software, Version 1.0.11.0 was used to conduct the CE/ICA. The results and graphical outputs are discussed and provided in the Mitigation Plan and CE/ICA. *Table 5-7* summarizes the results displaying the cost per output.

Table 5-7:
Average Cost per AAHU for All Alternatives

Name	Description	Output (AAHU)	Total Cost ($)	Average Cost/AAHU
No Action Alternative		0.00		
Alternative 1	Onsite creation at H110 and offline detention to offset TSP AAHU impacts	1.27	$128,840	$101,609
Alternative 2	Onsite creation at offline detention to offset TSP AAHU impacts	1.27	$126,425	$99,626
Alternative 3	GBWMB credits to offset TSP AAHU impacts	1.27	$103,131	$81,270
Alternative 4	Onsite creation at H110 and offline detention to provide same wetland acreage impacted by the TSP	2.63	$210,092	$79,853
Alternative 5	Onsite creation at offline detention to provide same wetland acreage impacted by the TSP	2.77	$209,803	$75,796

The most cost-effective and least cost mitigation plan was at the increment which compensates up to the AAHUs impacted by the TSP (by extension B50-A25), Alternative 3. At the increment which provides the same wetland acreage as impacted by the TSP (by extension B50-A25), Alternative 5 was the most cost-effective, and was initially identified as the best buy. The PGN states at Paragraph C-3, e.(4), "mitigation planning shall address a range of alternatives up to the full compensation of significant ecological resource losses." This indicates mitigation output increments exceeding the project impacts need not be analyzed or carried forward. Therefore, Alternatives 4 and 5, which provide output exceeding the project impacts were eliminated. Alternative 3 becomes the best buy among the remaining alternatives, as it has the lowest cost per output. Also, the USACE CECW-P guidance memorandum, "Implementation Guidance for the WRDA 2007- Section 2036(c) Wetlands Mitigation," dated November 6, 2008, requires mitigation planning for federal civil works studies to consider using mitigation bank credits first. Since Alternative 3 provides compensation up to the full compensation of significant ecological resources losses, meets the mitigation planning objective, and considers using available mitigation banks, it is selected as the justified mitigation plan for the TSP (by extension B50-A25) impacts.

The mitigation plan for Alternative 3 consists of purchasing forested wetland credits equal to the 0.699 AAHU of forested wetland impacts, and emergent wetland credits equal to the 0.570 AAHU of emergent wetland for a total of 1.27 AAHUs. The required credits would be purchased prior to project impacts on wetlands. The elements for a mitigation plan required in the 31 August 2009 CECW-P policy memorandum on "Implementation Guidance for Section 2036 (a) of WRDA 2007 – Mitigation for Fish and Wildlife and Wetland Losses" are provided in the Mitigation Plan and CE/ICA in *Appendix 1*, Attachment D.

5.22.8 Review of U.S. Fish and Wildlife Service (USFWS) Coordination Act Report (CAR) Recommendations

The following summarizes how each of the 11 recommendations made by CAR is addressed in the plan to mitigate for unavoidable adverse effects to aquatic resources. Based on the USFWS CAR (*Appendix 1*, Attachment A), 11 recommendations were made.

1. A 2:1 mitigation ratio is recommended for the coastal prairie impacts due to the time lag involved in creating or bringing to similar value another, possibly more degraded site, plus the uncertainties involved in recreating a coastal prairie ecotype. *Response: Mitigation for impacts to open herbaceous areas is not warranted as they do not constitute coastal prairie habitat.*

2. If the existing coastal prairie cannot be preserved and managed intact, USFWS recommends compensation in the form of purchasing, creating and managing a coastal prairie tract of at least 150 acres. *Response: Mitigation for impacts to open herbaceous areas is not warranted as they do not constitute coastal prairie habitat. The non-federal sponsor, HCFCD, remains committed to preserving and increasing where feasibile the areal extent of coastal prairie habitat within its jurisdiction.*

3. If possible, USFWS prefers to preserve tracts containing remnant plant communities of declining, high-quality ecotypes (such as coastal prairie, bottomland hardwood forest, cypress-tupelo swamps, etc.) intact. In the event removal is unavoidable, adequate mitigation will be sought. *Response: There are no bottomland hardwood forests or cypress-tupelo swamp habitat in the proposed project footprint. See the response to the recommendation above regarding coastal prairie.*

4. The USFWS requests the non-federal sponsor, HCFCD, consult with federal and state agencies to develop a mitigation plan. *Response: Appropriate coordination for aquatic resource and prairie mitigation has occurred.*

5. An invasive species plan will be developed for each mitigation site to address locally invasive plant and animal species. *Response: The mitigation for the federal project is being accomplished by purchasing mitigation bank credits. The mitigation bank already has active management for invasive species control.*

6. Wetland, forest and scrub-shrub habitats will be mitigated. *Response: Non-federal sponsor will mitigate impacts to wetland habitat through the purchase of wetland mitigation bank credits.*

7. Eliminate using concrete-lined channel portions where possible. *Response: Following this recommendation, no concrete will be used in the channel modifications.*

8. Provide slope stability to avoid soil erosion by planting native grasses. *Response: Native grasses for slope stability will be recommended during the design phase.*

9. Use drift fences along channel portions where possible to prevent unnecessary accumulation of soil or plant material from entering the channel. *Response: During construction, a SWPPP will be in place to provide for caring and controlling water entering the channel.*

10. Plant in-line and off-line basins with a suite of native grass and sapling species. Monitor these areas for a minimum of 5 years. *Response: The project now only has the offline basin as part of the proposed project. The non-federal sponsor, HCFCD, has established and*

follows a Vegetation Management Manual and policy which considers planting and using desirable native species where practical and feasible, and includes lists of desirable native species, and appropriate uses. The detention basin will primarily be a grass-bottom basin which will be cleared of the present woody species when excavated and maintained with appropriate herbaceous species. Appropriate grass species will be selected depending on the final design site factors such as hydrologic cycle, sloping, and flow velocities, and may include some native perennials.

11. If possible, leave dead snag trees, as they provide habitat for wildlife. *Response: The detention basin site will be cleared and excavated approximately 15 to 18 feet to provide the needed storage. Therefore, it will not be practical or possible to leave snags in place.*

6.0 CUMULATIVE EFFECTS ANALYSIS

Cumulative impacts are the incremental impacts the project's direct and indirect effects have on a resource in the context of other past, present and future effects on a resource from unrelated activities (40 CFR 1508.7). Cumulative effects to a resource include a project's direct and indirect impacts plus the impacts from other actions not caused by the project. These add to the overall environmental effect, whether adverse or beneficial. The objective for the cumulative effects analysis is to focus on key resource issues, potential effects to these resources and potential mitigation opportunities.

Cumulative effects can result from a wide range of activities including adding materials to the affected environment, repeatedly removing materials or organisms from the affected environment and repeated environmental changes over large areas and long periods. Complex cumulative effects can occur when different types combine to produce a single effect or suite of effects. Cumulative impacts may also occur when individual disturbances are clustered, creating conditions where effects from one episode have not dissipated before the next occurs (timing) or are so close their effects overlap (distance).

In assessing cumulative impact, consideration is given to the following.

- The degree to which the proposed action affects public health or safety
- Unique characteristics (physical, biological and socioeconomic factors) for the geographic area
- The degree to which the effects on the quality of the human environment are likely to be highly controversial
- The degree to which the possible effects on the human environment are highly uncertain or involve unique or unknown risks
- Whether the action is related to other actions with individually insignificant, but cumulatively significant, impacts on the environment

6.1 Projects Considered

As described earlier, cumulative impacts are those *which result from the incremental impact of the proposed action when added to other past present and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or persons undertake such actions.*

6.1.1 Past and Present Actions

Projects completed before 2005 are considered to be part of the affected environment presented in this GRR/EA, and form the baseline for the cumulative impacts analysis. Included within the concept of past projects are all flood damage reductions, roadway, utilities, building construction and other actions which occurred before the study was initiated. This includes renovating COH's Kashmere Gardens Library located at Pardee and Lockwood and completing the Lockwood Bridge over Hunting Bayou in 2001. Recent completion for a major County Hospital (LBJ Hospital – Harris County General Hospital District), and a University of Texas Medical

school campus, allows for health service delivery to major, formerly under-served low income populations in the study area and areas adjacent to it.

Most of the intensive land uses in the TSP/B50-A25 project area (primarily in Hunting Bayou's upper reach) are devoted to residential neighborhoods, and retail and commercial services. However, major past and current development include industrial, industrial supply, petro-chemical, warehouse and marshaling areas for oil field pipe, heavy truck transport and rail freight transport supporting the growing marine transportation industry which requires access to the Houston-Galveston ship channel beginning just below Hunting Bayou's confluence with Buffalo Bayou. Continuous improvements to major surface transport routes such as IH 610 and US 59 reinforce this COH area as a transportation and distribution center.

The bayou's middle and lower segments are less developed and contain most of the remaining natural areas of the Hunting Bayou watershed. Residential subdivisions near the bayou are the other predominant land uses.

6.1.2 Reasonably Foreseeable Projects

Because the study and project areas provide a strong combination of existing businesses oriented to oil and gas transportation and newer marine transport for commercial and industrial materials, investment in facilities improvements is expected to be ongoing. This includes continued investment in residential neighborhoods, faith-based institutions, schools and health providers. Since larger study areas would experience a reduction in flood risk resulting from the build alternatives, it is likely redevelopment and more intense land uses near the bayou would occur.

Private development is hard to predict given its competitive nature. Public investments in infrastructure such as highway, transport and water facilities are easier to identify. As mentioned, improvements to major highway segments through the study area are included in regional transportation plans (H-GAC and TxDOT long-term planning). COH's Comprehensive Drainage Plan will allow for upgrades in the study area from rural drainage to urban drainage structures, which will further increase confidence in flood risk reduction in the area.

Little public or commercial investment in the middle and lower segments is anticipated, except for the commercial and residential uses adjacent to the IH 10 corridor in the Jacinto City areas.

6.1.3 Cumulative Impact Assessment

6.1.3.1 Physical Resources

During the construction period, all the reasonably foreseeable (cumulative) projects in the study areas near Hunting Bayou would have the potential to contribute to short-term water quality degradation. These impacts would be mitigated by implementing stormwater management and erosion control measures consistent with TPDES General Permit requirements for construction activities. These measures would include preparing and implementing a SWPPP for each project. For the flood damage reduction projects, the potential exists for further reduction in depressed summertime DO concentrations and water temperature elevation if these projects result in removing bank vegetation providing water-side shade or involve concrete-lined channel sections. However, the build alternatives generally will not involve concrete-lined conveyance.

For the transportation-related projects, the affected areas would be revegetated following construction and include erosion control features to reduce water quality impacts.

All the cumulative projects would have the potential to contribute to degrading air quality. For the flood damage reduction projects, this would mostly consist of short-term impacts during project construction. Over the long-term, these projects would have few operational air quality concerns as channels and basins are maintained.

Transportation-related projects would have potential short-term and long-term impacts. All federal projects must show conformity with SIP for the area prior to construction, thus significant increases in the O_3 precursor emissions would not be anticipated.

The cumulative projects could potentially impact possible cultural resources in the area. However, all publicly funded projects must comply with various federal and state cultural resources regulations including approval from the SHPO, prior to construction. Where necessary, archeological and historic surveys would be conducted under SHPO's guidance to assure the various projects adhere to regulations. Any potential impacts would require mitigation as part of the project activity.

6.1.3.2 Biological Resources

The cumulative projects discussed will occur across the study area, and will likely have varying impacts on natural resources. The more sensitive wetland and related aquatic habitats occur in Hunting Bayou's middle and lower reaches outside the direct impact area from the TSP improvements located in the urbanized upper reach. The small wetlands loss from TSP will combine with the potential wetlands losses which could occur in the lower reaches. Mitigating the potential for net losses over time is the federal 404 Discharge of Fill Permit Program, which requires mitigation for wetland losses. Even with such protections, there is the continued potential for terrestrial habitat fragmentation and degrading aquatic resources.

6.1.3.3 Socioeconomic Resources

Cumulative projects would have some potential to require relocations; the projects requiring new ROW have the highest potential. During project planning, it is typical for the agency proposing the project to consider various alternatives prior to selecting the preferred alternative. Included in this consideration is the potential impact to local communities. Generally, avoiding impacts to these communities is preferred. When this is not possible, assistance is generally provided to locate replacement housing to displaced residents. If possible, properties would be located near the acquired property. Financial assistance is also anticipated to cover relocation costs, such as professional movers, truck rental, etc., incurred by each household required to relocate. Through these efforts, impacts to the local communities are generally minimized.

Cumulative projects would result in some impacts to transportation facilities. The federal flood damage reduction projects would result in replacing those transportation facilities (mostly bridges). The replacement facilities would be designed to conform to specific standards, with all bridges being designed to pass the 1.0 percent AEP (100-year) flood where practicable to comply with local floodplain management ordinances and design criteria. All the transportation-related projects would result in constructing either new or improved facilities to improve area mobility.

6.1.4 Review for the Potential Build Alternatives Effects Compared with the No Action Alternative

Table 6-1 summarizes the Two Upper Segment Plan Scales, the 1990 Authorized Plan and the No Action Alternative's biological, physical and socioeconomic impacts.

Table 6-1:
Summary for Existing Resource Conditions and Potential Impacts

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Topography and Bathymetry Changes to topography would occur in the vicinity of the channel proposed to be deepened and widened and at the proposed detention basin and the four proposed disposal basins. Topography in the study area is affected by the presence of creeks, bayous and streams (surface water features and associated floodplains), salt domes or salt caverns, roads, industrial reservoirs and levees, the surface geology of the Gulf coastal plain, and subsidence.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. No anticipated permanent direct or indirect or significant effects on topography or bathymetry would be anticipated for the No Action Alternative.	TSP/B50-A25 is 3.8 miles long within a maximum 310-ft ROW to contain the 60-ft /50-ft channel bottom width with 4:1 channel side slopes. Detention basin construction would affect 75/25 acres of predominantly uplands in the Homestead Road vicinity. The deepened and widened upper channel segment would extend a maximum of 22-24 ft below ground surface in some areas. Channel construction would directly and permanently affect topography for approximately 115 acres of land for the TSP. The B50-A25 requirement would be approximately 113 acres. The four proposed dredged material disposal areas would consist of a cumulative 119 acres of land (57.7 for the B50-A25 scale) which would permanently be used for disposal purposes throughout the project's life. After channel construction, restoring the channel banks to preconstruction conditions would occur as possible.	The 1990 Authorized Plan is approximately 15 miles long and would have a 50-ft bottom width in the upper segment and varying widths of 100 ft to 150 ft in the middle and lower stream segments. This plan would require 198 acres of additional ROW adjacent to the stream channel to facilitate channel improvements and 385 acres in multiple disposal areas.
Soils NRCS periodically updates information about soils. Soil surveys contain information which affects land use planning in survey areas. Soil survey reports identify soil limitations which affect various land uses and provide information about soil properties in the survey areas. No specific issues regarding area soils were identified. Up to 20 percent of soil materials generated during construction are anticipated to be sold for fill material to others. Note: Prime farmland soils are not present in the project area, although they are discussed separately.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. Additional direct, indirect and permanent or significant effects to soils or bayou sediments would not be anticipated for the No Action Alternative.	Direct permanent impact to 115 acres /113 acres for the B50-A25 scale of surface soils would occur. After construction, restoring surface soils and revegetating land surface to approximate preconstruction conditions would occur as possible. Soils removed during channelization and additional soils would be used to restore channel maintenance access areas to preconstruction contours. Through dynamic hydraulic modeling conducted during final design, the direct and indirect effect on Hunting Bayou soils would be minimized.	Direct permanent impact to 198 additional acres of ROW. After construction, restoring surface soils and revegetating land surface to approximate preconstruction conditions would occur as possible. Soils removed during channelization and additional soils would be used to restore channel maintenance access areas to preconstruction contours. Through dynamic hydraulic modeling conducted during final design, the direct and indirect effect on Hunting Bayou soils would be minimized

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Prime and Unique Farmland Soils Over several decades, large amounts of rural farmland in the Houston region have been converted to developed uses, thus prime agricultural land has been lost in Texas. Texas is pursuing conservation easements on land to preserve farms and ranches. No soils in Texas are identified as unique farmland soils.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. No direct, indirect permanent or significant effect to prime farmland soils would occur, because they are not present in the project vicinity (upper Hunting Bayou watershed in Harris County, Texas). Mapped farmland soils are identified downstream along the tidal reach of Hunting Bayou, but these soils would not be affected.	No direct, indirect, permanent or significant effect to prime farmland soils would occur. Mapped farmland soils are identified downstream along the tidal reach of Hunting Bayou, but these soils would not be affected by the TSP/B50-A25.	Mapped farmland soils are identified downstream along the tidal reach of Hunting Bayou, but none of these soils would be directly affected by channel construction.
Geology Soil characteristics and sediment related to weathering geologic formations. Sediment transport along area waterways, location for oil, gas, gravel, salt and other natural resources/minerals; favorable areas for underground CO_2 storage in project area related to presence of thick salt beds, mounded salt caverns, domes with the potential for oil and gas accumulation and production.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. Oil and gas, mineral, sand and gravel resources would continue to be developed in the project area. Salt domes, dissolution features, sink holes and fault movement, subsidence possibly related to operations at the Clinton Salt Dome and groundwater withdrawals in Harris County.	Local and regional geologic features would not be permanently affected by TSP/B50-A25, and local effects would be minimized to the extent possible using site-specific data collection and analyses incorporated into the preliminary design for the proposed Hunting Bayou FRM project.	Local and regional geologic features would not be permanently affected, and local effects would be minimized to the extent possible using site-specific data collection and analyses incorporated into the preliminary design for the proposed Hunting Bayou FRM project.
Sedimentation and Erosion Hydrogeomorphic changes could include landscape changes caused by active processes including erosion, fluvial sediment deposition, intensity, and location of currents, wave and tidal action.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. Direct permanent impact to sedimentation and erosion (geomorphology) other than natural occurrences not anticipated for No Action Alternative.	Through dynamic hydraulic modeling conducted during preliminary design, the effect on the upper Hunting Bayou channel morphology and function would be minimized so no direct impacts and no change in the WSELs would be expected (see *Appendix 2- Hydrology and Hydraulics*).	Through dynamic hydraulic modeling conducted during preliminary design, the effect on the Hunting Bayou channel morphology and function would be minimized so no direct impacts and no change in the WSELs would be expected.
Faulting and Subsidence Geologic hazards in the project area's vicinity; fault movement not considered potentially significant. Subsidence affects landscape elevation, could increase flooding, and combined with sea level rise, could inundate larger area compared to baseline.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. Direct or indirect permanent effects on area faulting are not anticipated for the No Action Alternative. If groundwater resources are not replaced by surface water sources as described by the Region H regional water plan, subsidence in the Houston area would continue as part of the No Action Alternative; groundwater resources would continue to be used to supply municipal water needs for Region H. The Harris-Galveston and Fort Bend Subsidence District Plans for management and control of land subsidence would not be achieved by regulatory deadlines.	The rate of subsidence has declined after the conversion to surface water. Harris-Galveston and Fort Bend County Subsidence District Plans for surface water conversion would continue to be implemented throughout the Houston extraterritorial jurisdiction. Significant fault movements within the Hunting Bayou watershed are not expected, although consideration of surface and subsurface faulting would be incorporated into the PED.	The subsidence rateThe rate of subsidence has declined after the conversion to surface water. Harris-Galveston and Fort Bend County Subsidence District Plans for surface water conversion would continue to be implemented throughout the Houston extraterritorial jurisdiction. Significant fault movements within the Hunting Bayou watershed are not expected, although consideration of surface and subsurface faulting would be incorporated into the PED.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Climate and Climate Change	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. Regional climate and climate change could or would occur as anticipated by climate change scientists; additional direct, indirect and permanent significant effects related to sea level rise (increase) exacerbated by continued groundwater withdrawals to meet water demands would permanently and adversely cause changes to local hydrology, increase in flood potential and flood hazards as a result of climate or climate change as a result of the No Action Alternative.	Regional climate and climate change could or would occur as anticipated by climate change scientists; additional direct, indirect, and permanent significant effects related to sea level rise (increase) and area subsidence would permanently and adversely cause changes to local hydrology, increase flood potential and flood hazards as a result of climate or climate change would likely occur in the vicinity of Galveston Bay. Based on the hydrologic modeling performed, the project area including all Hunting Bayou watershed segments is not anticipated to incur the results of climate change conditions through the anticipated period of analysis.	Regional climate and climate change could or would occur as anticipated by climate change scientists; additional direct, indirect, and permanent significant effects related to sea level rise (increase) and area subsidence would permanently and adversely cause changes to local hydrology, increase flood potential and flood hazards as a result of climate or climate change would likely occur in the Galveston Bay vicinity. Based on the hydrologic modeling performed, the project area including all Hunting Bayou watershed segments is not anticipated to incur the results of climate change conditions through the anticipated period of analysis.
Air Quality and Air Conformity The overall air quality in the HGB regulatory area is poor with numerous O_3 exceedance days, non-conformance with SIP, and health effects on children and the elderly, those with compromised immune systems or those diagnosed with COPD.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed. Air quality would not be expected to be adversely affected or benefit from implementing the No Action Alternative.	Based on the information provided in the construction estimate and the associated emissions estimate, constructing either upper segment plan scale would conform to current air emissions requirements. Predicted emissions for the other pollutants emitted as a result of the TSP/B50-A25 are below the air conformity emission thresholds.	The 1990 Authorized Plan would generate more emissions than the upper segment plan scales, but is estimated to be below air conformity thresholds.
Hazardous Air Pollutants The overall air quality in the HGB regulatory area is poor, with hazardous air pollutants emitted throughout the HSC area from industries and businesses, and during construction; the resultant health effects are particularly damaging to children and the elderly, those with compromised immune systems.	No anticipated permanent direct or indirect or significant effects on hazardous air pollutants would be anticipated for the No Action Alternative.	Results from the hazardous air pollutant compliance analysis indicate the Hunting Bayou FRM project would not violate these standards. Total hazardous air pollutant concentrations in air would be expected to remain well below applicable regulatory limits.	Results from the hazardous air pollutant compliance analysis indicate the 1990 Authorized Plan would not violate these standards. Total hazardous air pollutant concentrations in air would be expected to remain well below applicable regulatory limits.
Surface Water Resources and Water Quality Water quality is poor within the Hunting Bayou watershed, and the resource's health is declining, although Texas has implemented TMDL studies and assessments to address the watershed's poor water quality.	Surface water quality in the Hunting Bayou watershed is poor, and the resource's health is declining. Surface water resources would continue to be affected under the No Action Alternative by flood events which would occur consistent with existing frequency and duration. Surface water resources in the project area would be directly affected during flood events, and although these effects would be intense and high magnitude, they would be relatively short in duration. The expectation would be the adverse flood effects on surface water resources and water quality would be temporary.	There would be direct, indirect and long-term effect on the water quality of the Hunting Bayou watershed resulting from implementing the TSP/B50-A25. Controlling sediments to manage the effects of potential discharge to surface water would occur in conformance with the TDPES permit issued for construction activities. O&M would occur along the banks of the improved channel.	There would be direct, indirect and long-term effect on the water quality of the Hunting Bayou watershed resulting from implementing the 1990 Authorized Plan. Controlling sediments to manage the effects of potential discharge to surface water would occur in conformance with the TDPES permit issued for construction activities. O&M would occur along the banks of the improved channel.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Surface Water Hydrology and Drainage Surface water hydrology and drainage functions poorly within the project area such that flooding remains a significant problem.	The Hunting Bayou FRM project would not be constructed, and Hunting Bayou watershed's surface water hydrology and drainage would be directly affected for the long-term, as flooding would continue throughout the project area. The existing flood protection level along Hunting Bayou is between the 50- and 20-percent AEP events. During an intense rainfall event, Hunting Bayou's existing conditions do not provide adequate flood protection, nor does the bayou serve as an adequate outfall source for the local drainage system.	The TSP/B50-A25 would not involve precedent-setting methods, use innovative materials, or change prevailing practices. One unique project aspect is to build the detention basin so it is functional before widening and deepening the Hunting Bayou channel to help prevent flooding downstream structures during channel construction.	The 1990 Authorized Plan would not involve precedent-setting methods, use innovative materials, or change prevailing practices
Flood Hazards and Floodplain Values Flood hazards are significant, and floodplain values are low within the project area. New development within the area floodplains would continue to occur in accordance with the NFIP and COH Flood Plain regulations.	Without the TSP, the Hunting Bayou FRM project would not be constructed, and flood hazards and floodplain values would not be improved compared with baseline conditions. Flood events would continue to occur causing long-term, adverse, high intensity economic and social damage to residents, infrastructure, neighborhoods and local economic conditions.	The purpose of the TSP/B50-A25 is to reduce and control the potential for flood damage within the study area. New development within the area floodplains would continue to occur in accordance with the NFIP and COH Flood Plain regulations. Stormwater detention and hydraulic features combined with nonstructural measures would help offset the increase in impervious cover that may occur through time (although 92 percent of the watershed's upper segment is developed per the baseline condition).	New development within the area floodplains would continue to occur in accordance with the NFIP and COH, Galena Park, and Jacinto City Flood Plain regulations. Stormwater detention and hydraulic features combined with nonstructural measures would help offset the increase in impervious cover that may occur through time.
Groundwater Shallow groundwater flow patterns along Hunting Bayou, groundwater pollution and effects on channel seeps are relevant considerations to project design. The project area is relatively industrial, and many sources of below-ground releases to soils and shallow groundwater are present.	Groundwater resources would be impacted by potential releases to the environment in the project area, similar to baseline conditions; shallow groundwater quality could therefore degrade with time, although this effect would occur regardless of the proposed action.	The TSP/B50-A25's construction, operation, and maintenance would not be expected to affect ground water, availability, quantity or quality in the project area. The proposed detention basin would be designed to control outflow, and the bottom of the detention basin including underdrain soil filters should be above the seasonal high groundwater table.	The 1990 Authorized Plan's construction, operation and maintenance would not be expected to affect groundwater availability, quantity or quality in the project area.
Historic and Architectural Resources The study area's historic and architectural resources are generally poor. Housing was generally constructed during the 1950s; the resident population is minority and low income; and upkeep for these resources is lacking particularly in areas of historic, widespread flooding in the upper watershed.	No anticipated permanent direct or indirect or significant effects on historic and architectural resources would be anticipated for the No Action Alternative.	The area directly influenced by historic and architectural resources being present includes along the proposed channel expansion, the detention basin and mitigation area, the disposal areas, and areas with replacement or relocation of infrastructure or utilities. One potentially historic property (at 5002 Wipprecht Street) was identified within the Area of Potential Effect along the upper Hunting Bayou channel and was identified as potentially historic by THC (*Appendix 1,* Attachment F). However, no direct effects on this resource are anticipated for construction, operation or maintenance.	No historic structures were identified in the middle and lower bayou segments. But considerations affecting the upper segment plan scales, as noted in the TSP/B50-A25 column, also apply to the 1990 Authorized Plan.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Archeological Resources Result in the loss of paleontological and archeological resources. It is anticipated the health of this resource in the project area is poor due to existing development and long-term channelization of the bayou in the upper reach since the 1940s.	No anticipated permanent direct or indirect or significant effects on archeological resources would be anticipated for the No Action Alternative (see *Appendix 1*, Attachment F).	The area directly influenced by the presence of archeological resources includes along the proposed channel expansion, the detention basin and mitigation area, the disposal areas, and areas with replacement or relocation of infrastructure or utilities. Based on the investigations conducted, no archeological sites have been identified within the area of potential effect of TSP/B50-A25. The data review results have been compiled. It is anticipated the construction, operation or maintenance of TSP/B50-A25 would not result in a permanent direct or indirect effect on archeological resources.	Ten areas along the bayou would have to be evaluated prior to construction. These areas would be in the middle and lower bayou segments. Potential impacts in the upper segment are described in the TSP/B50-A25 column.
Population and Housing	The No Action Alternative would have a direct and indirect, long-term, highly detrimental effect on study area population and housing, and flooding continues within the upper Hunting Bayou watershed similar to the effect of baseline conditions (see *Appendix 6 - Real Estate Plan* and *Appendix 1 – Environmental*; Attachment C). The 1 percent event affects 5,110 structures for baseline conditions.	TSP/B50-A25 would be constructed within the project footprint along the proposed channel expansion, the detention basin and mitigation area, the disposal areas, and areas where infrastructure, bridges, roads or utilities would be replaced or relocated. The project footprint occurs within a highly developed watershed consisting of commercial, industrial and residential land uses. Approximately 70 displacement actions would occur due to the TSP (see *Appendix 6 – Real Estate Plan*).	The 1990 Authorized Plan would require displacing 125 single family residences.
Environmental Justice/Social Values	The No Action Alternative would have a direct and indirect, high adverse long-term effect on environmental justice and vulnerable populations in the study area. The No Action Alternative would allow watershed flooding to continue unabated resulting in social and economic impacts which are particularly difficult to recover from for low-income and minority populations, i.e., the majority of the study area residents.	The TSP/B50-A25 will temporarily affect minority residents displaced by ROW acquisition. Property displacement would occur as discussed in *Chapter 5* of this Draft GRR/EA. Based on the study conducted, adverse and disproportionate impacts are not anticipated.	The 1990 Authorized Plan will temporarily affect minority residents displaced by ROW acquisition. Property displacement would occur as discussed in *Chapter 5* of this Draft GRR/EA

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Economics	The No Action Alternative would have a direct and indirect, high adverse long-term effect on environmental justice and vulnerable populations in the study area. The No Action Alternative would allow watershed flooding to continue unabated resulting in social and economic impacts from which low-income and minority populations find it particularly difficult to recover. Low-income and minority populations comprise the majority of the study area residents (see *Appendix 5 – Economics Analysis*).	Minor, long-term loss of income and tax revenue to Harris County due to changing land use from residential, commercial or industrial to public use would occur for the 300/250 acres for the TSP/B50-A25. Federal benefits would be associated with less economic effects to the NFIP. Relatively large, contiguous land parcels in the TSP/B50-A25 vicinity are earmarked for dredge and fill material disposal in the watershed. TSP/B50-A25 would be implemented in an area of intermodal rail shipping facilities, industrial tank farms and other operations, and supporting commercial businesses which provide great benefit to Houston and the community in the context of economic welfare and "highest and best property use." These anticipated indirect effects could result in a long-term beneficial economic impact to the Houston area.	Minor, long-term loss of income and tax revenue to Harris County due to changing land use from residential, commercial or industrial to public use would occur for the 583 additional acres needed for the 1990 Authorized Plan. Federal benefit would be associated with less economic effects to the NFIP. Relatively large, contiguous land parcels in the project vicinity are earmarked for dredge and fill material disposal in the watershed.
Public Facilities and Services Flood damage reduction, police, fire, hospitals, EMT services and schools.	The No Action Alternative would not result in implementing structural measures for FRM in the upper Hunting Bayou watershed, and Harris County would not be able to meet their mission requirements for the study area. Indirectly, during flooding, public services would be adversely impacted for the time period needed for flood waters to recede and infrastructure to be repaired to pre-flood conditions. Other public resources such as police and hospitals would be directly and indirectly affected by limited mobility and hazards generated by the flood event. Social health services provisions to minority and low-income populations would be negatively affected under the No Action Alternative.	TSP/B50-A25 would provide a public benefit with respect to FRM for the project area (Hunting Bayou watershed). Providing additional FRM measures should decrease the potential for delayed response due to area-wide flooding for emergency response personnel. Short-term, adverse effects during construction are anticipated and would be mitigated for by implementing Traffic Control Plans and appropriate notifications and up-front planning.	The 1990 Authorized Plan would provide a public benefit with respect to FRM for the project area (Hunting Bayou watershed). Providing additional FRM measures should decrease the potential for delayed response due to area-wide flooding for emergency response personnel. Short-term, adverse effects during construction are anticipated and would be mitigated for by implementing Traffic Control Plans and appropriate notifications and up-front planning.
Utilities and Pipelines Electrical power corridors, oil and gas pipelines, utilities maintained by local entities.	The No Action Alternative would have no impact on utilities and pipelines in the project area.	Approximately 100 electrical lines, water lines, sanitary sewer lines, and related public utilities cross the proposed TSP/B50-A25 and would permanently be relocated. Approximately 33 oil and gas pipelines either intersect or are present in the TSP/B50-A25's immediate vicinity and would need to be adjusted.	Approximately 150 electrical lines, water lines, sanitary sewer lines, and related public utilities cross the 1990 Authorized Plan and would permanently be relocated. Approximately 50 or more oil and gas pipelines either intersect or are present in the 1990 Authorized Plan's immediate vicinity and would need to be adjusted.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Community Cohesion Altering access to community resources and impact to the community cohesion.	The No Action Alternative would have a direct, high adverse, long-term effect on community cohesion, as vulnerable populations would need to move away to escape the frequent flooding in the study area during storm events. The No Action Alternative would allow watershed flooding to continue unabated resulting in impacts to the social fabric and community cohesion for the study area consisting of long-term minority and/or low-income residents.	No loss of community identity or cohesion is expected as a result of the TSP/B50-A25. Residents to be displaced have the opportunity to relocate to adequate, comparable housing in nearby neighborhoods.	No loss of community identity or cohesion is expected as a result of the 1990 Authorized Plan. Residents to be displaced have the opportunity to relocate to adequate, comparable housing in nearby neighborhoods.
Relocations and Displacement	The No Action Alternative would not result in any involuntary relocation or displacement of area residents, except existing flood hazards may result in long-term residents leaving the area due to an inability to withstand continued flooding dangers and damages.	The TSP would require 70/69 for the B50 A25 displacement actions including 66/65 for the B50 A25 single and multifamily residences, two commercial properties, one religious property, and one industrial property needed for project ROW are common to both.	The 1990 Authorized Plan would require displacing 125 residential and 15 commercial businesses.
Land Use Planning and Policies Conformance with regional and/or local government land use plans or policies	The No Action Alternative would not require any changes to land use planning policy.	Local plans would have to update any references to infrastructure in the region due to implementing the TSP/B50-A25. The TSP would purchase, acquire, or control by easement 190 acres of land/138 acres for B50-A25 along the upper reach of Hunting Bayou. Proposed disposal of dredged material may occur at up to 4 locations which total 119acres in four locations / 57.7 acres for B50-A25 The proposed offline detention basin would total approx. 75 acres of land/25 acres for B50-A25, which is a subset of the 190 acres / 138 acres referenced above.	In addition to the upper segment changes discussed in the TSP/B50-A25 column, local planning would have to update changes the 1990 Authorized Plan would make to the middle and lower segments. This would take into account the additional ROWs and multiple disposal areas.
Local and Regional Land Use Changes in existing local or regional land use	The No Action Alternative would not require changes to existing land use, although local flood damage management measures to maintain the floodway conveyance and manage development within the floodplain would continue to be taken by Harris County and COH. New development within the area floodplains would continue to occur in accordance with NFIP.	Land use impacts would include long-term, permanent change from residential/private property to public ownership. Land would be needed for the 60-ft/50-ft bottom width channel along Hunting Bayou, dredged material disposal, the 75-acre/25-acre detention basin, compensatory mitigation for unavoidable project effects, relocating some elements of Hutchinson Park, temporary construction easements, to provide changes to roads and bridges, and relocating utilities.	In addition to upper segment changes similar to the other build alternatives, the 1990 Authorized Plan would impact Herman Brown Park in the bayou middle segment and parts of the estuarine lower segment.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Land Use Controls and Zoning Use or compliance with existing land use controls although the study area does not have zoning regulations.	The No Action Alternative would not require changes to existing land use, although local flood damage management measures to maintain the floodway conveyance and manage development within the floodplain would continue to be taken by Harris County and COH. New development within the area floodplains would continue to occur in accordance with NFIP.	There are no zoning or land use controls in the project study area.	Jacinto City/Galena Park have land use controls, and the proposed changes to the lower segment in the 1990 Authorized Plan may have to be coordinated with these municipalities.
Land Use Conflicts Flood hazards are significant and the floodplain's value in the study area is high.	The No Action Alternative would not require changes to existing land use, although local flood damage management measures to maintain the floodway conveyance and manage development within the floodplain would continue to be taken by Harris County and COH. New development within the area floodplains would continue to occur in accordance with NFIP.	TSP/B50-A25 would comply with local plans or laws, regulations and rules pertaining to land use.	The 1990 Authorized Plan would comply with local plans, regulations and rules pertaining to land use.
Public Lands Public lands in the study area include parks, schools, community centers and similar resources.	The No Action Alternative would result in no effect on public lands compared to baseline conditions.	TSP/B50-A25 would directly and permanently affect some elements of Hutcheson Park, as some facilities and features such as walkways, picnic areas and playground equipment are relocated to an adjoining land parcel. Ten schools are currently in the 1 percent AEP floodplain; after constructing TSP/B50-A25, 9 schools would have reduced risk from a 1 percent AEP event. Kashmere Gardens Elementary School would remain within the mapped 1 percent AEP floodplain after implementing TSP/B50-A25.	In addition to having the same benefit in the upper segment, the middle and lower segment would experience less flood risk as a result of areas being removed from the floodplain. One of these areas includes Herman Brown Park.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Hazardous Materials and Hazardous Wastes	The No Action Alternative would result in no direct or permanent impact to hazardous material and wastes within the study area.	Within 1,000 ft of TSP/B50-A25 are 36 properties, facilities or recorded sites on regulated state or federally-maintained reporting or HTRW management databases. These facilities include permitted PST sites, LPST sites, areas where voluntary cleanup is occurring, facilities transporting or handling various quantities of hazardous wastes or hazardous/ toxic chemicals, areas with reported spills or releases to the environment, and other sites being tracked for environmental regulatory compliance status. Two landfills are in the immediate TSP/B50-A25 ROW vicinity (Homestead Road and Kirkpatrick Landfills). During the PED phase, potential construction areas would be investigated in more detail so provisions can be made to avoid known or potential areas affected by chemicals, landfilled wastes and other releases. As always, local, federal and state requirements/regulations for HTRW management would be compiled with. SPCC Plans (if needed) and construction specifications would describe managing HTRW during construction, operation and maintenance.	The 1990 Authorized Plan would encounter similar potential constraints regarding HTRW in the upper segment. There is less potential for encountering regulated substances in the middle and lower segments. However, the multiple pipelines having to be relocated will have to be evaluated closely for past releases in the construction's vicinity. Work in the IH 10 vicinity may encounter regulated substances due to past releases from freeway accidents and materials released during freeway operation.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Traffic and Transportation, Traffic Circulation Patterns	The No Action Alternative would not require any changes to the transportation and traffic network.	Relocation and replacement would occur for 10 roadway bridges, 3 railroad bridges and 4 pedestrian bridges. The TSP/B50-A25 would also directly and permanently affect some traffic elements as roads are closed or relocated to facilitate long-term operation of TSP/B50-A25. During construction, adverse short-term traffic effects to the local area and residents would be expected to occur. Bridge and road-specific Traffic Control Plans would be developed and executed to help minimize disruption to area travel, service level and circulation/travel patterns. Individual bridge replacements would be expected to take 3 to 5 months each. Extensions for larger crossings could last 6 to 9 months. Some neighborhood area bridges would be closed during construction with traffic rerouted. For the larger roadway bridges (such as the IH 610 crossings), 1 lane would likely remain open or traffic could be rerouted to the frontage roads or to constructed bypass lanes. Travel delays would be expected. The bridge replacements are scheduled to occur throughout the 7-year planning level construction schedule, and would be staggered and phased to minimize neighborhood access, disruption and traffic impedance. Once the new bridges are constructed, traffic patterns would return to normal. The specific construction procedure for the railroad bridge replacements would be determined through coordination with railroad personnel.	The 1990 Authorized Plan will require removing/replacing the upper segment facilities described for the TSP/B50-A25 plus 30 bridges and facilities and at least 50 pipelines in the middle and lower segments. The same temporary impacts associated with the other build alternatives would affect the 1990 Authorized Plan.
Aesthetics and Visual Resources	Under the No Action Alternative, the visual environment would remain essentially the same except as changes occur over time at individual properties.	The TSP/B50-A25 overbank areas would be replaced with the same type of maintained grasses. The TSP/B50-A25 would not be altering horizon views of remaining adjacent residences. No substantial impacts anticipated.	The 1990 Authorized Plan would remove large areas of riparian forest adjacent to the bayou in the middle and lower segments. While this would alter the views along the bayou, aesthetic plantings are proposed that would restore views over time.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Human Noise-Sensitive Receptors	Under the No Action Alternative, the existing noise environment would remain consistent with baseline conditions.	Construction noise would occur and would be short-term, localized and at times a high intensity. However, construction would occur in accordance with COH Noise Ordinance during daylight hours to minimize noise effects. Further, it is anticipated areas more than 300 ft from proposed construction would experience a baseline level of noise comparable to the existing sound environment. No permanent effects to the sound environment would be expected, although minor short-term, low intensity adverse noise effects may occur during maintenance operations.	The 1990 Authorized Plan will impact noise sensitive receptors in the upper segment in ways similar to the other build alternatives. Impacts to neighborhoods adjacent to the bayou in the middle segment would also experience daytime construction noise primarily from earth moving equipment and trucks conveying excavated materials to off-site disposal locations.
Ecological Noise-Sensitive Receptors	Under the No Action Alternative, the existing noise environment would remain consistent with baseline conditions.	Construction noise would occur and would be short-term, localized and at times a high intensity. Wildlife would startle and move away from the noise generated during construction activities. Areas more than 300 ft from proposed construction are anticipated to experience a baseline level of noise comparable to the existing sound environment. No permanent effects to the sound environment would be expected during operation, although minor short-term effects would occur during channel maintenance (mowing and channel repair).	Construction noise would occur and would be short-term, localized and at times a high intensity. Wildlife present in the upper segment would avoid active construction sites. Areas more than 300 ft from proposed construction are anticipated to experience a baseline level of noise comparable to the existing sound environment. No permanent effects to the sound environment would be expected during operation, although minor short-term effects would occur during channel maintenance (mowing and channel repair).
Recreation and Navigation including Boating The water quality in the upper Hunting Bayou reach is not supported for recreation, contact, boating or fishing.	The No Action Alternative would not affect recreation and navigation compared to baseline conditions. Navigation servitude is the dominant right of the government under the Commerce Clause in the U.S. Constitution to use, control and regulate the navigable waters of the U.S. and the submerged lands thereunder for various commerce-related purposes including navigation and flood control. Hunting Bayou is considered a navigable watercourse along the lower 3.3 miles (tidally influenced and EFH). The proposed channel modifications are 10 miles upstream from the mouth; therefore, navigation servitude does not apply.	No impacts would result from the TSP/B50-A25.	Recreational fishers would avoid the construction areas in the middle and lower segments as the water column disturbances would not encourage fishable conditions. Boating may be interrupted during construction, which suggests the need for posting boating conditions and possible temporary closures of the bayou to boating due to safety considerations.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Safety and Security Expose people, structures or population to safety or security risks or adverse effects from using surface water source of FRM to Houston extraterritorial jurisdiction.	No changes to safety or security risks would be expected as result of the No Action Alternative.	Relocation and replacement would occur for 10 roadway bridges, 3 railroad bridges and 4 pedestrian bridges. Security measures along the channel crossings at roads and pedestrian bridges along the Hunting Bayou FRM project would be implemented in accordance with PED plans and construction documents (specifications).	Similar measures cited for the other build alternatives would apply to the 1990 Authorized Plan, which would require additional facility removals/replacements in the middle and lower segments.
Energy and Mineral Resources	The No Action Alternative would result in no effect on energy and mineral resources compared to baseline conditions.	TSP/B50-A25 would require energy to construct, maintain and operate. Hunting Bayou's middle reach contains the Clinton Salt Dome, but no adverse effects are anticipated due to TSP/B50-A25.	The 1990 Authorized Plan would require energy to construct, maintain and operate. The middle reach of Hunting Bayou contains the Clinton Salt Dome, but no adverse effects are anticipated due to construction/ operation of the bayou.
Health and General Welfare of the People	The No Action Alternative would not contribute to the health and general welfare of the people, and would adversely affect for the long-term vulnerable populations including minority and low-income residents.	TSP/B50-A25 would contribute to the health and general welfare of the people as a sufficient, sustainable, good quality and long-term structural measure for FRM.	The 1990 Authorized Plan would contribute to the health and general welfare of the people as a sufficient, sustainable, good quality and long-term structural measure for FRM.
Upland Habitat Upland habitat in the TSP/B50-A25 channel footprint is primarily highly fragmented low quality forest and scrub-shrub. In the offline detention basin, it is primarily low to medium quality forest and scrub-shrub, primarily <50 years old, with many nonnative species, and approximately 3 acres of upland herbaceous area, containing remnant prairie species, which is under encroachment by woody species.	The No Action Alternative would result in no change to this resource.	Approximately 75 acres of upland habitat would be affected by the TSP/B50-A25 project components, and another 34 acres would be affected by the disposal sites for the project if they are used.	Approximately 30 acres of upland habitat would be affected by the 1990 Authorized Plan components, and another 66 acres would be removed from riparian areas next to the bayou. Some 385 acres would be affected by the disposal sites for the project.
Aquatic Resources (Species) Finfish and benthic species are characteristic of those highly tolerant to low water quality and highly altered stream environment.	The No Action Alternative would result in no change to this resource.	The perennial channel that would be impacted would be replaced with the same type of low flow perennial channel with no substantial alteration to the current aquatic habitat environment.	Channel flows in the middle and upper segment would be reduced due to channel widening.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Wetlands Wetlands are small, noncontiguous, and highly fragmented, and primarily of low quality. Hunting Bayou is a highly altered stream consisting of approximately 6.9 acres of open water within the TSP reach	The No Action Alternative would result in no change to this resource.	Approximately 3.67 acres of forested and scrub-shrub wetlands would be permanently impacted by the TSP/B50-A25 components and another 0.7 acres of emergent wetlands if disposal sites are used for a total of 4.37 acres of forested, emergent, and scrub-shrub wetlands to mitigate for. Approximately 1.18 acres of fringe wetlands along the perennial (low-flow) channel margin would initially be impacted, but would be expected to recover along the new perennial channel margin. Approximately 6.9 acres of Hunting Bayou open water in the perennial channel would be initially impacted, but would be replaced with the new perennial channel.	Upper segment impact would include the fringe wetlands (1.18 acres), but the 4.37 acres of impact realized by the 1990 Authorized Plan would be avoided. The 1990 Authorized Plan anticipated no wetlands would be adversely affected in the middle and lower segments.
Riparian Habitat Riparian habitat is generally poor in the project reach, predominately by maintained grasses and sparse tree cover of residential backyards, businesses or parks with only a few small areas of low quality scrub-shrub or forested natural vegetation. Stream bank is highly modified, non-native grass covered, with approximately only 1.2 acres of thin pockets of fringe wetland vegetation consisting of naturally-recruited native and non-native emergent species at the perennial channel margin. Channel-adjacent wetlands are limited to 2.2 acres of primarily low-quality emergent and forested wetlands.	The No Action Alternative would result in no anticipated changes to riparian habitat caused by not taking any action. The No Action Alternative would not require relocations, and would not cause indirect impacts to riparian habitat.	Permanent impacts would be made to a primarily highly altered riparian habitat and vegetation. The majority of riparian habitat impacted would be replaced with the same grass covered channel slope and overbank vegetation. The TSP/B50-A25 has cost provisions for limited tree planting, similar to the sparse urban tree cover along most of the channel. Approximately 6.9 acres of open water resources would be directly affected, but would be replaced with the same perennial channel. Approximately 1.2 acres of fragmented fringe wetland vegetation would be initially impacted, but would be expected to recover along the new perennial channel margin. Impacts to natural channel riparian cover would be limited to 7.9 acres of low quality upland forest and scrub-shrub on the overbanks, and 2.2 acres of emergent and forested wetlands. Implementing the TSP/B50-A25 could indirectly result in redeveloping land in areas where residential or businesses would relocate. In the areas where the majority of the proposed ROW acquisition would occur, properties which may be developed or redeveloped would not include riparian habitat; therefore, it is not likely there would be indirect impacts to those resources.	The 1990 Authorized Plan would impact 66 acres of riparian vegetation, which would be mitigated for through aesthetic plantings.
Fishes	The No Action Alternative would result in no change to this resource.	No substantial effects are anticipated to this resource.	No long term adverse effects are anticipated for this resource.
Rare, Threatened, Endangered or Protected Species	The No Action Alternative would result in no change to this resource.	No effects are anticipated to this resource.	The 1990 Authorized Plan anticipated no impacts to T&E species.

Resource Category	No Action Alternative	TSP/B50-A25 Direct Effects and Significance	1990 Authorized Plan Direct Effects and Significance
Migratory and Resident Bird Species The non-federal sponsor, HCFCD, implements initiatives to enhance the environment when possible	The No Action Alternative would result in no change to this resource (see Habitat and Habit Values below).	Temporary and minor effect to migratory or resident birds may occur from the TSP/B50-A25. Construction would result in a decrease in the habitat values adjacent to TSP/B50-A25 and may also cause possible temporary disturbances to normal behavior from an increase in noise levels from construction activities.	Temporary and minor effects to migratory or resident birds may occur from the 1990 Authorized Plan. Construction would result in a decrease in the habitat values adjacent to the 1990 Authorized Plan and may also cause possible temporary disturbances to normal behavior from an increase in noise levels from construction activities.
Wildlife Habitat and Habitat Values	The No Action Alternative would result in no change to this resource.	Temporary effects to wildlife habitat which would result from TSP/B50-A25 include the decreased attractiveness of habitat adjacent to the project corridor and possible disturbances to normal wildlife behavior patterns due to increased noise levels from construction activities. TSP/B50-A25 would result in direct, short-term, adverse impacts on wildlife habitat and habitat values including habitat loss through its conversion to surface water conveyance infrastructure and maintained ROW.	Temporary effects to wildlife habitat resulting from the 1990 Authorized Plan include the decreased attractiveness of habitat adjacent to the project corridor and possible disturbances to normal wildlife behavior patterns due to increased noise levels from construction activities. The 1990 Authorized Plan would result in direct, short-term, adverse impacts on wildlife habitat and habitat values including habitat loss through its conversion to surface water conveyance infrastructure and maintained ROW.
Nuisance and Noxious Species	The No Action Alternative would result in no change to this resource other than what would occur under natural conditions of species migration.	Maintenance practices within the bayou ROW will control invasive plant species to some extent.	Maintenance practices within the bayou ROW will control invasive plant species to some extent.
Ecosystems and Fragmentation *(see wildlife habitat and habitat values above)*	The No Action Alternative would result in no change to this resource.	The most substantial permanent impact would be to small, highly fragmented, primarily low quality wetlands. The TSP/B50-A25 would not further fragment remaining large contiguous areas or corridors of natural habitat, but would permanently impact isolated tracts of upland habitat. The upland habitat is primarily low to medium quality mixed hardwood and scrub-shrub uplands consisting mainly of young tree growth, predominantly in the offline detention basin with a mixture of common native and nonnative species and would not be considered a unique or rare ecosystem type. The upland herbaceous areas containing remnant prairie species that would be impacted is very small (3.2 acres), is currently being encroached by woody species, and would therefore provide negligible prairie fauna habitat.	The 1990 Authorized Plan would affect the upper segment similar to the other build alternatives, except for the detention area. No habitat fragmentation is anticipated for the middle and lower bayou as the widening plan will increase the bayou's capacity to carry additional flows. Affected riparian areas will be essentially replaced through plantings.
Managed and/or Protected Areas	The No Action Alternative would result in no change to this resource.	No managed habitat areas exist in the upper segment.	No managed habitat areas exist in the middle and lower segments.

7.0 PUBLIC INVOLVEMENT AND AGENCY COORDINATION

This chapter overviews the public involvement and agency coordination process the non-federal sponsor, HCFCD, has implemented by developing FRM measures for Hunting Bayou. The opportunity for public input into the Hunting Bayou TSP development was strongly encouraged by the non-federal sponsor, HCFCD, during the planning projects. The public was invited and encouraged during various public meetings conducted during the plan reformulation process to contribute and make concerns known during community organization meetings and by input provided by the citizen advisory committee.

Public involvement activities occurred primarily during the period of 1998 through 2007. During this period, B60-A75 was identified as the locally preferred alternative, in part based on input from stakeholders. Starting in 2007, the non-federal sponsor initiated design and construction efforts for B60-A75 at their own risk, in accordance with Section 211(f) WRDA 1996. Continued coordination with the affected neighborhood has occurred regularly over the following years, as is documented in Section 7.1.1. Public input assisted in the process of identifying a LPP which provides the greatest risk reduction from potentially catastrophic events to a socially and economically vulnerable population while minimizing population displacements and other impacts to the surrounding community and natural resources to the extent possible.

7.1 Public Involvement and Scoping

Involvement and dissemination of information to the general public has been accomplished through various methods including public meetings, published notices and newsletters. A list with the general public meetings held is shown in *Table 7-1*.

Table 7-1:
General Public Meetings

Date	Location	Purpose
June 11, 1998	Houston Public Library, Kashmere Gardens Branch	Public scoping: present proposed action and explain public's role in project planning/scoping.
September 2, 1998	Kashmere Multi-Service Center	Study update including info on establishment of citizens' advisory committee.
September 23, 1999	Kashmere Multi-Service Center	Study update with objectives and constraints, economic criteria, and conceptual measures being considered.
October 4, 2000	Kashmere Multi-Service Center)	Study update for upper watershed. Present optimal plan and options being considered for various parts of the watershed.
October 12, 2000	Good Shepherd Methodist Church	Study update for lower watershed. Present optimal plan and options being considered for various parts of the watershed.
March 25, 2003	Kashmere Multi-Service Center	Study update. Present 5 alternatives being considered for upper watershed.

Date	Location	Purpose
April 21, 2003	Francis Scott Key Middle School	Study update. Present 6 alternatives being considered for upper watershed.
November 10, 2007	St. Francis of Assisi Catholic Church	Present information of project being considered for Hunting Bayou.

A synopsis is provided in the following paragraphs for each meeting, the public notice and newsletters.

June 11, 1998 Meeting

A public scoping meeting was held on June 11, 1998, at the Houston Public Library, Kashmere Gardens Branch. The announcement for the scoping meeting was published in the *Houston Chronicle* on May 12 and 27, 1998. Meeting notices were also mailed to 74 elected officials, government agencies, local organizations, civic groups, the media, businesses and interested citizens. The meeting's purpose was to invite and encourage members of the public and government agencies to help determine the scope of significant issues to be examined in the proposed Draft GRR/EA for reformulating the flood damage reduction plans for the Hunting Bayou watershed. A presentation by the non-federal sponsor, HCFCD, explained the proposed action and the public's role in project planning/scoping. The public was then invited to comment on specific factors they would like to be considered in the Draft GRR/EA. One speaker commented at the meeting, and three written comments were provided. Issues raised included the need for additional drainage outlets and identifying some of the past flooding problems in the area (streets and houses flooded).

September 2, 1998 Meeting

On September 2, 1998, a public information meeting was held at the Kashmere Multi-Service Center to provide an update on the study. The announcement for the public meeting was published in the *Houston Chronicle* and the *North Channel Sun.* Approximately 2,000 meeting notices were mailed to elected officials, government agencies, local organizations, civic groups, the media, businesses and interested citizens. The meeting consisted of a presentation by the non-federal sponsor, HCFCD, updating the activities which had occurred since the June 1998 scoping meeting. This included information on establishing a citizens' advisory committee described below, a discussion about past flood problems, and the concepts being considered to solve flooding problems. The public was then invited to participate in a question and answer period. Ten speakers commented at the meeting. Issues raised included the need for coordination with local government entities concerning local street flooding and roadside ditch issues, mobility/transportation problems during flood events, residential flooding, bayou clean-out issues, and flood impacts concerning emergency response (police/fire protection issues) in the area.

September 23, 1998 Meeting

A second public information meeting was held at the Kashmere Multi-Service Center on September 23, 1999. The announcement for the public meeting was published in the *Houston Chronicle* and the *North Channel Sun.* Approximately 40,000 meeting notices were mailed to elected officials, government agencies, local organizations, civic groups, the media, businesses and interested citizens. The meeting consisted of a presentation by the non-federal

sponsor, HCFCD, to provide an update on the study and included a discussion about various activities and analyses performed since the September 2, 1998 meeting. This included information on developing objectives and constraints for the study.

October 4 and October 12, 2000 Meetings

During October 2000, two public information meetings were held. The first meeting on October 4, 2000 was held at a site in the upper watershed (the Kashmere Multi-Service Center), and the second meeting on October 12, 2000 was held in the lower part of the watershed at the Good Shepherd Methodist Church. The announcements for the public meetings were provided by mailing 505 newsletters concerning the study and distributing 1,038 flyers to neighborhood groups. Meeting notices were also mailed to approximately 40,000 elected officials, government agencies, local organizations, civic groups, the media, businesses and interested citizens. The meetings consisted of a presentation by the non-federal sponsor, HCFCD, to provide an update on the study, and included a discussion about various activities and analyses performed since the September 1999 meeting. This included information on identifying the Optimal Plan and options to that plan in the upper watershed and the lower watershed. The public was then invited to participate in a question and answer period. Five speakers commented at the meeting held in the upper watershed, and 13 speakers commented at the meeting in the lower watershed. Issues raised included possible channel straightening, local/lateral flooding concerns, using the large detention site for recreational activities, tidal concerns, suggestions for using pumping to remove floodwaters from Hunting Bayou, concerns about relocations and property values, existing bayou maintenance issues, bridge construction/closure concerns, concerns about an increase in mosquitoes with the development of the detention basin, and park enhancements. No opposition to the proposed flood damage reduction project was expressed by the public or agencies, either at the public information meetings or in written correspondence.

General Re-evaluation Report and Environmental Assessment (GRR/EA)

Throughout preparing this Draft GRR/EA, an effort has been made to locate, inform and seek input from interested individuals and organized groups. This effort included issuing public notices and press releases, and holding scoping and public information meetings. Individuals who submitted correspondence or who requested to be added to the mailing list will be sent copies of all future public notices, including public notices for public meetings. The findings of the Environmental Assessment will form the basis for a decision to prepare and circulate for comment and review a Finding of No Significant Impact or a determination that an environmental impact statement is necessary.

The USACE originally published a Notice of Intent to prepare an EIS in August 2002. Since that time, plan formulation and reevaluation have reduced the magnitude and extent of proposed FRM facilities. Therefore, the USACE and the non-federal sponsor, HCFCD, decided to evaluate impacts in an EA. A Supplemental Environmental Impact Statement would be prepared if the EA results indicate potentially significant adverse environmental impacts. A withdrawal notice of the original Notice of Intent to prepare an EIS was published in the Federal Register on July 03, 2013.

March 25 and April 21, 2003 Meetings

During March and April 2003, two public information meetings were held in the upper watershed. The first meeting was held at the Kashmere Multi-Service Center on March 25 2003,

and the second was held at the Francis Scott Key Middle School on April 21, 2003. The second public information meeting was necessary to allow the public a better opportunity to express their views concerning the plans discussed at the first meeting, since there was an overflow crowd at the first meeting location (greater than 300 persons attended, with some people having to be turned away). Between 6,000 and 7,000 meeting notices were mailed to homeowners located mostly in Hunting Bayou's upper watershed announcing the two meetings.

The first meeting consisted of a presentation by the non-federal sponsor, HCFCD, about the project and included a discussion on various activities and analyses performed since the October 2000 meetings. This included information on five possible alternatives being considered for the project in the upper watershed. The public was then invited to comment on the possible alternatives. Sixteen speakers commented at the first meeting. The public generally agreed some type of flood control measures should occur; however, some were very concerned about the potential impacts from any forced relocations and buyouts on the elderly and low-income people living in the area and the general land acquisition process. In addition to the 16 speakers at the first meeting, greater than 300 written comments/questions were provided as a result of the meeting. The public generally indicated they wanted more specific information on the alternatives and potential impacts that would occur.

The second public information meeting conducted by the non-federal sponsor, HCFCD, in 2003 (on April 21, 2003) consisted of a presentation consistent with the presentation on March 25, 2003. During the presentation, the non-federal sponsor, HCFCD, personnel received several written comments/questions from the public and responded to them at the meeting. They also answered some questions received as a result of the March 25, 2003 meeting. In addition to the written comments/questions responded to, 12 speakers commented at the meeting. Overall, approximately 160 written comments/questions were provided as a result of the meeting.

November 10, 2007 Meeting

The non-federal sponsor, HCFCD, hosted a community update meeting on November 10, 2007 at St. Francis of Assisi Catholic Church attended by 325 residents. Harris County Commissioner El Franco Lee and U.S. Congressman Gene Green, HCFCD Precinct Coordinator Curtis Lampley and Project Manager Bill St. John presented on the Hunting Bayou project. An open house with exhibits preceded and followed the meeting.

Newsletter

The joint HCFCD/USACE periodic newsletter *Flow* has been presenting information on the Hunting Bayou federal study since 1999. These newsletters have provided information on study alternatives being considered, meeting notices, synopses for meetings held, general flooding and insurance information and in later editions, the flood damage reduction plan being considered for implementation. These have been generally distributed within the parts of the watershed being affected by alternatives or plans being considered, and in conjunction with public meetings as described above.

7.1.1 Community Organization Meetings

Information on the Hunting Bayou federal study and project has also been presented at various community organization meetings summarized in *Table 7-2*.

Table 7-2:
Community Organization Meetings

Date	Location	Purpose
January 2006	Northeast Concerned Citizens Civic League Meeting	Discuss the federal study/project
November 2006	COH Land Assemblage Redevelopment Authority Meeting	Discuss the federal study/project and partnering to assist with relocating families into affordable homes
May 2007	Houston Habitat for Humanity Meeting	Discuss the federal study/project and partnering to assist with relocating families into affordable homes
November 2008	Houston Gardens Civic Club Meeting	Discuss Project Hunting

In addition to the community organizations listed above, the majority of post-2007 outreach has been coordinated with the Kashmere Gardens Super Neighborhood Council, a COH-recognized council of stakeholders for the Kashmere Gardens Super Neighborhood, which encompasses the entire TSP project area. A super neighborhood is a COH-geographically designated area where residents, civic organizations, institutions and businesses work together to identify, plan and set priorities to address their community's needs and concerns. The Kashmere Gardens Super Neighborhood Council represents the vast majority of local stakeholders impacted/benefitted by the project, and was determined to be the most appropriate venue for continued outreach as HCFCD acquires real estate and initiates construction of the TSP. The meeting topics have evolved with the progression of each phase of study and initial construction. Previous topics included discussion of the project alternatives and identification of the TSP. More recent meeting topics have dealt with volunteer residential property acquisitions, the detention basin acquisition, and initial stages of construction for the detention basin and interim channel improvements. All meetings offer the public additional opportunities to submit comments and/or discuss concerns with the non-federal sponsor, HCFCD. Regular on-going meetings with the Kashmere Gardens Super Neighborhood Council are listed below by year and date.

2006
August 8, 2006
September 12, 2006
December 12, 2006

2007
March 17, 2007
May 15, 2007
June 12, 2007
September 11, 2007
December 11, 2007

2008
March 11, 2008
July 8, 2008
October 14, 2008

2009
February 10, 2009
March 10, 2009
July 14, 2009

2010
January 12, 2010
May 11, 2010
October 12, 2010

2011
March 8, 2011
August 16, 2011

2012
May 8, 2012
June 16, 2012

2013
June 22, 2013

2014
March 11, 2014

7.1.2 Other Public Involvement and Communication

In addition to meetings, project status update letters were mailed on March 7, 2007 to 7,500 residents in the current TSP project limits, and a response to a constituent letter from Senator Kay Bailey Hutchison was mailed January 11, 2007. Personnel from the non-federal sponsor, HCFCD, also conducted a tour of an existing stormwater detention basin with area residents on April 14, 2008 to show them what their basin could potentially look like and how it could function with the completed Hunting Bayou project. The non-federal sponsor, HCFCD, has also attended monthly meetings between 2004 and 2008 with Commissioner El Franco Lee to update the commissioner on the federal study and project status.

7.1.3 Citizen Advisory Committee

In addition to conducting public information meetings, a citizen advisory committee was established to provide a method to communicate with the various stakeholders and to solicit comments on the project. The advisory committee included those with stakeholder interests from public works, environmental, recreational, community and political leaders. A list of the specific interest groups included on the committee follows.

- Harris County Flood Control Task Force
- Bayou Preservation Association
- The Park People
- COH Parks and Recreation Department
- Super Neighborhood 52 – Kashmere Gardens
- COH Department of Public Works and Engineering
- Harris County Precinct 1
- Harris County Precinct 2
- Greater Houston Partnership
- Jacinto City
- Galena Park
- North Channel Chamber of Commerce
- Citizen and Civic Group Participation

Committee meetings generally consisted of an update on the study status, ongoing activities (analyses and findings) and a future schedule. The committee members also participated in question and answer sessions during these meetings.

7.2 Agency Coordination

Various federal and state resource agencies were consulted prior to and during the Draft GRR/EA preparation. The following sections document the agencies contacted and summarize the outcome from agency coordination and involvement during this study.

7.2.1 Agencies Contacted

The federal and state resource agencies were either contacted in writing (mailing public notices, public meeting announcements or coordination letters), through announcements published in local newspapers, through direct coordination by using the telephone and e-mails, or at scheduled meetings during the course of the study.

The agencies contacted are listed below, and copies of typical coordination letters and any responses received from the various agencies are provided in *Appendix 1*, Attachments C and F.

7.2.1.1 Federal Government and Agencies

- National Marine Fisheries Service (NMFS)
- Natural Resources Conservation Service (NRCS)
- U.S. Environmental Protection Agency (EPA), Region 6
- U.S. Fish and Wildlife Service (USFWS)

7.2.1.2 State Government and Agencies

- Coastal Coordination Council
- Texas Commission on Environmental Quality (TCEQ)
  - Air Quality Planning and Assessment Division
  - Environmental Strategic Assessment Group
  - Industrial and Hazardous Waste Department
  - Office of Policy and Regulatory Division
  - Water Permits and Resource Management Division
  - Water Quality Division
- Texas Department of Transportation (TxDOT)
- Texas General Land Office
  - Coastal Division
  - Texas Coastal Management Program
- Texas Historical Commission (THC)
- Texas Parks and Wildlife Department (TPWD)
  - Resource Protection-Upper Coast
  - Wildlife Diversity Program

7.2.1.3 Local Government and Agencies

- HCFCD
- City of Galena Park
- City of Houston (COH)
- COH Department of Public Works and Engineering
- COH Parks and Recreation Department
- City of Jacinto City
- Harris County Precinct 1
- Harris County Precinct 2

7.2.2 Agency Involvement

Agencies were initially notified about the study with the scoping meeting announcement in the *Houston Chronicle* on May 12 and 27, 1998, and by mailing notices for the scoping meeting. Initial coordination letters were provided to the following resource agencies on October 9, 1998.

- National Marine Fisheries Service (NMFS)
- Natural Resources Conservation Service (NRCS)
- U.S. Environmental Protection Agency (EPA), Region 6
- U.S. Fish and Wildlife Service (USFWS)
- Texas Coastal Coordination Council
- Texas General Land Office
- Texas Historical Commission (THC)
- Texas Commission on Environmental Quality (TCEQ), formerly the Texas Natural Resource Conservation Commission
- Texas Parks and Wildlife Department (TPWD)

Announcements for the various public information meetings were also provided to these agencies; however, no official representatives from these agencies attended any of the public information meetings. On September 6, 2000, resource agency representatives from the Texas Coastal Coordination Council, TCEQ and TPWD were briefed on the progress of the study and potential impacts during one of the scheduled Joint Evaluation Meetings regularly conducted by the USACE's Regulatory Branch. The briefing consisted of a presentation about the study and included a discussion on various activities and analyses performed since the starting the study. This included information on identifying the Optimal Plan which had been developed, options to that plan in the upper watershed and the lower watershed, and what potential impacts had been identified at the time of the meeting. Comments from the agencies in attendance concerned water quality issues and potential impacts to wetland areas and mitigation. The TPWD indicated they would want to see some mitigation activities conducted along the lower side slopes or bottom of the proposed channel to allow for water quality and habitat improvements. The agency representatives also indicated they would like to be briefed again, along with their normal NEPA reviewers, after specific impacts had been identified.

On October 16, 2001, the non-federal sponsor, HCFCD, mailed a letter to all the resource agencies listed above, along with one to the TxDOT to set up a resource agency meeting for two of the three Section 211 projects it was conducting for Hunting Bayou and White Oak Bayou. Based on resource agencies' responses, a meeting was scheduled for Tuesday, January 8, 2002. E-mails were also sent to the agencies informing them about the meeting schedule. Prior to the scheduled meeting, the SHPO requested information on the proposed plan (the modified NED Plan) be provided for its review. The requested information was provided to the SHPO on December 13, 2001, and included a layout for the proposed ROW for the plan and a brief description of the plan. Mr. William "Jamie" Schubert, TPWD, was the sole agency representative in attendance at the January 2002 meeting.

Since 2001, the non-federal sponsor, HCFCD, has held periodic meetings with a core group of resource agencies to provide information on the study status and request input on the study.

The non-federal sponsor, HCFCD, has also coordinated with certain agencies through the course of this study for specific issues. A synopsis of coordination with specific agencies follows.

7.2.2.1 State Historic Preservation Officer (SHPO)

As discussed in Chapter 5, consistent with SHPO's recommendations in their November 6, 1998, correspondence, an archeological survey for the project area was conducted under Texas Antiquities Permit No. 2431. The documentation and findings from the survey and assessment are contained in the report titled, *Archeological Survey and Cultural Resources Assessment of Hunting Bayou and Surrounding Area, Harris County, Texas* (Greenstone Geoscience 2001). The SHPO indicated its concurrence with the findings and recommendations contained in the June 2001 archeological survey and cultural resources assessment report in correspondence dated April 19, 2001 and August 16, 2001 (see THC correspondence contained in *Appendix 1*, Attachment F).

As a result of transmitting information to the SHPO, additional correspondence was received during January 2001 indicating archeological surveys and additional information may be needed concerning the residences, apartments and businesses constructed prior to 1956 and may be relocated as part of the TSP (see SHPO THC letter dated December 13, 2001, postmarked January 14, 2002, contained in *Appendix 1*, Attachment F). Consistent with the THC recommendations, an additional archeological survey and historical reconnaissance was conducted under Texas Antiquities Permit No. 2842. The documentation and findings from the survey and reconnaissance are contained in the draft report titled: *Archeological Survey and Historical Reconnaissance of Hunting Bayou and Surrounding Area, Harris County, Texas* (Greenstone Geoscience 2002b). The study's conclusions indicated neither the archeological (subsurface) survey nor the historical reconnaissance found any evidence of historically or archeologically significant materials or structures within the TSP project area. No building within the project area met the consideration criteria for placement on the NRHP, nor did any area meet these criteria as a district. No prehistoric material was recovered during this phase of the work nor was any surface suitable for prehistoric occupation uncovered. Greenstone Geoscience recommended this project proceed with no further investigation. Copies of this study were provided to the THC for review and comment.

As discussed in Chapter 5, an updated survey and evaluation for affected bridges and structures was conducted in January 2008 to determine NRHP eligibility. The study concluded no historical engineering structures would be impacted; therefore, none of the 17 bridges are identified for listing in the NRHP. Bridge survey reports are available upon request. The SHPO indicated its concurrence with the findings in correspondence dated April 9, 2008 (see THC Correspondence in *Appendix 1*, Attachment F).

Due to the length of time elapsed since the last historical reconnaissance survey, in 2010 the THC indicated the need to reevaluate the project area for historical resources. A Phase I History / Architectural survey was submitted to the THC. The THC concurred with the conclusion the structures in the survey area did not retain enough integrity to be eligible for inclusion in the NRHP individually or as a historical district. THC noted one exception, which was the M.W. Sinai Grande Lodge A.F. and A.M. building at 5002 Wipprecht Street. THC's opinion was this structure is eligible under Criterion A for Social History and Ethnic heritage, because it is a continued fraternal organization and is an important institution in the Kashmere Gardens community. The THC determined the TSP would clip or displace the chain-link fence

surrounding the property and remove approximately one-third of the property facing Hunting Bayou (see *Appendix 6 – Real Estate Plan*). The structure itself would not be demolished, and the TSP would not impact the building's eligibility or integrity; therefore, the determination "No Historic Properties Affected: Project May Proceed" was determined. As part of the construction contracting efforts and final design, an Unanticipated Discoveries Plan may need to be developed to include an INADVERTENT FINDS legal provision which would be made part of requirements and included with site development specifications. If, during construction activities, archeological or historical remains are uncovered, construction would immediately cease and the SHPO would be notified. Through coordination with the SHPO and implementing protective covenants and required mitigation agreements, no impacts to archeological resources would result from implementing TSP (see *Appendix 1*, Attachment F).

7.2.2.2 Texas Department of Transportation (TxDOT)

On October 24, 2001, a meeting was held with the TxDOT to obtain information concerning bridges and traffic within the study area. Information on bridge safety and peak traffic flow was obtained from that meeting. The TxDOT personnel indicated they would need to be included in any final bridge design plans for the project, would need to approve those plans, and would need to be involved during the project construction phase. As a plan became identified, the non-federal sponsor, HCFCD, coordinated with the TxDOT regarding bridge modifications intended for the TSP, to ensure planned road improvements by the TxDOT, including bridge crossings, could accommodate TSP's needs. This coordination, initiated in 2006, was to ensure the TxDOT reconstruction of these bridges would more easily allow future modifications to Hunting Bayou required by the TSP. Through an Interlocal Agreement, $2 million has been provided to the TxDOT for their use in reconstructing three IH 610 main lanes and two feeder roads (upstream from Liberty Road at Kirkpatrick) and the Kelley Road overpass across IH 610. The TxDOT had finished reconstructing these bridges as of 2011. The IH 610 main lanes and feeder roads are included as part of the 17 bridges proposed for reconstruction as part of the TSP. The Kelley Road bridge is not included with the 17 bridges, because the proposed plan for the new Kelley Road bridge would accommodate the TSP channel width requirements.

7.2.2.3 U.S. Fish and Wildlife Service (USFWS)

Correspondence regarding coordination with the FWCAR is also contained in *Appendix 1*, Attachment C. This includes an initial 1998 coordination letter and reply documenting no threatened or endangered species under USFWS jurisdiction is likely to occur within the areas proposed for a possible project. A USFWS fish and wildlife planning aid letter was received on January 11, 2007. The letter provided input regarding TSP impacts to wildlife resources. A third-party consultant also prepared the FWCAR on behalf of the USFWS. The final FWCAR was submitted June 2008. In a letter dated August 22, 2008, the USFWS concurred with the FWCAR.

7.2.2.4 Texas Parks and Wildlife Department (TPWD)

The non-federal sponsor, HCFCD, held a meeting with TPWD on February 18, 2009 to discuss the habitat modeling and mitigation for the proposed TSP. The three topics discussed were 1) the habitat impact assessment results, 2) the proposed mitigation for the federal study, and 3) TPWD's February 5, 2009 comments on the resource agency meeting's summary meeting notes the non-federal sponsor, HCFCD, provided. The TPWD provided feedback on the models used for the habitat impact assessment. The non-federal sponsor, HCFCD, provided information

and answered questions regarding the planned mitigation for non-wetland impacts. The non-federal sponsor, HCFCD, briefed TPWD on the proposed wetland mitigation and status for ongoing site investigations for the inline detention landfill tract where mitigation was proposed. The TPWD explained and discussed their comments on the resource agency meeting notes summary. As discussed in Section 5, on July 30, 2009 and again in December 2012, the non-fedeal sponsor coordinated with the TPWD to receive updated protected species or species of concern information contained in their TxNDD. The latest TxNDD data was provided on December 10, 2012. Based on the data received, the following federally listed species were documented within a 10-mile radius of the project area:

- Bald eagle (Haliaeetus leucocephalus)
- Texas prairie dawn (Hymenoxys texana)
- Houston toad (Anaxyrus houstonensis)

Qualified biologists, including local flora expert Dr. Larry Brown, have conducted flora and fauna surveys including presence and absence surveys for T&E species for the TSP. No listed species were documented during the surveys.

The USFWS has indicated no threatened or endangered species under its jurisdiction are likely to occur within the areas proposed for improvement (USFWS 1998). The NMFS provided a list of T&Es. However, in these cases there are no known documented rare, T&E plants, animal, invertebrates or exemplary natural communities in the immediate vicinity of proposed construction.

7.2.3 Required Agency Filings

Consistent with 40 CFR 1506.9 requirements, copies of the Draft GRR/EA and Final GRR/EA will be filed with the Director, Office of Federal Activities, EPA, in Washington, D.C. Copies would also be circulated to those federal and state agencies with jurisdiction or regulatory authority for review consistent with 40 CFR 1502.19. These agencies will have additional opportunities to comment. These opportunities would be after distributing the Draft GRR/EA, which has a 45-day public comment period, during the Public Hearing within the public comment period, and after distributing the Final GRR/EA. Federal agencies are required to prepare EAs in accordance with 40 CFR 1502, and to file the EAs with EPA as specified in 40 CFR 1506.9. As of October 1, 2012, federal agencies file an EA by submitting the complete EA, including appendices, to the EPA through the *e-NEPA* electronic filing system.

The CWA Section 404 (b)(1) Evaluation Review (Short Form) and a Section 401 Water Quality Certification Tier II Questionnaire and Alternatives Analysis Checklist in accordance with Title 30, Texas Administrative Code Section 279.1-13 were developed and are provided in *Appendix 1*, Attachment E.

7.2.4 Placeholder for Study Authority Consultation with Native American or Tribal Nations

In the Greenstone Geoscience findings of 'no effect' (on historic or pre-historic native Indian resources), the level of coordination necessary for the project was discussed with SWG. A comprehensive list of tribal nation contacts will be provided with the NEPA document along

with a letter specifically requesting their input as necessary. This input will be requested during the period allocated for public review of the NEPA document.

8.0 CONCLUSIONS, RECOMMENDATIONS AND A COMPARISON OF THE 1990 AUTHORIZED PLAN WITH THE TENTATIVELY SELECTED PLAN (TSP) AND NATIONAL ECONOMIC DEVELOPMENT (NED) PLAN

The 1990 Authorized Plan is no longer the preferred plan for implementation. Reevaluating the 1990 Authorized Plan indicates a less environmentally damaging alternative exists. The TSP, an alternative to the 1990 Authorized Plan, can better achieve planning goals and objectives than can the 1990 Authorized Plan. The TSP involves fewer ROW and mitigation acquisitions, fewer population displacements and fewer impacts to natural resources than what the 1990 Authorized Plan would require for implementation. Implementing the TSP reduces risk from the 1 percent AEP (100-year) event to 4,465 structures; 645 structures remain at risk to an event with a 1 percent or less AEP. Without the project, AAEV inundation damages are estimated at $19.8 million. With the TSP implemented, AAEV residual inundation damages are estimated at $5.4 million – a $14.4 million (73 percent) reduction in AAEV inundation damages. These values are presented at the 2Q13 FY13 price level at FY2014 a 3.50 percent federal discount rate.

The NED Plan, B50-A25, reasonably maximizes net excess benefits at least cost, but induces flood damages downstream--a consequence of the plan the non-federal sponsor, HCFCD, desires to avoid. The non-federal sponsors LPP, B60-A75, which has been named the TSP, produces comparable net excess benefits to the NED Plan with greater overall risk reduction than the NED Plan without inducing damages at the 1 percent or more frequent AEP event. However, the TSP is more costly than the NED Plan. The nonfederal sponsor prefers the TSP's performance over the NED Plan. The TSP is therefore the recommended plan for implementation. To propose an LPP more costly than the NED Plan, an exception from ASA(CW) is required. Approval from ASA(CW) to recommend B60-A75 as the LPP was obtained in May, 2014. The non-federal sponsor, HCFCD, will pay the difference between the TSP's total project cost over the NED Plan. Extensive public outreach specifically oriented to minority and low income residents in the project area was achieved throughout the reevaluation study. These efforts resulted in the basic understanding that while the public wanted effective remedies for the flooding problems affecting the watershed and project area, these remedies had to be accomplished by minimizing adverse effects on families and neighborhoods. The TSP would use available land for detention and limit the excavated channel's bottom width to minimize displacements to only those necessary to implement an effective and complete flood risk reduction project.

The TSP consists of the following major features.

- Excavate approximately 905,882 cubic yards of earthen material to widen and deepen the Hunting Bayou channel. The channel would be constructed as an earthen, grass-lined, trapezoidal channel with a 60-ft bottom width and 4:1 side slopes ratio extending from the Hunting Bayou's upstream end at US 59 to 0.3 miles downstream from ERRY. The channel's width would approximately double from the existing conditions, and would range from 100 to 300 ft wide along the 3.8-mile project length.
- The constructed Hunting Bayou channel segment through ERRY would be a concrete-lined open channel to replace the existing culverted concrete-lined channel.

- Construct an approximate 75-acre offline detention basin east of Homestead Road.
- Bridge replacements or extensions along the proposed channel improvements length would consist of replacing 10 roadway bridges, three railroad bridges and four pedestrian bridges.
- Mitigate wetlands for unavoidable project effects by purchasing wetland mitigation bank credits to offset identified impacts. Mitigation has not been implemented as of the date of this report.
- Potentially use three currently vacant upland disposal sites for placing excavated material identified as Disposal Sites 4, 5a and 6. Re-use project excavated soil at a fourth site. The UPRR Disposal Tract adjacent to the proposed offline detention basin is also being used for construction fill for a planned intermodal rail yard expansion by UPRR.
- Displace some commercial and residential property.

As shown in *Table 8-1*, the TSP's total economic first cost is $183.5 million with total annual cost of approximately $7.8 million. Net excess benefits (i.e., the benefits minus costs) are $7.4 million, and the BCR is 1.92. *Table 8-1* shows $29 million has been expended by the non-federal sponsor, HCFCD, for an alternative to the 1990 Authorized Plan. Under the authority of Section 211, WRDA 1996, as amended, and specifically Section 211(f)(7) WRDA 1996, as amended, the non-federal sponsor, HCFCD, can proceed with implementing improvements or an alternative for such element for Hunting Bayou, Texas, as authorized by Section 101(a)(21) of WRDA 1990 (Public Law 101-640). The non-federal sponsor, HCFCD, has made expenditures at its own risk.

Table 8-1:
TSP Annual Project Cost and Benefit Summary, 2Q2013 Prices, FY14 Interest Rate

GRR Study Cost	**$9,334,488**
Constructed Work, EOY 2007-2013*	**$20,104,891**
01--Lands and Damages	$11,940,013
02-Relocations	$1,395,447
30- PED	$2,510,823
31-Construction Management	$4,258,608
Unconstructed Work, EOY 2013-2021	**$124,880,248**
01--Lands and Damages (includes least cost mitigation)	$11,942,201
02-Relocations	$48,808,261
09-Channels and canals	$14,662,956
15-Floodway Control and Diversion Structures	$14,092,502
30- PED	$4,616,000
31-Construction Management	$7,757,000
Contingencies-22.6 percent **	$23,001,328
Project First Cost	**$144,985,139**
IDC	$28,535,540
Uncompensated NED Losses	$618,590
Total Economic First Cost	**$183,473,757**
Annualized Economic First Cost	$7,822,167
Annual O&M	$168,756
Total Annual Cost	$7,990,923
Total Annual Cost in $1,000s	$7,991
Annual Benefits in $1,000s	$15,364
Net Excess Benefits (benefits-costs)	$7,373
Benefit-Cost Ratio (benefits/costs)	1.92

**Constructed costs are actual costs-to-date with no inflationor interest added.*
***contingency established as a result of ATR review*
Notes: 3.5 percent interest rate, FY13 Price level
Project Code 30 is PED for TSP only.
Expended PED costs at time of GRR are considered sunk costs and are not counted in the IDC computations.
Project Micro-Computer Aided Cost Estimating System, Version 4.1 (MCACES), Second Generation costs not assigned to a construction contract are spread throughout the entire projected contract activity schedule.
For IDC calculation, Contract costs spread uniformly over contract period
O&M annual $168,756 cost includes mowing 228 acres and O&M for a 2-million-gallon-per-day lift station.

Costs expended to date are shown in *Table 8-2* and *Table 8-3* by year expended and by activity, respectively. These expenditures apply to both the TSP and to the NED Plan. Costs expended to date include preparation of the GRR/EA, design of certain project components, initial phases of detention basin construction, and limited construction of channel modifications.

Table 8-2:
Expenditures by Year

Year	Total Net Expenses
1998	$597,406
1999	$1,061,598
2000	$927,169
2001	$663,150
2002	$616,325
2003	$914,059
2004	$556,521
2005	$312,932
2006	$5,170,820
2007	$4,895,980
2008	$479,317
2009	$2,708,685
2010	$5,597,038
2011	$1,612,492
2012	$1,868,571
2013	$1,457,317
Total	**$29,439,378**

Table 8-3:
Expenditures by Activity

Expenses by HCFCD Stage & Activity	
Stage & Activity	**Net Expenses**
Construction Stage	**$4,123,576**
Construction	$4,123,576
Design	**$221,352**
Design	$221,352
Feasibility	**$9,334,488**
Planning	$9,334,488
Project Development	**$1,480,745**
PER	$1,480,745
Project Support Activities	**$808,727**
Environmental	$295,859
Geotechnical	$115,669
Materials Testing	$8,047
Public Outreach	$314,021
Survey	$75,130
Right of Way	**$13,335,460**
Right of Way	$11,940,013
Relocation	$1,017,379
Demolition	$378,068
Turnover & Startup	**$135,032**
Vegetation	$135,032
Total	**$29,439,378**

The NED Plan's economic performance is presented in *Table 8-4*. Total economic first cost is $166.3 million, net excess benefits are $6.7 million, and the BCR is 1.93. The TSP's cost share is based on the NED Plan.

Table 8-4:
NED Plan (B50-A25) Annual Project Cost and Benefit Summary, 2Q2013 Price Level, FY14 Interest Rate

GRR Study Cost	**$9,334,488**
Constructed Work, EOY 2007-2013*	**$20,104,891**
01--Lands and Damages	$11,940,013
02-Relocations	$1,395,447
30- PED	$2,510,823
31-Construction Management	$4,258,608
Unconstructed Work, EOY 2013-2021	**$105,477,352**
01--Lands and Damages (includes least cost mitigation)	$10,349,054
02-Relocations	$44,080,401
09-Channels and canals	$14,330,209
15-Floodway Control and Diversion Structures	$6,812,604
30- PED	$3,929,250
31-Construction Management	$6,548,750
Contingencies-22.6 percent **	$19,427,083
Project First Cost	**$125,582,243**
IDC	$26,665,001
Uncompensated NED Losses	$4,708,700
Total Economic First Cost	**$166,290,432**
Annualized Economic First Cost	$7,089,578
Annual O&M	$123,896
Total Annual Cost	$7,213,474
Total Annual Cost in $1,000s	$7,213
Annual Benefits in $1,000s	$13,953
Net Excess Benefits (benefits-costs)	$6,739
Benefit-Cost Ratio (benefits/costs)	1.93

**Constructed costs are actual costs-to-date with no inflationor interest added.*
**contingency established as a result of ATR review
Notes: 3.5 percent interest rate, FY13 Price level
Project Code 30 is PED for TSP only.
Expended PED costs at time of GRR are considered sunk costs and are not counted in the IDC computations.
Project Micro-Computer Aided Cost Estimating System, Version 4.1 (MCACES), Second Generation costs not assigned to a construction contract are spread throughout the entire projected contract activity schedule.
For IDC calculation, Contract costs spread uniformly over contract period
O&M annual $123,896 cost includes mowing 116 acres and O&M for a 2-million-gallon-per-day lift station

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A comparison of project features and effects is presented in *Table 8-5*. The table demonstrates the TSP is a smaller scope than the 1990 Authorized Design.

Table 8-5:
Comparison of the 1990 Authorized Plan and TSP by Project Feature

1990 Authorized Plan Description	TSP Description
Total length of 15 miles extending from the mouth of Hunting Bayou at its confluence with the HSC to the vicinity of US 59.	Widen and deepen 3.8 miles of the upper stream segment from 0.3 miles south of ERRY upstream to the vicinity of US 59.
The enlarged channel would be a trapezoidal cross-section with grass-lined side slopes of one vertical on three horizontal and areas of stone rip rap where erosive velocities would occur.	The enlarged channel would be a trapezoidal, grass-lined channel with one vertical on four horizontal side slopes.
The channel bottom width would vary from 50 ft in the upper stream segment to 100 ft in the lower stream segment.	The channel width would double, and would be at least 300 ft wide along some reaches of the 3.8-mile project length. The channel's bottom width would be 60 ft.
A total of 432 acres of ROW, of which198 acres of ROW would be in Herman Brown Park, and 385 acres for dredged material disposal would be required. Some 30 bridge modifications and replacements would be required. Over 50 pipelines including utility lines would need to be relocated.	A total of 309 acres of additional ROWs and 119 acres of disposal areas would be required. An offline detention basin would be excavated to depths of 22 ft and encompass 75 acres. Bridge modifications and replacement of 17 bridges would be required consisting of 10 roadway bridges, 3 railroad bridges and 4 pedestrian bridges, as needed for security or public safety. Construction includes a widened concrete-lined channel through ERRY. Fencing would be installed at public access points. Relocating or reconstructing some streets or construction within existing street ROWs would be required.
Would reduce flood risk from the 4 percent storm event under future development conditions. With present local drainage conditions in the watershed, would reduce flood risk from a flood greater than a 40-year flood or a flood with a 2.5 percent AEP.	With present local drainage conditions in the watershed, the plan would provide flood risk reduction from a flood ranging between 2 and 4 percent AEP frequency in the upper stream segment.
In 1990, the BCR for the 1990 Authorized Plan was 10.2, and the discount rate for FY 1988 was 8.625 percent.	The BCR for the TSP is 1.92, and the discount rate for FY 2014 is 3.50 percent.
Would reduce the 1 percent AEP floodplain area from 5,334 acres to 760 acres. About 5,093 structures would have reduced risk from the 1 percent AEP floodplain with 17 structures remaining in the residual 1 percent floodplain.	Would reduce the 1 percent AEP floodplain area from 5,600 acres to 2,250 acres. No wetlands are located in the area where floodplain was reduced. About 4,465 structures would have reduced risk from the 1 percent AEP floodplain with 645 structures remaining in the residual floodplain.
Would require displacing 125 residential family units and 15 commercial businesses.	Would require 66 single-family and multi-family displacement actions.

8.1 Recommendations

8.1.1 Tentative Selected Plan (TSP) Approval Recommended

The TSP should be approved for implementation as a federal project with such modifications thereof as may be advisable at the discretion of the Commander, USACE. Cost share is based on the NED Plan. The non-federal sponsor, HCFCD, concurs with this recommendation.

Table 8-6 compares the economic performances of the TSP, the NED and the 1990 Authorized Plan. Project performance with the period of analysis, federal discount rate and price level as reported in the authorizing document of the 1990 Authorized Plan is presented as well as the 1990 Authorized Plan's project performance under updated period of analysis, price level, current discount rate and updated cost. The TSP and NED Plan are presented at the period of analysis, price level and current federal discount rate that conform to guidance requirements and reflect current watershed conditions. The TSP and NED Plan are also presented under current conditions and at the 7 percent federal discount rate as required by the Office of Management and Budget (OMB Circular A-94 and Executive Order 12893, January 26, 1994). The 1990 Authorized Plan, when reevaluated under current watershed conditions, produced a BCR of 1.18 with net excess benefits of $3.0 million.

Table 8-6:
Comparison of the NED Plan (B50-A25), the TSP (B60-A75) and the 1990 Authorized Plan

	B50A25 3.50%	B50A25 7%	B60A75 3.50%	B60A75 7%	Authorized Plan [1]	Authorized Plan [3]
Price Level	Jan-13	Jan-13	Jan-13	Jan-13	Jan-88	Jan-13
Interest Rate	0.035	0.07	0.035	0.07	0.08625	0.035
Period of Analysis, years	50	50	50	50	100	50
Flood Control (includes Mitigation) – First Cost						
GRR Study	$9,334,488	$9,334,488	$9,334,488	$9,334,488		
Lands and Damages, Relocations	$67,764,915	$67,764,915	$74,085,922	$74,085,922		
PED and Construction Management	$17,247,431	$17,247,431	$19,142,431	$19,142,431		
Construction	$21,142,814	$21,142,814	$28,755,459	$28,755,459		
Construction Contingency	$19,427,083	$19,427,083	$23,001,328	$23,001,328		
Total First Cost	$134,916,730	$134,916,730	$154,319,628	$154,319,628	$59,581,000	$125,523,114
IDC	$26,665,001	$56,343,556	$28,535,540	$64,853,813		
Uncompensated NED Losses	$4,708,700	$2,770,489	$618,590	$363,964		
Recreation First Cost [2]	n/a	n/a	n/a	n/a	$441,000	$929,083
Total Economic Cost	$166,290,431	$194,030,775	$183,473,758	$219,537,405	$60,022,000	$126,452,197
AAEV Total First Cost						
Flood Control	$7,089,578	$14,059,441	$7,822,167	$15,907,647	$5,870,000	$5,351,516
Recreation	n/a	n/a	n/a		$62,000	$39,610
AAEV Operations & Maintenance (O&M)						
Flood Control	$123,896	$123,896	$168,756	$168,756	$193,200	$95,475
Recreation	n/a	n/a	n/a	n/a	$17,100	$8,450
AAEV Total NED Cost	$7,213,474	$14,183,337	$7,990,923	$16,076,403	$6,142,300	$5,495,052
AAEV Total NED Benefits						
Flood Control	$13,952,966	$13,952,966	$15,363,566	$15,363,566	$59,919,000	$29,610,633
Recreation	n/a	n/a	n/a	n/a	$336,400	$166,241
BCR						
Flood Control	1.93	0.98	1.92	0.96	10.2	5.39
Recreation	n/a	n/a	n/a		4.25	3.46
AAEV Net Excess Benefits						
Flood Control	$6,739,492	($230,371)	$7,372,643	($712,837)	$54,049,000	$24,115,581
Recreation	n/a	n/a	n/a	n/a	$274,400	$157,791

[1] *The authorized data is taken from Buffalo Bayou and Tributaries, Texas Feasibility Report , House Document 101-208, 1990*
[2] *Non-federal sponsor, HCFCD, is not exercising the project's recreational authority at this time.*
[3] *Update to 1990 Authorized Plan followed budget program process of escalating costs with CWCCIS indices to current prices and adjusting for differing project life and discount rate.*

8.1.2 Cost Share Allocation

> "If the sponsor prefers a plan more costly than the NED plan, the NER Plan or the combined NED/NER Plan, and the increased scope of the plan is not sufficient to warrant full Federal participation, ASA (CW) may grant an exception as long as the sponsor pays the difference in cost between those plans and the locally preferred plan. The LPP, in this case, must have outputs similar inkind, and equal to or greater than the outputs of the Federal plan.." Planning Guidance Notebook, paragraph 2-3.f (4), ER 1105-2-100, 22 April

As noted in the GRR/EA Section 1.3, Congress approved the Authorized Design for construction with WRDA 1990. As stipulated in WRDA 1996, Section 202(a), projects authorized prior to enacting WRDA 1996 (10/12/1996) have a 25 percent non-federal/75 percent federal cost share. WRDA 1986, Section 103(a) stipulates the maximum non-federal contribution will not exceed 50 percent of the total project cost. Five percent of the non-federal contribution will be cash. Exhibit E-1 of ER 1105-2-100 (22 April 2000) echoes Section 103(a) in stipulating that the maximum non-Federal contribution will not exceed 50 percent of TPC, with a 5 percent cash contribution by the non-federal sponsor and 45 percent LERR&D In this particular project, LERR&Ds, a non-federal responsibility, contribute significantly to the total project cost such that the federal cost share will assume a portion of LERR&D cost to meet the non-federal cost share 50 percent maximum contribution.

For projects recommended that are more costly than the NED Plan, cost apportionment for the Federal project will be based on the NED Plan cost. *Table 8-7* provides the cost share for the NED Plan at a 50-50 apportionment: $67,458,365 (federal) and $67,458,365 (non-federal). The total for these shares equals the $134,916,730 total project first cost. A 5 percent cash contribution is also required from the non-federal sponsor, HCFCD, for construction activities as required by Section 103(a)(1) of WRDA 1986. Both the 5 percent cash contribution by the non-federal sponsor, HCFCD, for construction and the limit adjustment to the federal contribution are highlighted in *Table 8-7*.

Table 8-7:
Cost Apportionment of NED Plan
2Q2013 (FY 2013) Price Level

Flood Risk Management Components	Federal Cost	Non-Federal Cost	Total Cost
GRR Study Cost	$4,667,244	$4,667,244	$9,334,488
LERR&D	$0	$79,637,648	$79,637,648
--Rail Bridge Modifications [1]	$318,322	$0	$318,322
Construction - Federal Cost Share	$45,536,548	$0	$45,536,548
Mitigation (least cost plan)	$0	$89,724	$89,724
Subtotal	$50,522,114	$84,394,616	$134,916,730
5% Cash	($6,745,836)	$6,745,836	$0
Subtotal	$43,776,278	$91,140,452	$134,916,730
(Percent) [2]	32%	68%	100%
50% Adjustment	$23,682,087	($23,682,087)	$0
NED Plan Total Project	**$67,458,365**	**$67,458,365**	**$134,916,730**

[1] Rail Bridge Modifications are federal cost-shared construction items re: Section 3, 1946 Flood Control Act

[2] Non-federal costs will be no less than 25 percent and not greater than 50 percent for the NED Plan, Section 103(a),WRDA of 1986.
NOTE: All costs shown are first costs. Contingency applied only to unconstructed costs.
The Section 902 cost limit is $1,658.589 million.

Table 8-8 provides the cost allocation for the TSP with federal cost share based on the NED Plan as displayed in Table 8-7. The additional non-federal sponsor's, HCFCD, contribution of $19.4 million to construct the Locally Preferred Plan/TSP is shown in *Table 8-8* in addition to their NED Plan cost allocation.

Table 8-8:
Cost Apportionment of TSP
2Q2013 (FY 2013) Price Level

Flood Risk Management Components	Federal Cost	Non-Federal Cost	Total Cost
GRR Study Cost	$4,667,244	$4,667,244	$9,334,488
LERR&D	$0	$79,637,648	$79,637,648
--Rail Bridge Modifications [1]	$318,322	$0	$318,322
Construction - Federal Cost Share	$45,536,548	$0	$45,536,548
Mitigation (least cost plan)	$0	$89,724	$89,724
Subtotal	$50,522,114	$84,394,616	$134,916,730
5% Cash	($6,745,836)	$6,745,836	$0
Subtotal	$43,776,278	$91,140,452	$134,916,730
(Percent) [2]	32%	68%	100%
50% Adjustment	$23,682,087	($23,682,087)	$0
NED Plan Total Project	**$67,458,365**	**$67,458,365**	**$134,916,730**
Additional NonFederal Cost of TSP		**$19,402,898**	**$154,319,628**

[1] *Rail Bridge Modifications are federal cost-shared construction items re: Section 3, 1946 Flood Control Act*

[2] *Non-federal costs will be no less than 25 percent and not greater than 50 percent for the NED Plan, Section 103(a),WRDA of 1986.*
NOTE: All costs shown are first costs. Contingency applied only to unconstructed costs.
The Section 902 cost limit is $1,658.589 million.

Table 8-9 displays the NED Plan's fully-funded cost, incorporating escalation factors for information purposes. Inflation factors are based on established planning guidance and on information derived from pertinent guidance, Engineering Manual (EM) 1110-2-1304, Civil Works Construction Cost Index. *Table 8-10* displays the TSP's fully funded cost for comparison purposes only.

Table 8-9:
NED Fully Funded Total Project Cost
Includes Escalation, 22.6 Percent Contingency and FY 2013 Baseline Prices

WBS Structure		TOTAL PROJECT COST (FULLY FUNDED) ($1,000s)
WBS NUMBER	Civil Works Feature & Sub-Feature Description	
2	Relocations	$59,723
	Relocations Spent By Sponsor	$1,395
9	Channels & Canals	$19,646
15	Floodway Control & Diversion Structure	$8,966
1	Lands And Damages	$13,575
	Lands Spent By Sponsor	$11,940
30	Planning, Engineering & Design	$5,607
	Planning, Engineering & Design Spent By Sponsor	$11,845
31	Construction Management	$9,787
	CM Spent By Sponsor	$4,259
	Project Cost Totals:	**$146,743**

Table 8-10:
TSP Fully Funded Total Project Cost
Includes Escalation, 22.6 Percent Contingency and FY 2013 Baseline Prices

WBS Structure		TOTAL PROJECT COST (FULLY FUNDED) ($1,000s)
WBS NUMBER	Civil Works Feature & Sub-Feature Description	
2	Relocations	$65,975
	Relocations Spent By Sponsor	$1,395
9	Channels & Canals	$20,091
15	Floodway Control & Diversion Structure	$18,548
1	Lands And Damages	$ 15,491
	Lands Spent By Sponsor	$11,940
30	Planning, Engineering & Design	$6,596
	Planning, Engineering & Design Spent By Sponsor	$11,845
31	Construction Management	$10,475
	CM Spent By Sponsor	$4,259
	Project Cost Totals:	**$166,615**

8.2 Value Engineering

A value engineering study of the TSP was conducted in May 2013 and closed out in December 2013. Nine value engineering alternatives were proposed and subsequently rejected for project implementation, with concurrence from USACE-SWG. The value engineering study report is on file with USACE-SWG value engineering officer, Jon Plymale. Another value engineering study

will occur in the PED phase of the plan implementation, per previous discussions with the USACE-SWG project team.

8.3 Plan Implementation

The TSP is the plan proposed for implementation. The TSP complies with all USACE policies including those under Section 211 of WRDA 1996. The TSP is economically justified based on the net excess benefits which have been calculated for the plan. TSP components are technically feasible and environmentally acceptable, and the plan is in compliance with all NEPA requirements. All TSP components comply with USACE standard policies and are proposed for federal cost-sharing.

Under the authority of WRDA 1996 Section 211, the non-federal sponsor, HCFCD, has constructed some of TSP's flood risk reduction components. The components which have already been constructed and those planned to be constructed are compatible with the TSP, as required by Section 211 (e)(2)(B). Cost-sharing for the constructed items has been shown in conformance with USACE requirements.

Implementing the remaining project components and project cost-sharing for the entire project will be based on a PPA. The PPA outlines the responsibilities for the federal government and the non-federal sponsor, HCFCD, for specifically authorized new construction projects. A PPA for the Hunting Bayou federal project will be prepared upon approval of the GRR.

Mechanisms are in place to execute project construction. The non-federal sponsor, HCFCD, has experience implementing Section 211 WRDA 1996 projects, and will work with the USACE to prepare the proper documentation and audit requirements for federal reimbursement.

8.3.1 Non-Federal Sponsor, HCFCD Expenditures/Activities/Construction to Date

Costs expended to date by the non-federal sponsor, HCFCD, are shown previously in *Table 8-2* and *Table 8-3* by year expended and by activity, respectively. These costs-to-date are actual costs and do not include inflation or interest added.

8.3.2 Section 902, Water Resource Development Act (WRDA) 1986 Limitation

The Hunting Bayou 1990 Authorized Plan is part of the Buffalo Bayou and Tributaries, Texas authorization found in WRDA 1990 Section 101(a)(21). Because the authorization includes the main stem of Buffalo Bayou and its tributaries, the Section 902 calculation incorporates all tributaries included in the authorization. The USACE Section 902 Analysis Certified Tool, 2010 was used for the calculation and followed the guidance in paragraph G-15.a. of ER 1105-2-100, 30 June 2004.

WRDA 1996 Section 211(e)(2)(A) (Public Law 104-303) signed into law October 12, 1996 authorized non-federal interests to undertake major FRM projects with federal funding assistance (subject to federal funding availability) or credit for the non-federal interest for its portion of the work subject to Secretary of the Army approval. Section 211(f)(7) authorized the no-federal sponsor, HCFCD to develop a FRM alternative to the 1990 Authorized Plan for Hunting Bayou. The non-federal sponsor, HCFCD, started implementing the alternative to the 1990 Authorized Plan to reduce future flood damage as soon as possible and is doing so at its own risk. Because

Hunting Bayou was added to the 211(f) authorization, the non-federal sponsor, HCFCD, may be reimbursed for the efforts taken to reduce flood damages in the Hunting Bayou watershed as approved by the Secretary of the Army. The costs expended by the non-federal sponsor, HCFCD, to date have been included in the 902 project cost limit computation.

The 902 analysis result shows the FY 13 authorized cost of Buffalo Bayou and Tributaries inflated $1,513.116 million through construction is less than the maximum $1,658.589 million Section 902 cost limit. The Project Cost Increase Fact Sheet is included in *Appendix 5*, Attachment 1.

8.4 Non-Federal Sponsor, HCFCD, Responsibilities and Items of Local Cooperation

I recommend the Hunting Bayou Flood Risk Management Project generally as described in this report as the TSP and with such modifications as may be advisable and within statutory discretion, authorized by Section 203 of the Flood Control Act of 1968, be approved and remaining construction implemented to completion.

The Total Project First Cost for the Alternative to the 1990 Authorized Plan including features already constructed and GRR study costs totals $154.3 million. Total average annual costs for the project are $7.8 million. The Fully Funded Project Cost for the project is $166.6 million.

Cost share will be based on the NED Plan that has Total Project First Costs of $134.9 million including already constructed features and GRR study costs. Total average annual costs are $7.1 million. The Fully Funded Project Cost of the NED Plan is $146.7 million.

The non-federal sponsor is pursuing federal cost-share of implementation of the TSP, based on costs of the identified NED Plan, under its authority granted by Section 211(e)(2)(A) of WRDA 1996. To meet those requirements under Section 211, the non-federal sponsor has complied with or agrees to comply with all the stipulations for reimbursement provided by the law and with implementation guidance found in PGL 53.

In addition, the non-federal sponsor agrees to participate in and comply with applicable Federal floodplain management and flood insurance programs. Furthermore, in accordance with Section 402 of the Water Resources Development Act of 1996, as amended (33 U.S.C. 701b-12), the non-federal sponsor agrees to prepare and implement a floodplain management plan to preserve the level of flood protection provided by the project.

Prior to implementation, the non-federal sponsor, HCFCD, shall agree to perform items of local cooperation which may include, if applicable, the following.

a. May request the government accomplish Section 211 work and/or betterments. Such request shall be in writing and shall describe the Section 211 work and/or betterments to be accomplished by the government. Solely responsible for all such costs and will pay all such costs to the government in advance.

b. May elect to construct betterments during the construction period. If so, will notify the government in writing, and describe the betterments it intends to construct. Solely responsible for all costs due to the requested betterments including costs associated with

obtaining permits, and shall pay all such costs directly to its contractor or contractors and without reimbursement by the government.

c. Provide a minimum of 25 percent, but not to exceed 50 percent of total flood damage reduction costs as further specified below.

    1. Provide the required non-federal share of design costs allocated by the government to flood damage reduction in accordance with the terms of a design agreement entered into prior to commencing design work for the flood damage reduction features.

    2. Provide, during the first year of construction, any additional funds necessary to pay the full non-federal share of design costs allocated by the government to flood damage reduction.

    3. Provide, during construction, a contribution of funds equal to 5 percent of total flood damage reduction costs.

    4. Provide all lands, easements and ROWs, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on lands, easements and ROWs to enable the disposal of dredged or excavated material all as determined by the government to be required or to be necessary to construct, operate and maintain the project.

    5. Provide, during construction, any additional funds necessary to make its total contribution for flood damage reduction equal to at least 25 percent of total project costs.

d. Shall not use funds from other federal programs, including any non-federal contribution required as a matching share therefore, to meet any of the non-federal obligations for the project, unless the federal agency providing the funds verifies in writing that such funds are authorized to be used to carry out the project.

e. Not less than once each year, inform affected interests about the extent of protection afforded by the project. Publicize floodplain information in the area concerned, and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project.

f. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements and ROWs or the addition of facilities which may reduce the protection level the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function.

g. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements and ROWs required to construct, operate and maintain the project, including

those necessary for relocations, the borrowing of materials or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies and procedures in connection with said Act.

h. For so long as the project remains authorized, operate, maintain, repair, rehabilitate and replace the entire project or functional portions of the project including any mitigation features, at no cost to the federal government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal and state laws and regulations and specific directions prescribed by the federal government.

i. Give the federal government a right to enter, at reasonable times and in a reasonable manner, upon property the non-federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating or replacing the project.

j. Hold and save the United States free from all damages arising from the construction, maintenance, repair, rehabilitation and replacement of the project and any betterments, except for damages due to the fault or negligence of the Government or its contractors.

k. Keep and maintain books, records, documents or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completing the accounting for which such books, records, documents or other evidence are required, to the extent and in such detail as will properly reflect total project costs, in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20. Furthermore, in accordance with C.F.R. Section 33.26, the non-federal sponsor must comply with the Single Audit Act Amendments of 1996 (31 U.S.C 7501-7507), as implemented by the Office of Management and Budget Circular No. A-133 and Department of Defense Directive 7600.10.

l. Comply with all applicable federal and state laws and regulations including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and all applicable federal labor standard requirements including, but not limited to, 40 U.S.C. 3141-3148 and 40 U.S.C. 3701-3708 (revising, codifying and enacting without substantive change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.).

m. Perform or ensure performance of any investigations for hazardous substances that the Government or the non-federal sponsor determines to be necessary to identify the existence and extent of any hazardous substances regulated under CERCLA, Public Law 96-510, as amended (42 U.S.C. 9601-9675), which may exist in, on or under lands, easements or ROWs that the Government determines to be required for the project's construction, operation and maintenance of the project. However, for lands the federal government

determines to be subject to the navigation servitude, only the federal government shall perform such investigations in accordance with such written direction.

n. Assume, as between the federal government and the non-federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA materials located in, on or under lands, easements or ROWs the government determines necessary to construct, operate or maintain the project.

o. Agree, as between the federal government and the non-federal sponsor, the non-federal sponsor shall be considered the project's operator for the purpose of CERCLA liability, and, to the maximum extent practicable, operate, maintain, repair, rehabilitate and replace the project in a manner which will not cause liability to arise under CERCLA.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national civil works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified prior to transmittal to the appropriate authority as proposals for implementation funding. However, prior to transmittal to the Congress, the non-federal sponsors, the states, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

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