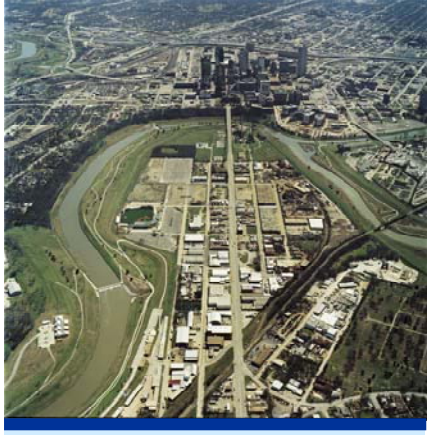

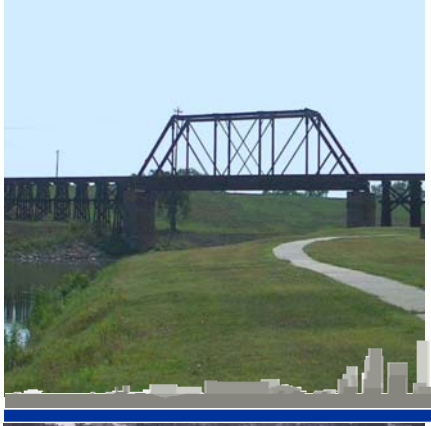

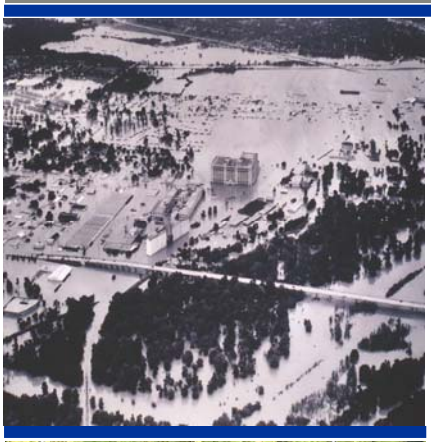

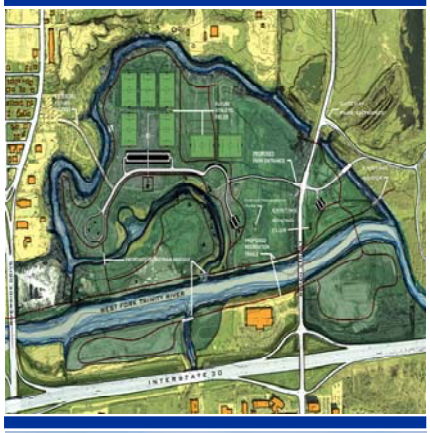

Images courtesy of CDM, Gideon Toal, and Bing Thom Architects

Fort Worth Central City Preliminary Design

Habitat Evaluations

Draft Supplement No. 1 to the Final Environmental Impact Statement

Appendix E

January 2008

Appendix E
Habitat Evaluations

BACKGROUND

Initial project planning for the Authorized Central City Project followed traditional Corps of Engineers plan formulation guidance and resulted in a formulation of a National Ecosystem Restoration Plan and a Flood Damage Reduction plan. A local plan was concurrently developed that emphasized flood damage reduction through relocation of features of the existing federal project. The local plan, as generally described in the April 2003 Trinity River Vision Master plan, was authorized by Congress prior to completion of the Corps project report. That Authorization includes limitations to total and Federal costs and requires determinations of environmental acceptability and technical soundness. Ecosystem improvements were incorporated into the Authorized "Community Based Alternative". Within the Rockwood study reach, two severed oxbows were configured and designed to achieve ecosystem restoration outputs. The largest valley storage site proposed for the Authorized Central City Project is the Riverbend site. A majority of adverse impacts of the Authorized Central City Project to riparian, wetland, and upland forest resources would be the result of increasing the valley storage capacity at the Riverbend site. Extensive riparian woodland and emergent wetland improvements were designed into the Riverbend site, however, much of those improvements are required to mitigate the adverse impacts of site development on significant habitat resources. Habitat mitigation is also required within the Authorized project to compensate for adverse impacts caused by inundation of Marine Creek, diversion of Lebow Creek, and impoundment of riparian resources associated with Samuels Avenue Dam (operational water surface elevation of 525 feet). Aquatic mitigation would be developed at Ham Branch, which surfaces at the eastern bluffs of Fort Worth and flows through Harmon Park to its confluence with the West Fork Trinity River. The total project, as documented within the Upper Trinity River Central City Fort Worth, Texas Final Environmental Impact Statement dated January 2006, with the project's environmental improvements was considered to sufficiently and totally compensate for the project's direct and induced impacts to important aquatic, wetland, riparian and upland forests. The Authorized Central City Project was ultimately administratively determined to be environmentally acceptable.

The Riverside Oxbow ecosystem restoration study resulted in an administratively approved project, which focuses on restoration of an oxbow of the West Fork of the Trinity River that had been severed during channelization of a segment of the West Fork. Key components of the approved Riverside Oxbow Ecosystem Restoration Project include removing an earthen plug at the upper end of the oxbow to connect it to the Trinity River, modification of the Beach Street crossing of the oxbow to remove an existing undersized culvert as well as fill in the oxbow and to construct a replacement span bridge. Structures would be placed in-channel to regulate flow and water depth for habitat quality and maintenance of water surface elevation within the channel. Aquatic habitat would also be improved by providing riparian forest and native grassland vegetative buffers adjacent to the oxbow. Other restoration measures of the approved plan include improving and adding additional acreages of wetlands adjacent to the remnant Sycamore Creek channel and development of two ponded areas within drying beds associated with an abandoned waste water treatment facility. Previously highly disturbed floodplain areas would be restored to native grasslands with riparian forested mottes and the forested floodplain along West Fork would be improved through selectively clearing non-native invading plant species and planting of native hard and soft mast trees. Details of the plan including projected ecosystem restoration and limited recreation benefits along with an analysis of environmental effects are discussed in detail within the Riverside Oxbow, Upper Trinity River, Fort Worth, Texas, Interim Feasibility Report and Integrated Environmental Assessment, dated April 2003. An Addendum to the Report was approved in April 2005, which removed some restoration measures from the project due to the non-essential nature of the restoration measures and their location in the floodplain.

The City of Fort Worth in June 2006 requested that the Corps consider the benefits of modifying the Authorized Central City Project by incorporating features of the Riverside Oxbow Ecosystem Restoration project and including areas within the Riverside Oxbow project as replacement hydraulic mitigation sites. The request listed seven reasons for this proposal including improving fish and wildlife habitat, real estate cost savings, and fewer impacts due to construction within the same time frame. Preliminary evaluation by the Corps of the city's proposal during the summer and early fall of 2006 indicated that such a proposal had merit. In the fall of 2006, Corps of Engineers Headquarters direct the Fort Worth District to initiate more detailed planning level investigation of the City of Fort Worth's proposal. The U.S. Fish and Wildlife Service's Habitat Evaluation Procedures (HEP) as described in their Ecological Services Manual (102 ESM 5) are the basis of the habitat evaluations used for the planning level analysis and the results of the HEP analyses are reported in this Appendix.

For purposes of this Supplement to the Final Environmental Impact Statement for the Central City Project, the "No Action" alternative is considered to be the separate implementation of the authorized Central City project and the administratively approved Riverside Oxbow project. The habitat outputs of this No Action and the Modified Central City alternatives are based on a common "future without (w/o) project" condition to allow comparison of the two alternatives' outputs. This "future w/o project" condition is the same as that used in the original Central City and Riverside Oxbow studies except in some areas of the Riverside Oxbow project where land use changes necessitated revising the "future w/o" project condition.

HABITAT EVALUATION PROCEDURE

Species models used to determine Habitat Suitability index (HSI) values were developed by the original Central City and Riverside Oxbow study teams. For each of these studies similar species guilds that are representative of each habitat type evaluated was developed and a list of structural features to be determined in the field was compiled. Results of these two independent studies are documented in their respective project reports and environmental documents. During the current study to evaluate the potential to modify the existing authorized Central City project, additional habitat evaluations were conducted solely to address specific sites that were found to not be adequately addressed in the prior studies. For example, additional clarification of a proposed valley storage site within the Gateway East study reach of the Riverside Oxbow approved project required updated information and consequently some additional habitat evaluation was undertaken in that area.

Updated Vegetation Mapping

Analysis of existing vegetation was conducted following methods conducted for the original studies. A primary reason for this level of detail was to assure avoidance of important resources on sites that would not have been affected by the prior valley storage requirements and to establish a similar level of detail for the combined study area. For example, the analysis conducted on the original Riverside Oxbow was based upon spectral analysis and limited ground-truthing to meet funding and time constraints for that study as compared to more detailed analysis with significantly more ground-truthing for the original Central City Study. Existing vegetation mapping for the Riverside Oxbow study was upgraded to match the level of analysis conducted for Central City. In addition, two additional areas that were not included in either of the previous study areas may potentially be affected by fill. One site is located on an existing closed sanitary landfill on the east side of the West Fork of the Trinity River just east of Gateway Park. The other potential fill site is within an old limestone quarry near North Interstate Highway Loop 820 near Meacham International Airport. Vegetation/land use mapping of both these sites was conducted solely for impact assessment as no habitat development would be feasible in these two sites. The vegetation data and mapping outputs for the combined study area are stored electronically and maintained by the Fort Worth District. See Figure E-1 for a map of the vegetation of the entire study area.

Acreages used in calculating Habitat Units (HU's) and Average Annual Habitat Units (AAHUs) were derived through Geographic Information System (GIS) interpretation of recent digital-orthophotography and color IR with field verification of habitat types by biologists with the Corps of Engineers, US Fish and Wildlife Service, and Texas Parks and Wildlife Department from August 2006 through July 2007.

As the majority of the habitat development would come from the Riverside Oxbow area under the modified Central City alternative, most effort was concentrated to assuring that the analysis was based upon sound understanding of the existing and future without a project conditions within this area.

Within the original and revisited Riverside Oxbow study area which totals approximately 1200 acres in size nine study reaches (Figure E-1) was developed to track proposed project impacts and benefits. Table E-1summarizes the conditions found during the current study as it was found that several significant changes in land use had transpired since the original study was completed.

Table E-1
Vegetation Type or Land Use (acres) within Central City and Riverside Oxbow study areas as determined during current study (2006-2007)

	Disturbed	Forbland	Grassland	Grassland Savannah	Riparian Forest	Upland Forest	Shrubland	Water	Emergent Wetland
Central City	1827.6	0.0	2313.8	17.4	314.8	535.4	1.3	299.6	14.9
Riverside Oxbow	172.3	8.6	509.3	16	278	68.3	44.4	84.6	19
Total	1999.9	8.6	2823.1	33.4	592.8	603.7	45.7	384.2	33.9

Projections of the Future “Without Project” Condition

During plan formulation for the authorized Central City and approved Riverside Oxbow projects, “future without project” conditions were projected for points in time over a 50 year period of analysis for the each study reach. Existing acreages of riparian resources were believed to be fairly well protected by existing regulations and public appreciation was believed to be sufficient to prevent substantial loss of acreages of riparian forest. However, habitat quality was projected to decrease at a slightly higher rate over time due to invasion by invasive non-native species such as chinaberry and Chinese privet. Upland forest was projected to lose acreage and habitat quality at a slightly higher rate due to the position of these resources near the outer edges of the floodplain, or outside of the floodplain. Developmental pressures and reduced regulatory control would contribute to upland forest losses. Emergent wetlands, although protected extensively by regulatory controls, are known to be ephemeral in nature, and there is little incentive to maintain existing wetlands that were not established for environmental restoration or environmental mitigation purposes. Therefore, based upon observations of existing wetlands and the ongoing changes that natural forces are causing, it is believed that for the most part existing wetlands will be significantly reduced in acreage and quality during the planning period. These “future w/o project” habitat conditions were annualized and used as a basis for evaluating the impacts and benefits of the Central City and Riverside Oxbow projects as documented in their respective reports.

During this evaluation of modifying the authorized Central City project to incorporate features of the Riverside Oxbow project and to consider areas within Riverside Oxbow as replacement hydraulic mitigation sites “future without project” conditions were revised to include changes that were not anticipated in the original studies. Most significant has been the increased disturbances of riparian and adjacent habitat by natural gas exploration. A fifty-year period of analysis was used to calculate the Average Annual Habitat Units (AAHUs) for the "Future without

Project" condition and for the No Action and Modified Central City alternatives, utilizing the methodology identified in the US Fish and Wildlife Service's 102-ESM-5 guidance. The "Future without Project" assumptions are described in detail in Attachment 1 to this Appendix and "Future w/o project" AAHUs for all study reaches were calculated and are displayed in the attachment to this appendix. These "future without project" AAHUs were the basis for computing the impacts and benefits of the No Action and Modified Central City alternatives.

MODIFIED CENTRAL CITY ALTERNATIVE

A primary objective in formulating the modified Central City alternative is to minimize adverse effects to existing resources and to minimize placement of project features in locations that would decrease the ability to improve resources identified as important for fish and wildlife habitat utilization. Early during the revised study, representatives of the Corps of Engineers, U.S. Fish and Wildlife Service, and Texas Parks and Wildlife Departments identified resources that should be avoided to protect the key aspects of the previously approved Riverside Oxbow project and location of those resources where impacts would not threaten the potential restoration opportunities. Figure 7 showing those important resources within the Riverside Oxbow is incorporated into the Supplemental EIS. As the study progressed and additional valley storage sites were identified for consideration within the entire modified study area, important resources, such as riparian forest and wetlands were identified and recommendations made for avoidance to the extent possible. Figure E-1 shows existing vegetation and land uses determined during this study, including identification of location of the important resources established as habitat types to avoid to the extent practicable during the development of valley storage excavation site locations and physical placement.

Major structural developments associated with the Authorized Central City project would remain unchanged and include the Bypass Channel, the Interior Water Feature, all related flood control gates, all pedestrian and vehicular bridges, and future development by private interests of the Trinity Uptown area. Among the proposed modifications are the relocation of the Samuels Avenue Dam and associated small craft locking facility and Marine Creek Dam, the removal of the primary valley storage at Riverbend, and addition of new valley storage areas along West Fork including the Ham Branch area and Riverside Oxbow and Gateway Park. The negative impacts are less significant because much of the existing riparian, upland forest, and wetland habitat in the Riverbend area will not be impacted and therefore a greater net gain of habitat outputs is possible. A substantial amount of riparian and upland forest habitat will also be developed by utilizing the Riverside Oxbow and Gateway Park valley storage sites for dense forest and wetland development.

Some minor impacts would still result to riparian forest, upland forest and wetland habitat due to excavation, access roads, and other changed project features and are summarized in Table E-2. For example 5.4 acres of riparian habitat within Ham Branch (Site 9) lie within the valley storage area that would be developed by breaching the levee and reconstructing a new levee to the north, but would not be removed by construction. The impacts in Ham Branch to these resources would be negligible as they would only be affected by backwater from extremely rare events. Impacts that required further consideration include the riparian forest impacts from the Riverside Oxbow and Gateway Park sites, upland and shrub land impacts within Gateway Park sites other than site 17, shrub land in the fill sites, and upland forest within the valley storage contingency sites. The minor riparian forest impacts within the Riverside Oxbow and Gateway Park should be more than compensated as a result of the extensive riparian forest that would be developed in that area following excavation for valley storage.

Table E-2
Habitat Impacts due to Changed Features
(Valley Storage and Disposal Sites)

	Riparian Forest		Wetland		Upland Forest		Grassland	
	Acres	AAHU	Acres	AAHU	Acres	AAHU	Acres	AAHU
Primary Valley Storage Site								
2	0.1	0.05	0	0	0	0	20.7	9.23
5a	0	0	0	0	0.5	0.20	17.2	5.96
5c	0	0	0	0	0	0	14.2	4.9
21	0	0	0	0	0.5	0.17	14.0	4.84
9	0	0	0	0	2.2	0.98	66.0	23
3	0	0	0	0	1.0	0.5	3.4	1.63
10	0.2	0.1	0	0	0	0	1.2	0.67
11	0	0	0	0	0	0	9.0	0.71
12,14	1.9	1.13	0.8	0.14	0	0	86.5	49.2
13	0	0	0	0	0	0	2.3	0.18
15	0.6	0.45	0	0	0.2	0.12	16.3	1.52
16,18	4.7	3.52	0	0	10.5	5.35	60.6	5.67
17	0	0	0	0	0.3	0.14	24.9	2.34
21	0	0	0	0	0.5	0.17	14.0	4.84
Subtotal	**7.5**	**5.25**	**0.8**	**0.14**	**15.7**	**7.63**	**350.3**	**114.69**
Disposal Sites								
5b east	0	0	0	0			12.7	4.39
5b west	0	0	0	0	0.09	0.03	13.8	4.77
South of 5c	0	0	0	0	0.5	0.29	7.7	2.66
Near Bypass	0	0	0	0	0.1	0.05	0.6	0.31
Near Meacham	0	0	0	0	3.9	2.3	10.3	0.85
WWTP	0	0	0	0	0.4	0.18	0.2	0.02
1st Street landfill	0	0	0	0	1.85	0.07	74.5	6.12
Subtotal	**0**	**0**	**0**	**0**	**6.84**	**2.92**	**119.8**	**19.12**
Contingency Valley Storage Sites								
1	0	0	0.2	0.04	3.7	2.68	24.2	10.79
6	0	0	0	0	0.4	0.16	15.9	5.51
7	0.2	0.11	0	0	0.1	0.03	22.3	7.72
8	0	0	0	0	0	0	16	5.54
22	0	0	0	0	8.5	4.04	98.2	46.75
Subtotal	**0.2**	**0.11**	**0.2**	**0.04**	**12.7**	**6.91**	**176.6**	**76.31**

Stream Aquatic

Aquatic impacts to Marine Creek would be reduced by the Modified alternative because of less stream length being inundated due to a lower water surface elevation and even though a

short reach of Marine Creek would be excavated. Negative impacts to Lebow Creek would be totally eliminated due to the relocation of Samuels Avenue Dam, precluding the need to fill the lower end of the creek and to relocate the mouth of the stream downstream of the dam. However, the improvements to the stream aquatic habitat proposed to occur within Lebow Creek as part of the Authorized Central City Project would not be achieved because of the relocation of Samuels Avenue Dam upstream of the location previously approved negating the feasibility of providing a continuous low flow near Brennan Avenue . The aquatic mitigation plan presented for the authorized Central City project required aquatic mitigation in Lebow Creek and additional aquatic mitigation within Ham Branch to offset impacts to Marine Creek. The current analysis for the Modified Central City alternative indicates that the Ham Branch aquatic mitigation would be inadequate to compensate for even the reduced impacts to Marine Creek. Subsequently, additional aquatic mitigation is proposed within Sycamore Creek within the Riverside Oxbow area.

Slope from the proposed Trinity River connection, through Sycamore Creek channel and the oxbow to its confluence with the West Fork below Beach Street Dam is only approximately 6 feet, of which only 1 foot would be Sycamore Creek and the remaining 5 feet would be in the Oxbow. A series of rock weirs would be utilized in the oxbow and smaller rock structures would be developed in Sycamore Creek to provide the basis for developing pools, riffles, and runs through the entire system. See Figure 12 of the SEIS for approximate location of those rock weirs. See Figure E-2 for a conceptualized drawing of how the aquatic features would be longitudinally incorporated into Sycamore Creek and into the Riverside Oxbow.

Sycamore Creek would average 10 feet in width at riffle control structures and would have average depth of about 1 foot over its approximate 3,200 foot restored length. Average velocity through the riffle complexes would be about 1 foot per second, which would be beneficial to anticipated darter utilization of the riffles and provide sufficient oxygenation within pools to support a wide variety of high value fisheries.

Stream bank riparian grasses along with preserved specimen burr oak and pecan trees existing along the alignment of the restored Sycamore Creek would provide shading, cover and supplemental food components to the aquatic system. Based upon this concept, which mimics high quality streams within the Central City study area such as lower segments of Marine and Lebow Creek it is anticipated that the Sycamore Creek Channel as restored would ultimately provide at minimal 0.75 acres of high value aquatic habitat. An Index of Biotic Integrity score of 47 was estimated to be appropriate for Sycamore Creek as proposed to be restored. Following the methodology that was utilized in the original Central City EIS, an IBI score would translate into an estimated future with project habitat suitability of 0.85. Since the stream based aquatic habitat would provide fisheries benefits to the entire 3200 feet of restored Sycamore Creek there would be a minimum of 0.64 habitat units established. As flow would be maintained during all times of each year, the seasonally adjusted habitat units and average annual habitat units attributable to stream restoration in Sycamore Creek would also be 0.64.

Stream impacts would be essentially fully mitigated by implementation of the aquatic mitigation plan at the Ham Branch site referenced in the original Central City EIS, and by implementation of restoration of flows through Sycamore cutoff with developed in-channel riffles and pools as a component of the Modified alternative. Table E-3 displays the analysis of stream based aquatic impacts, mitigation improvement analysis. With Sycamore Creek using a conservative estimate of 0.75 acres of stream habitat, the net AAHU after implementation of improvements would result in a net gain of 0.22 AAHUS. This difference is considered to be within the margin of error for this analysis and therefore it can be presumed that the stream aquatic impacts are fully compensated by the implementation of Hams Branch and Sycamore Creek channel improvements. Additional benefits from returning base flows and structural habitat modifications of aquatic habitat of the Riverside Oxbow would be restoration benefits in excess of those determined for the original Riverside Oxbow study. The modified alternative

would provide stream aquatic habitat benefits of 4.8 AAHUS while the no action alternative provided no documented net stream aquatic habitat benefits.

Table E-3
Stream Aquatic Impact, Mitigation and Improvement Analysis
Modified Central City Alternative

	Habitat Units at Sampling Date	Future Without (Seasonally Adjusted)	Future With Project	Future With Project and Stream Mitigation	Gain or (Loss)
	HU	AAHU	AAHU	AAHU	AAHU
Marine creek					
Plunge pool riffle	1.60	0.80	0	0	(0.80)
Waterfall to Exchange	1.12	0.28	0.11	0.11	(0.17)
Lebow Creek					
Confluence area	0.20	0.10	0.10	0.10	0
Upstream reach	0.31	0.16	0.16	0.16	0
Ham Branch	0.25	0.25	0.25	0.8	.55
Sycamore Creek	NA	0.0	0.00	0.64	0.64
Net AAHU Following all Mitigation					.22
Riverside Oxbow	NA	0.0	4.6	4.6	4.6
TOTAL AAHU					**4.82**

Habitat Development

The study of the Modified Central City alternative evaluates a shift of the primary location of habitat development from the previously authorized Riverbend area of the West Fork on the west side of Fort Worth to the Riverside Oxbow and Gateway Park locations on the on the east side of downtown Fort Worth. Two small oxbow restoration components in the Rockwood Park area are proposed for retention into the Modified Alternative as proposed for the Authorized plan. The primary habitat development features of the approved Riverside Oxbow project including the restoration of West Fork Trinity River flows through the oxbow, improvement of existing riparian forest values, creation and improvement of wetlands, and development of native grassland buffer along the oxbow corridor have been retained. The primary difference between the approved Riverside Oxbow project and the Modified alternative has been to significantly increase the size of area where riparian forest could be developed in both the reaches above and below Beach Street. This increase in riparian forest development was possible due to the relocation of valley storage to the Riverside Oxbow area. Excavation provides the valley storage needed, however, additional hydraulic roughness is required at some sites to balance the hydrology and hydraulics of the study area to minimize adverse downstream hydraulic impacts. The hydraulic model was run and it was determined that the roughness of the existing downstream riparian forest within the Gateway Park East study reach is approximately what should be established for some the valley storage sites. Based upon this analysis, the existing riparian forest was further evaluated to determine the components of the forest that could be incorporated into the excavated valley storage sites to provide the required hydraulic roughness and provide riparian forest habitat benefits.

The Gateway Park East reach of the modified study area has been found to contain areas of high quality riparian woodlands, areas that are severely degraded due to abandoned drying beds, as well as a very narrow riparian corridor comprised of non-mast producing light seeded invader trees and shrubs. According to the Draft Fish and Wildlife Coordination Act Report for the Riverside Oxbow Ecosystem Interim Feasibility Study, two sites were evaluated within the dense riparian forest within the Gateway Park East zone along the West Fork downstream of the abandoned waste water treatment plant and East Fourth Street. These habitat evaluation sites were identified as Sites 002 and 003. Site 002 was generally described as woodland with medium dense understory. Dominant tree species included sugar hackberry, pecan, Chinaberry (non-native), box elder and American elm. Shrub consisted of box elder, privet (non-native) and coralberry. The predominant grass identified was wild rye. Vines and forbs identified in Site 002 included pokeweed, poison ivy, hedge parsley, wild onion, saw greenbrier, giant ragweed, common trumpet-creeper, toothed spurge, stinging nettle and *Viola sp*.

Site 003 was generally described as woodland with open understory dominated by pecan, a hard mast producer. Cedar elm, hackberry, box elder and American elm were also observed. Shrubs and grass found were the same as at site 002. Vines and forbs identified included poison ivy, dead-nettle (also known as henbit a non-native), wild celery, hedge parsley, dandelion, greenbrier and Japanese honeysuckle (non-native).

Some of the data collected at these sites are helpful in describing the character of the forest that would be useful for guiding forest development within the proposed valley storage sites. These data are shown in the Table E-4. Other data collected provides information more specific to habitat quality determinations than providing descriptors of the forest stand.

Table E-4
Structural Riparian Habitat Composition Parameters Estimated at Gateway Park East Corridor
(From USFWS Draft Coordination Act Report for Riverside Oxbow, September 2002)

Parameter	Site 002	Site 003	Forest Average
Percent Tree Canopy Closure	85	70	77.5
Percent Tree Canopy Closure of Mast Producers Greater than 6 inches dbh	10	70	40
Percent Canopy Closure of Deciduous Trees in Stand	85	70	77.5
Average dbh of Overstory Trees (inches)	11	22	16.5
Average Height of Overstory Trees (feet)	40	50	45
Percent Shrub Crown Cover (less than 15 feet in height)	15	40	27.5

While the information in Table E-4 provides a description of the dense forest it does not provide information that could be used to establish roughness coefficients for use in the hydraulic modeling. After further consideration, it was determined that basal area of trees (Table E-5) within this area would be a good parameter to use for establishing the relationship of existing forest density to existing over bank roughness. Future basal area can be projected based upon anticipated tree growth rates within the proposed forest establishment zones at time intervals that would provide forecasting useful for determining both future over bank roughness and habitat suitability values.

Table E-5
Existing Basal Area of Trees and Shrubs Gateway Park East Corridor

	Tree Basal Area in Square ft per acre	Shrubs Basal Area in Square Feet per Acre	Total Square Feet per Acre
Site A	70	5	75
Site B	80	5	85
Site C	90	15	105
Site D	60	5	65
Site E	110	10	120
Average	**82**	**8**	**90**

To develop a tree basal area of 82 square feet per acre within high density riparian forest, it was determined that trees would need to be planted on approximate 8 foot center in the valley storage areas. This is based upon an estimate that under predicted growth conditions in the valley storage excavation areas, one inch diameter trees would grow to approximately five inches in diameter at breast height (dbh) within 15 years. Six hundred (600) trees per acre with 5 inch dbh would provide 82 square feet per acre basal area. In addition, to account for anticipated mortality and to provide habitat variety, it was determined that 100 seedlings and 40 shrubs or vines per acre would be planted within the areas proposed for high density forest development. See Figure 12 of main body of SEIS for locations of the proposed high density forest development within valley storage excavations.

While initial tree planting density within the proposed deeply excavated valley storage areas was determined to provide hydraulic roughness similar to that currently existing in downstream study reaches, the species selected for planting reflect those that would provide optimum fish and wildlife habitat. Additional forest habitat that would be developed in other areas of the Riverside Oxbow include light riparian forest development and scattered riparian forest development. Light riparian development would consist of native grassland with tree, shrub and vine plantings at ten percent of the high density forest. Scattered density forest would consist of tree shrub and vine plantings at five percent of the high density forest plantings. Both light and scattered density forest was evaluated as savannah as defined by the US Fish and Wildlife Services habitat modeling guidelines. Figure 12 indicates areas within Riverside Oxbow that would be developed as savannah or other grasslands. Improvement of existing forest would consist of plantings of trees and shrubs at the density described in the original Riverside Oxbow restoration report.

Trees, shrubs and vines recommended for planting cannot be specifically chosen at this time due to unknown site specific soil quality and moisture conditions; however, the following list provides a number of species by types that would provide future habitat quality within the range of projected values. Some additional soil manipulations including furrowing to provide strips of slightly drier soils may be necessary to establish some of these species. Slopes around the perimeters of the valley storage excavation sites would also provide appropriate areas for habitat development.

Tree plantings should consist of 60 percent hard mast broken down as follows:

40% Oaks	20% Hickories
1. Shumard oak	1. Pecan
2. Burr oak	2. Black walnut
3. Water oak	
4. Overcup oak	
5. Southern red oak	

Soft mast and other hardwoods plantings should be derived from the following groups by percent as indicated:

10% Elms:	10% Other Hardwoods
1. Cedar elm	1. American Holly (Ilex opac)
2. Texas sugarberry	2. Mulberry
	3. Bois d' Arc
	4. Green ash
	5. Boxelder

Shrubs and vines should be selected from the following list and planted at the densities described for each riparian forest and savannah restoration:

1. Native wild plums
2. Yaupon
3. Deciduous holly
4. Sumac
5. Redbud
6. Rough-leafed dogwood
7. Coralberry
8. Common persimmon
9. Swamp privet
10. Hawthorn
11. Buttonbush
12. Trumpet creeper
13. Peppervine
14. Blackberry/dewberry
15. Virginia creeper
16. Carolina snailseed
17. Coral honeysuckle (*Lonicera sempervirens*)

Future With Modified Alternative and Revised Riverside Oxbow Habitat Suitability Determinations for No Action Alternative

Professional judgment by an interagency team was used to estimate forest structural changes over the 50 year period of analysis and to determine future habitat suitability indices for riparian forest development, management of existing forest, wetland development and management and grassland savannah consisting of five percent or ten percent tree canopy or pure native grasslands. It was determined that riparian forests developed on existing floodplain grasslands would develop an ultimate 0.80 habitat suitability by year 50 while riparian forests developed on deeply excavated floodplain lands would generate 0.60 habitat suitability units per acre by year 50. The reduced values anticipated at year 50 for the deeply excavated lands were based upon estimations of tree growth restrictions from slightly increased flooding depths and durations and the difficulties in reclamation of areas where parent soils have been disturbed and removed. Habitat suitability for management of existing forests and wetland developments were similar to projections for similar habitat developments utilized in previous studies within the general Upper Trinity River study area. These future conditions were then annualized over the 50 period of analysis. Planning assumptions over time, acreages of trees managed or developed, wetlands developed and various grassland habitat improvements are contained within Attachment 1 to this appendix.

In order to allow a direct comparison of the Modified Central City alternative with the No Action alternative it was determined that the features outlined within the Riverside Oxbow Project Report and Addendum (2005) as part of the No Action alternative should be reassessed using the same professional judgment used in determining habitat suitability indices for similar habitat measures of the Modified Central City alternative.

With the Modified Central City Alternative, the proposed habitat development within the Riverside Oxbow/Gateway Park study area in the Oxbow North, Oxbow Central, Oxbow South, Gateway Central, Gateway South, Gateway Beach, Gateway Park and Gateway East study reaches consists of :

1. Create or develop 137.6 acres of riparian forest on existing grasslands and excavated valley storage sites
2. Improvement of riparian forest habitat on 263.6 acres
3. Create, develop and improve 52.2 acres of wetlands
4. Develop 76.9 acres of native grassland savannah with 5% to 10 % tree cover
5. Develop native grassland on 10.1 acres
6. Improve habitat quality of 53.3 acres of native riparian grasslands
7. Establish turf grass for stabilization on 124.7 acres

Development of oxbows within the West Fork Rockwood reach and the development and management of riparian forest within the Ham Branch area of the West Fork South study reach

would also be constructed as outlined within the Central City action alternative described within the Final Environmental Impact Statement for the Central City project (2006).

Development of wetland functional values requires that appropriate soils are inundated or saturated with sufficient frequency and duration to encourage growth of aquatic plants that are selected for fish and wildlife habitat utilization. Water for these wetlands will be derived from local sources including the Trinity River to maintain or augment water from local drainage and precipitation runoff. Gateway Beach wetlands would be located in an area that receives significant runoff and is also at a depth near groundwater, therefore minimal supplemental watering would be needed for this site, however for this and the other wetlands, pumping stations will be implemented following a design to allow complete filling of the wetlands within a 30 day time period as needed to best mimic naturally occurring conditions in this ecoregion.

COMPARISON OF OUTPUTS BETWEEN NO ACTION AND MODIFIED ALTERNATIVE

Table E-6 provides a summary of the acres of the habitat types that would be involved within the “No Action” alternative which includes both the authorized Central City project and approved Riverside Oxbow project report conditions.

Table E-7 provides a summary of the acres of habitat types that would be involved with the Modified Alternative action of removing the Riverbend Valley Storage, hydraulic mitigation and habitat development measures and modifying Riverside Oxbow ecosystem restoration features by adding riparian woodlands, improving wetland development and native grassland and grassland savannah development.

Table E-6
Habitat Development Acres considered in the No Action Alternative

Study Reach	No Action Alternative														
	Riparian Acres				Wetland Acres			Upland Acres				Savannah & Grassland Acres			
	P	C	I	S	P	C	S	P	C	I	S	P	C G	C S	S
Clear Fork West	0	0	0	0					-7.29		-7.29		-47.42	0	-47.42
Clear Fork East	0	0	0	0					-1.65		-1.65		-1.01		-1.01
North Main	0	-4.88	0	-4.88					-22.23		-22.23		-138.72		-138.72
West Fork North	0	0	0	0					-3.10		-3.10		-71.20		-71.20
West Fork South	0	1.4*	7.4*	8.8					-3.01		-3.01		-31.45		-31.45
West Fork Riverbend[2]	0	69.86	19.17	-49.98	0	6.22	6.22		4.22	13.30	17.52		-104.38	0	-104.38
West Fork Rockwood[2]															
Central City Subtotal	**0**	**66.38**	**26.57**	**92.25**	**0**	**6.22**	**6.22**	**0**	**-33.06**	**13.30**	**-19.76**	**0**	**-394.19**	**0**	**-394.19**
Oxbow North	18.5	20	20.3	58.80	0	0		0	0	0	0	0	36.4	12	48.40
Oxbow Central	3.1	0	0	3.10	0	12.3	12.3	0	0	0	0	0	0	71.6	71.6
Oxbow South	0	2	7.8	9.80	0			0	0	0	0	0	0.9	14.9	15.8
Gateway Central	0	1.5	9.7	11.20	0			0	0	0	0	0	3.2	12.9	16.1
Gateway South	5.2	13.3	15.7	34.20	0			0	0	0	0	0	1.3	15.6	16.9
Gateway Beach	0	21.6	27.4	49.0	0	10	10	0	0	0	0	0	0	0	0
Gateway Park	0	0	0	0	0			0	0	0	0	0			
Gateway East	0	7	97.1	104.1	0	26.8	26.8	0	0	0	0	0	3.8	3.8	7.60
Riverside Oxbow Subtotal	**26.8**	**65.4**	**178.0**	**270.2**	**0**	**49.1**	**49.1**	0	0	0	0	0	**45.6**	**130.8**	**176.4**
TOTAL	**26.80**	**131.78**	**204.57**	**363.15**	**0**	**55.32**	**55.32**	**0**	**-33.06**	**13.30**	**-19.76**	**0**	**-348.59**	**130.8**	**-217.79**

P = Preserve
I= Improve existing habitat
C= Create or Develop new habitat acreage (-) indicates losses of acres within respective study reach : * Ham Branch Features
S= Subtotal acreage within habitat type
C G = Create or Develop Native Grasslands
C S =Create or Develop Savannah/grasslands

Table E-7
Habitat Development Acres considered in the Modified Alternative

Study Reach	Riparian Forest Acres				Wetland Acres				Upland Forest Acres				Grassland/Savannah Acres					
	Preserve	Create	Improve	Subtotal	Preserve	Create	Improve	Subtotal	Preserve	Create	Improve	Subtotal	Preserve	Create Native	Create Savannah	Turf	Improve Native	Subtotal
Clear Fork West	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-7.4	0.0	0.0	-7.4	-48.1	0.0	0.0	0.0	0.0	-48.1
Clear Fork East	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.7	0.0	0.0	-1.7	-1.0	0.0	0.0	0.0	0.0	-1.0
North Main	-4.9	0.0	0.0	-4.9	0.0	0.0	0.0	0.0	-22.2	0.0	0.0	-22.2	-138.7	0.0	0.0	0.0	0.0	-138.7
West Fork North	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.7	0.0	0.0	-3.7	-99.5	0.0	0.0	0.6	0.0	-98.9
West Fork South	0.0	1.4	7.4	8.8	0.0	0.0	0.0	0.0	-5.7	0.0	0.0	-5.7	-14.4	0.0	0.0	90.8	0.0	76.4
West Fork Riverbend	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West Fork Rockwood	-0.1	20.5	0.0	20.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	22.5	0.0	24.3
SUBTOTAL	**-5.0**	**21.9**	**7.4**	**24.3**	**0.0**	**0.0**	**0.0**	**0.0**	**-40.7**	**0.0**	**0.0**	**-40.7**	**-299.9**	**0.0**	**0.0**	**113.9**	**0.0**	**-186.0**
Oxbow North	-0.2	24.9	37.9	62.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.2	0.0	0.0	11.3	46.4	56.5
Oxbow Central	-1.9	45.2	2.8	46.1	-0.8	0.0	0.0	-0.8	0.0	0.0	0.0	0.0	-86.5	0.5	21.5	37.2	0.0	-27.3
Oxbow South	0.0	21.7	0.0	21.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-5.7	1.5	0.0	3.3	0.0	-0.9
Gateway Central	-0.1	0.0	2.1	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0	16.8		0.0	22.3
Gateway South	-0.6	14.6	24.4	38.4	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	-0.2	-16.3	0.0	0.0	4.5	0.0	-11.8
Gateway Beach	-4.5	31.2	34.6	61.3	0.0	15.0	6.9	21.9	-11.7	0.0	0.0	-11.7	-61.7	8.1	35.9	41.0	6.9	30.2
Gateway Park	-0.2	0.0	55.0	54.8	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	-0.1	41.2	0.0	2.7	27.3	0.0	71.2
Gateway East	0.0	0.0	106.8	106.8	0.0	37.2	0.0	37.2	-0.2	0.0	0.0	-0.2	0.5	0.0	0.0	0.1	0.0	0.6
SUBTOTAL	**-7.5**	**137.6**	**263.6**	**393.7**	**-0.8**	**52.2**	**6.9**	**58.3**	**-12.2**	**0.0**	**0.0**	**-12.2**	**-124.2**	**10.1**	**76.9**	**124.7**	**53.3**	**140.8**
East First Street**									-1.9				-74.5	0.0	0.0	79.1	0.0	4.6
WWTP**									-0.4				0.0	0.0	0.0		0.0	0.0
Meacham Airfield area disposal**									-3.9				-10.3	0.0	0.0	0.0	0.0	-10.3
SUBTOTAL	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**-6.2**			**-6.2**	**-84.8**	**0.0**	**0.0**	**79.1**	**0.0**	**-5.7**
TOTAL	**-12.5**	**159.6**	**271.0**	**418.1**	**-0.8**	**52.2**	**6.9**	**58.3**	**-59.0**	**0.0**	**0.0**	**-59.0**	**-508.9**	**10.1**	**76.9**	**317.7**	**53.3**	**-50.9**

Preserve if positive number, a negative value indicates a loss of habitat acres * Ham Branch Features **Disposal Sites not within identified study reaches
Create or Develop new habitat acreage: For summary information, any losses identified in the preserve column would be subtracted from this column

Acreages provide a means of describing the extent of action proposed with either alternative, however, habitat suitability indices varies widely by the type of habitat measure being proposed. To be consistent with the procedures to develop and display habitat outputs resulting from alternative implementation, and to provide a reasonable means to determine localized project impacts, or benefits, the project alternatives were evaluated using the Habitat Evaluation Procedures as the method to project time weighted values (average annual habitat values). Table E-8 provides a comparative breakout of habitat gains and losses for each habitat type considered between the No Action and Modified Alternatives.

Table E-8
Habitat Outputs (AAHUs) By Study Reach (Outputs are after impacts)

Study Reach	No Action Alternative[1]				Modified Central City Alternative			
	Riparian	Wetland	Upland	Savannah & Grassland	Riparian	Wetland	Upland	Savannah & Grassland
Clear Fork West	0.00	0.00	-10.43	-24.56	0.00	0.00	-10.48	-24.87
Clear Fork East	0.00	0.00	-0.81	-0.38	0.00	0.00	-0.81	-0.39
North Main	-2.87	0.00	-11.09	-71.85	-2.87	0.00	-12.18	-75.90
West Fork North	0.00	0.00	-0.77	-26.89	0.00	0.00	-1.17	-40.50
West Fork South	2.04	0.00	-1.49	-11.88	2.04	0.00	-2.75	-16.65
West Fork Riverbend[2]	44.34	12.47	-8.80	-28.40	0.00	0.00	0.00	0.00
West Fork Rockwood[2]	--	--	--	--	7.15	0.00	0.00	-12.93
Central City Subtotal	**43.51**	**12.47**	**-33.39**	**-163.96**	**6.32**	**0**	**-25.96**	**-169.60**
Oxbow North	20.25	2.68	0.00	27.49	22.14	0.00	0.00	-7.17
Oxbow Central	-1.37	10.26	0.00	25.74	16.39	-0.14	0.00	-38.76
Oxbow South	1.68	0.00	0.00	13.62	9.50	0.00	0.00	-0.10
Gateway Central	7.92	0.00	0.00	13.17	0.96	0.00	0.00	11.03
Gateway South	7.44	0.96	0.00	-0.6	8.24	0.00	-0.12	-2.20
Gateway Beach	12.26	6.40	0.00	-6.45	21.15	16.71	-5.35	28.64
Gateway Park	0.00	0.00	0.00	-7.79	5.31	0.00	-0.23	-5.89
Gateway East	15.15	22.42	0.00	-0.92	19.81	31.21	-0.09	0.87
Riverside Oxbow Subtotal	**63.13**	**42.72**	**0**	**64.26**	**103.5**	**47.78**	**-5.79**	**-15.33**
Gateway Oakland(1st street fill)	0.00	0.00	0.00	0.00	0.00	0.00	-0.07	0.54
Meacham Airfield area fill site	0.00	0.00	0.00	0.00	0.00	0.00	-2.30	-0.85
TOTAL	**106.84**	**55.19**	**-33.39**	**-99.70**	**109.82**	**47.78**	**-34.12**	**-185.23**

(1) From original project reports, Riverside Oxbow Department of Army approved measures reassessed with same over time conditions as Modified Central City alternative
(2) Reaches combined in final Central City EIS

Outputs in Table E-8 are those that remain after impacts have been subtracted from any positive gains attributed to habitat development. The results indicate that the Modified Alternative would provide greater overall riparian forest benefits, but slightly less wetland and upland forest benefits. However, within Riverside Oxbow study reaches the habitat outputs are improved

substantially for riparian forest, and moderately improved for wetlands. The outputs in Table E-8 take into account impacts listed in Table E-2 and impacts attributable to unchanged features within the original Central City study reaches. Therefore the AAHUS documented reflect net project gains by reach and overall study area by alternative. The net gains for riparian and wetlands indicate that these two resource types have been fully compensated in the Modified Central City alternative as was demonstrated for the Original Central City components within the FEIS and for the approved Riverside Oxbow project report. Mitigation for upland forest impacts with the Modified alternative could be accomplished by out of kind riparian forest development benefits.

RISK AND UNCERTAINTY Development of forest on highly disturbed soils is extremely dependent on site preparation and long term operation and management. Studies have been initiated to assist in determining how well tree plantings will survive and grow within the excavated valley storage sites. Habitat Suitability Indices (HSI's) displayed in the attachment were based on the presumption that these studies will indicate that a reasonable growth rate of desirable forest species will occur over the study period. Initial results of groundwater studies on frequency, depth, and duration of surface water flooding indicate that as long as no excavated site slated for riparian forest habitat development has a bottom elevation below 500 ft NGVD, forest habitat development should proceed as estimated, however, if additional refinement of data during future studies indicate otherwise the projected habitat suitability indices may vary. Initial studies also indicate that sedimentation from overbank flooding into the valley storage areas will not present major issues related to growth of planted vegetation.

Sustainability: Riparian forest developed within the valley storage mitigation sites will forever be subject to extremes of moisture due to periodic inundation and possible soil water changes. The project will be designed to drain rapidly to ensure valley storage capability is maintained. Further issues related to fluctuating ground water tables may be identified for future resolution. While initial studies indicate little deposition of sediments will occur, the forest as it matures will shed limbs, leaves and even full trees from disease or wind storm events. Further, without some means to trap and eliminate floatables and other trash that will enter into the depressed areas, there ultimately will be some buildup and loss of valley storage. While unlikely that reclamation of valley storage within the excavated sites will be required within the 50 year planning horizon, it should be recognized that valley storage losses could possibly accumulate to the point that maintenance excavation would be required, and that the subsequent potential to adversely impact the benefits of the forest development could be high. Any future excavation in the valley storage sites would be conducted in order to retain the design level flood protection associated with the existing West Fork channel improvements and Central City Modifications.

MONITORING AND LONG TERM MANAGEMENT The need for monitoring and long term management of habitat development initiatives for the proposed Modified Central City alternative is well established. The high density riparian forest that would be established in the Riverside Oxbow and Gateway Park portion of the study area is needed for both hydraulic roughness and to meet habitat development objectives. The need to promote tree growth rapidly to provide necessary hydraulic roughness and habitat benefits requires that tree and shrub planting densities will be higher than normally promoted in this ecoregion. As these trees and shrubs develop and mature, periodic inspection of basal area will be required. Adjustments through clearing and cleaning of non natural deposits of trash and floatables will be necessary. Funding for monitoring and long-term management is essential to help assure success on both counts.

ADAPTIVE MANAGEMENT While there is optimism for the success of the proposed reclamation of valley storage excavation sites within the Riverside Oxbow by establishing a high density riparian forest, there is risk that the growth rate may not meet expectations or that local site conditions may not foster the long term survival of vegetation that would be initially planted. To minimize this possibility, additional data will be sought during detailed design to determine best grading plans to promote correct soil moisture and provide for maximum acreages of areas

that would be successfully maintained. Once final plans are determined and the project constructed, monitoring will be conducted on an annual basis for tree survival and following any flooding events. Should it be determined that adjustments in tree species or methods of planting need to be modified prior to replanting, such adjustments will be made. Should it be determined that the long term site conditions will not promote high density, high value riparian forest habitat, modifications to include changing the restoration to accommodate more ephemeral wetlands, with modified fill zones to promote tree growth will be considered. Cost to implement adaptive management on the valley storage excavation sites could be as high as initial site preparation and planting, however, success on other restoration sites within the Riverside Oxbow area would be higher. It is suggested that a minimum of 10% of the total habitat development costs be budgeted for adaptive management.

The Corps of Engineers along with the local sponsor and resource agencies would develop a complete adaptive management plan prior to development of habitat measures associated with this project. The basis for that plan is described within this paragraph. Goals for hydraulic roughness and environmental success will require careful consideration to assure that both objectives are met. Generally for environmental success, an 85 percent survival of all trees planted would be expected over the first three years after planting. However, at minimal, due to the risk and uncertainties specified, additional monitoring parameters would be added to account for introduction of undesirable species such as non-native privets or chinaberry, or high densities of low habitat producing trees such as willows. Prescriptive modifications would be proposed in relation to on-site monitoring results and could include changes in species to promote within the wetlands as well as within the woodlands. Native riparian grassland development was historically managed by naturally occurring fires and mass grazing events, which can not be duplicated within the urban environment. In addition, it is well established that within native grasslands, some species planted may not germinate for several years after planting. Therefore it will be necessary to do yearly evaluations of growth rates and density establishment by species. Selected mowing regimes will be developed based upon need to foster or hinder develop of species as they develop. A secondary but necessary output of the adaptive management plan would be a complete Operations and Management Plan that the sponsor would utilize following completion of the construction phase of the project and handoff to the sponsor for future maintenance and future Corps of Engineers annual inspections.

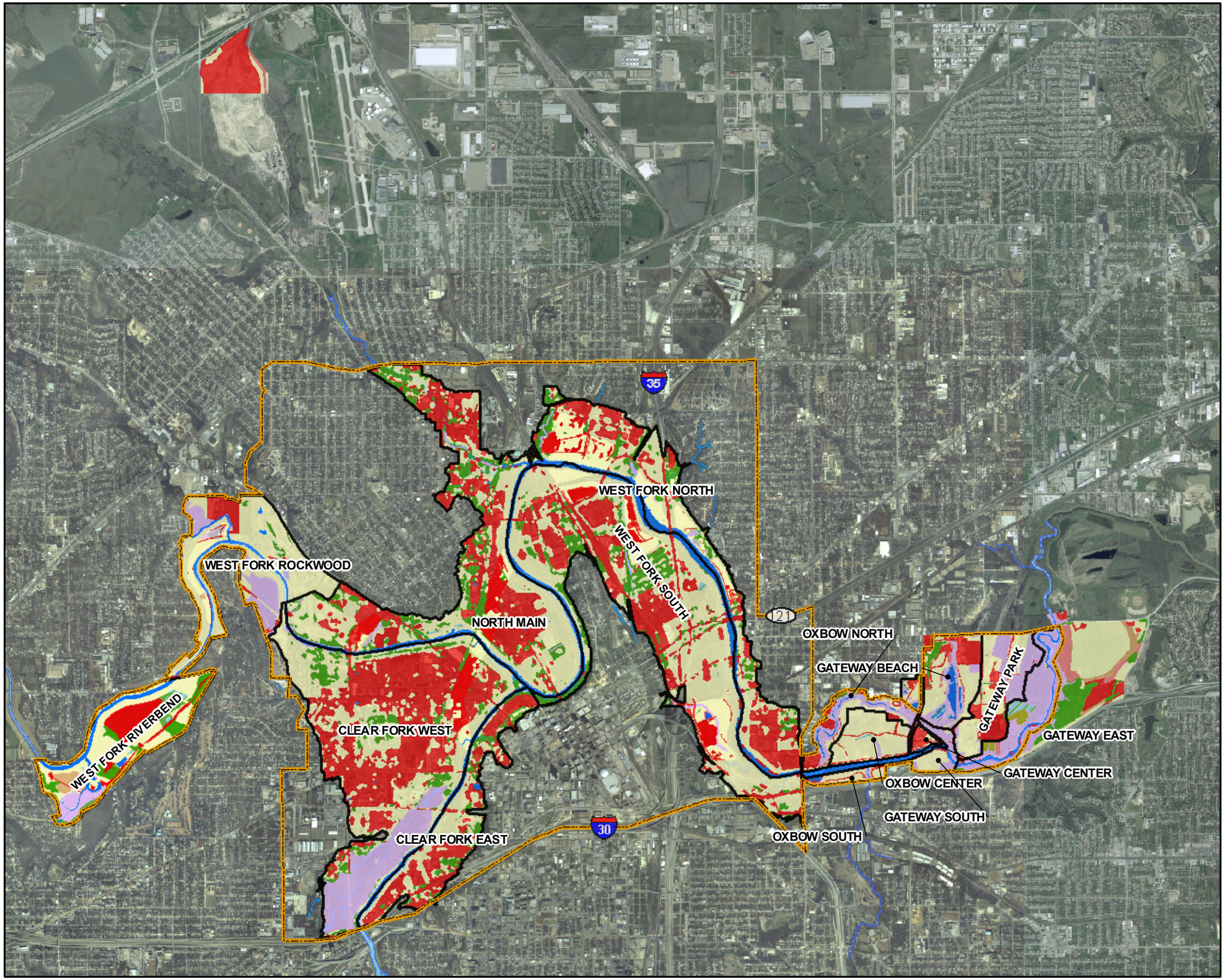

Figure E-1
Existing Vegetation Classes
Modified Central City

Legend

- MODIFIED STUDY AREA
- STUDY REACH BOUNDARIES

EXISTING VEGETATION CLASSES

- DISTURBED
- FORBLAND
- GRASSLAND
- GRASSLAND/SAVANNAH
- RIPARIAN
- SHRUBS
- UPLAND
- WATER
- WETLAND
- RIVERS

N

0 0.375 0.75 1.5 Miles

Aerial Photography Date: January 2005

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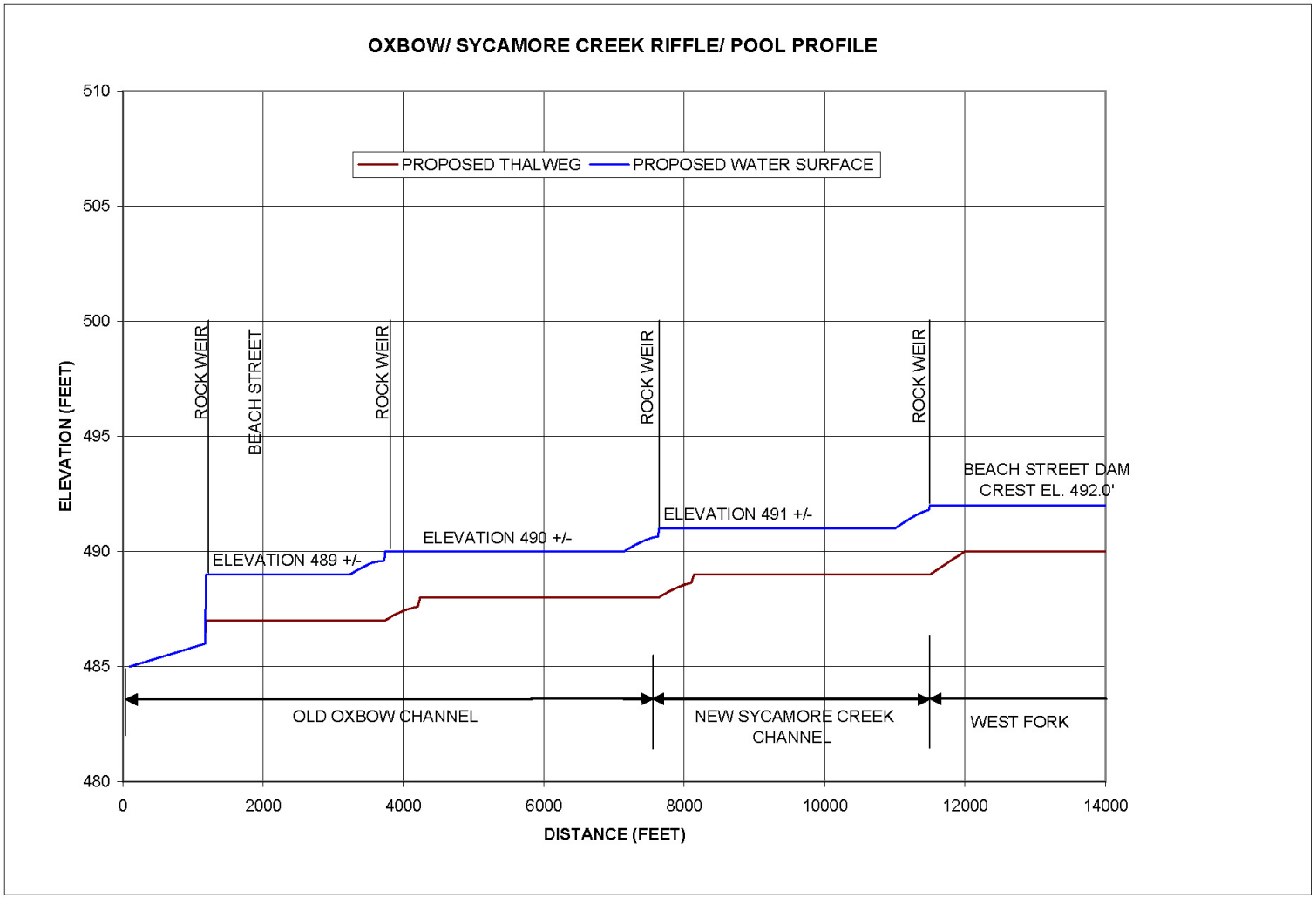

Figure E-2
Proposed Riverside Oxbow-Sycamore Creek Aquatic Habitat Development

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