APPENDIX F

ENVIRONMENTAL RESOURCES

(INCLUDING SECTION 404(b)(1) EVALUATION)

APPENDIX F

ENVIRONMENTAL RESOURCES

ENVIRONMENTAL SETTING

General Description

The proposed project area is located within a highly developed metropolitan area, leaving the flood plain areas adjacent to the river of major environmental concern. Constructed in 1957 with Federal funds, The Dallas Floodway Project is located immediately upstream of the study area. The Floodway project consisted of channelizing and constructing levees along both sides of the Trinity River from Mountain Creek downstream to the Atchison, Topeka, and Santa Fe (AT&SF) Railroad bridge. The environmental characteristics within this area were significantly modified by the project's construction, but since that time some of the riparian vegetation and wildlife habitat has re-established naturally. From the AT&SF Railroad bridge downstream to the Highway 635 and Interstate 20 Trinity River crossing, the proposed project area consists mainly of bottomland hardwoods, wetlands associated with interior drainage areas, old oxbow scars, and gravel mining operations, open water ponds, and open grasslands located on upland sites developed from reclaimed mine areas and abandoned row-crop agriculture plots, commonly used for grazing livestock.

Climate

The Trinity River watershed is located in a region of temperate mean climatological conditions, experiencing occasional extremes of temperature and rainfall of relatively short duration. According to the National Oceanic and Atmospheric Administration (NOAA 1997) Station at Fort Worth, Texas, the 30 year mean rainfall amount is 33.7 inches per year with the most recent ten year (1987-1996) average being 37.88 inches. The extreme annual rainfall values since 1887 are a maximum of 53.54 inches occurring in 1991 and a minimum of 17.91 inches occurring in 1921. The maximum precipitation in a 24 hour period was 9.57 inches in September 1932. Precipitation is distributed fairly uniformly throughout the year, with the exception of a slight peak in the spring and a low in mid-to-late summer (Yelderman 1993). The mean relative humidity is 65 percent and the average temperature is 65.8°F. Recent temperature extremes range from -1°F in December 1989 to 115°F in June 1980. The average freeze dates are March 23, which is the last in spring and November 13, which is the first to occur in the fall. The temperature falls below freezing an average of 41 days a year, but this drop is usually followed by daily thaws. The length of the growing season is approximately 235 days.

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

Air Quality

The proposed Dallas Floodway Extension (DFE) project would be located within the Environmental Protection Agency's Air Quality Control Region (AQCR) 215 for Texas. AQCR 215 consists of 19 counties including Dallas, Denton, and Tarrant Counties, Texas. AQCR 215 is classified as a non-attainment area for ozone (O_3) and attainment/unclassifiable for other National Ambient Air Quality Standards including lead (Pb), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and particulate matter of aerodynamic shape less than or equal to 10 micrometers in diameter (PM10) (40 Code of Federal Regulations 52.2308(a)).

In 1995 and 1996 the Texas Natural Resource and Conservation Commission (TNRCC), Office of Air Quality, reported that the average annual criteria pollutant concentrations for the city of Dallas, Texas, were as follows: lead - 0.03 ug/m3, PM10 - 29 ug/m3, carbon monoxide - 0.75 parts per million (ppm), sulfur dioxide - 0.003 ppm, ozone - 0.023 ppm, nitrogen dioxide - 0.017 ppm (Personal Communication: Mr. Larry Butts, Office of Air Quality, TNRCC, Austin, Texas).

Air quality is closely related to trees. Trees can reduce or increase energy use by providing shade, alter air flow, lower air temperatures through transpiration and directly remove or contribute to atmospheric pollution (McPherson et al. 1994, Nowak et al. 1997). Two computer models (Citygreen™, Version 2.0, American Forests and the United States Department of Agriculture's Urban Forest Effects (UFORE)) were initially used to describe the effects which trees have on the removal of the five gaseous criteria pollutants in the DFE. Both Citygreen and UFORE simulation models utilize standard field, air pollution, and meteorologicial data to quantify forests effect (Nowak et al. 1997); however, the Citygreen model used established pollution uptake coefficients of averaged data collected at monitoring sites located in Chicago, Illinois; Baltimore, Maryland; Milwaukee, Wisconsin; and Austin, Texas (Citygreen Users Manual 1997). The UFORE model that was used, derived pollutant uptake coefficients from information collected during 1994, at monitoring sites located in Dallas (four pollutants) and Fort Worth (one pollutant), Texas (Personal Communication: Dr. David J. Nowak, USDA Forest Service, Northeastern Forest Experiment Station, Syracuse, New York). In the interest of using the most accurate information available, the UFORE model was utilized to describe the environmental setting and to evaluate the proposed project and alternative environmental impacts mentioned later in this appendix.

The UFORE estimates of the annual pollution removal rates of trees (in tons/year) currently in the Great Trinity Forest area are 13.30 for carbon monoxide, 11.74 for sulfur dioxide, 32.93 for nitrogen dioxide, 77.16 for PM10, and 145.19 for ozone (Table 1). The estimated total removal rates of air pollutants by trees presently in the Dallas and the existing and future without project for the detailed project area are also summarized in Table 1. It is assumed that herbaceous vegetation also has some pollutant uptake capabilities since they functionally similar to trees, however, refereed published material describing these coefficients is lacking. Because of this it was not possible to determine pollution removal capabilities of the herbaceous plants in the study analysis.

Table 1

The annual removal of regulated air pollutants by trees in areas related to the proposed project calculated using USDA's UFORE[1] computer model. The removal values in the table are expressed in tons/year.

Area	Carbon Monoxide	Sulfur Dioxide	Nitrogen Dioxide	Particulate Matter (10*um*)	Ozone
Existing Great Trinity Forest	13.30	11.74	32.93	77.16	145.19
Existing City of Dallas[2]	137.72	128.92	355.96	955.24	1,491.82
Detailed Project Area Existing Conditions	1.41	1.24	3.48	8.17	15.37
Detailed Project Area Future Without	2.02	1.78	4.99	11.70	22.02

1- Urban Forest Effects (UFORE) is the computer model developed by Dr. David J. Nowak of the United States Department of Agriculture (USDA) Forest Service, Northeastern Forest Experiment Station.

2-Based on City size of 331 square miles with a tree cover of 28.2% (Nowak et al., 1996)

Vegetational Cover

The proposed project is located in the Blackland Prairie vegetative ecoregion (Correll and Johnston 1970; Gould 1975; Simpson 1988). Running from the Red River south to near San Antonio, the Blackland Prairie stretches in a well defined band for roughly 300 miles and owes its name to the deep, dark calcareous clay soils which cover it. Under natural conditions, Blackland Prairies are dominated by grasses such as little bluestem (*Schizachyrium scoparium*), big bluestem (*Andropogon gerardii*), switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum avenaceum*), and sideoats grama (*Bouteloua curtipendula*) with narrow fringes of bottomland hardwoods being found along rivers and streams (Nixon and Willett 1974).

Within the proposed project area, the topography is gently rolling to nearly level and elevations are approximately 400 feet above sea level (USFWS, 1989). The predominant soil is classified as frequently flooded Trinity Clay (Coffee et al. 1980). Tree species common to this area include elm (*Ulmus sp.)*, sugarberry (*Celtis spp.)*, pecan (*Carya illinoensis)*, oak (*Quercus sp.*), black willow (*Salix nigra)*, cottonwood (*Populus deltoides*), and osage orange (*Maclura pomifera)*.

Bottomland Vegetation

Bottomlands occur in the transition zone between aquatic and upland ecosystems. Bottomland hardwood systems are considered to be Texas' most diverse ecosystem. Prior to European settlement, Texas had approximately 16 million acres of bottomland hardwood riparian habitat. Today the state has less than 5.9 million acres (Texas Center for Policy Studies 1995).

Bottomlands serve several important functions. They contribute to the state's biodiversity. According to the Texas Environmental Almanac (1995), 189 species of trees and shrubs, 42 woody vines, 75 grasses, and 802 herbaceous plants occur in Texas' bottomlands. They are also known to support 116 species of fish, 31 species of amphibians, 54 species of reptiles, 273 bird species and 45 species of mammals. At least 74 species of threatened and endangered animals depend directly on bottomland hardwood systems and over 50 percent of neotropical songbirds not listed as endangered or threatened are associated with these systems. Besides providing critical wildlife and bird habitat, bottomland hardwood systems 1) serve as catchment and water retention areas in times of flooding; 2) help control erosion; 3) contribute to the nutrient cycle, and 4) play a vital role in maintaining water quality by serving as a depository for sediments, wastes and pollutants from runoff. Despite these important functions, bottomland hardwoods ecosystems are one to the most endangered ecosystems in the United States (MacDonald et al. 1979). For all these reasons, the bottomland vegetation system is of great environmental concern in the analysis of the proposed project area.

In addition, according to Nixon and Willett (1974), the bottomland hardwood forests associated with the Sabine, Neches, Trinity, and San Jacinto river were classified as distinct vegetational types by Bray (1906) and Collier (1964). They occupy large areas and are considered by Bray (1906) and Braun (1950) to be westward extensions of hardwood forests typical of river bottom areas to the southeast.

Botanical surveys show that black willow and cottonwood are dominant in the upstream Dallas Floodway portion while downstream from the AT&SF Railroad bridge to the Dallas County line, the dominant tree species are mature black willow, cedar elm (*U. crassifolia)*, sugarberry, green ash (*Fraxinus pennsylvanica)*, pecan, American elm (*U. americana*), box elder (*Acer negundo)*, cottonwood, red mulberry (*Morus rubra)*, and osage orange. The dominant understory woody, shrub and vine species consist of immature trees of the same species as those listed above along with western soapberry (*Sapindus drummondii)*, swamp privet (*Lagustrum spp.)*, common greenbrier (*Smilax rotundifolia)*, honeysuckle (*Lonicera spp.)*, and poison ivy (*Rhus toxicodendron)*. There is little herbaceous groundcover, but, in areas with dense canopy cover, the dominant species are poison ivy, wild onion (*Allium canadense*), violets (*Viola ssp.*), *Aster sp.*, Virginia creeper (*Parthenocissus quinquefolia)* and Canadian wild rye (*Elymus canadensis*). In areas where the canopy cover is more open, the tree species are the same, but the percent cover of herbaceous vegetation increases with the dominant species being marsh elder (*Iva annua)*, ragweed (*Ambrosia trifida)*, and a couple members of the sedge family (*Carex cherokeensis and C. crus-corvi)*. A more comprehensive list of plant species found within the proposed project area can be found in Table 2 located at the end of this appendix.

Wetland Vegetation

According to the Texas State Almanac (1995), interior wetlands which include bottomland hardwood forests (above), riparian vegetation, inland freshwater marshes, and the playa lakes of West Texas account for 80 percent of the total wetland acreage in Texas and the vast majority are located on private property. In the last 200 years, Texas has lost over 60 percent of these inland wetlands due to agriculture conversion, timber production, reservoir construction and urban and industrial development.

Much of the land within the proposed project area has been highly disturbed by human activities which have altered the topography of the local landscape. These include removal of topsoil (used as cover material for the nearby Linfield Landfill), removal of dirt (used as fill material for the construction of nearby road and railroad beds), mining of gravel by commercial business enterprises and construction activities associated with encroaching industries, commercial businesses, residential neighborhoods, and parklands. Many of these areas have also been impacted by illegal dumping activities over the years. Substantial quantities of concrete and building materials, asphalt shingles, roofing tiles, household furniture and appliances, and old tires were observed during reconnaissance visits.

In many cases the alteration of the topography within the proposed project area has led to the development of wetlands and these, along with isolation of oxbow scars from the main stem of the Trinity River, have led to wetlands being scattered throughout the flood plain in isolated depressions or very low gradient drainages.

The essential characteristics that define a wetland are constant or recurrent, shallow inundation or saturation at or near the surface of the substrate and the presence of physical, chemical, and biological features that reflect these conditions. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation.

Hydrophytes are herbaceous plants capable of growing in an environment that is periodically but continuously flooded for more than 5 days during the growing season (Hammer 1992; Mitsch and Gosselink 1986). Obviously, these include some plant species that are primarily terrestrial, but capable of surviving short periods of flooding or saturated soil conditions. Reconnaissance surveys of the depressional and low gradient wetlands found within the proposed project area during the spring and summer of 1997 showed very little evidence of emergents – plants that typically grow in shallow water such as cattails (*Typha*), bulrush (*Scripus*), and sedges (*Carex*), and no evidence of submerged or floating plants such as pondweed (*Potomogeton*) and duckweed (*Lemna*), respectively. The dominant types of vegetation growing along the edges of these depressional wetlands were marsh elder and ragweed, both terrestrial species that are known to inhabit low, moist, disturbed areas (Mahler 1988). Within the forested portion of the proposed project area, black willow, cottonwoods and green ash were often found growing in the shallow water or along the edge of these wetlands.

The vegetation found on gravel mining and other excavation sites varied depending on: 1) the extent to which the site was disturbed during excavation operations; 2) whether any restoration and/or mitigation measures were undertaken following shut down of operations; 3) the amount of time that has past since the disturbance; and 4) the current soil makeup and moisture regime. One area which had been mined for its top five feet of soil was characterized by an open field with low, shallow water or saturated soil areas in the middle dominated by sedges, surrounded with higher upland sites dominated by terrestrial grasses and marsh elder and scattered with a few trees. The growth of these trees was obviously being stunted. This was probably caused by a combination of factors including a lack of nutrients normally found in topsoil and because the remaining soil, characterized by a few inches of silty clay over sandy clay, would be incapable of retaining moisture following rain events. The trees would be growing under almost continual drought conditions. Others of these disturbed sites are characterized by quickly colonizing weedy species such as giant ragweed, annual sunflower, and goldenrod. Willow and cottonwoods are the most common colonizing tree species in the most recently disturbed sites. If left undisturbed the sites would probably continue to succeed into areas characterized by the same species that are noted in the bottomland vegetation section.

Wetland delineation surveys have determined that much of the bottomland hardwood forest located within the proposed project area are jurisdictional wetlands under Section 404 of the Clean Water Act. The area that would be impacted by the foot print of either the NED or Chain of Wetlands alignment is approximately 50 percent jurisdictional. The lower NED alignment would cross the White Rock Creek flood plain which was determined to be over 90% jurisdictional forested wetlands. The foot print of the lower swale alignment for the chain of wetlands crosses jurisdictional wetlands over the first half of the alignment only. Permanent water in the form of water hazards at the golf course have been determined to be non jurisdictional.

From a planning perspective, all regulatory wetlands in the area, whether currently forested or not, are becoming forested. The future without a project analysis, therefore, includes all of these jurisdictional areas as forested wetlands. The goal of the U.S. Fish and Wildlife Service for Resource Category 2 habitats (in this case, both bottomland hardwoods as well as jurisdictional forested wetlands) is the same as the Corps of Engineers and planning team's goal, which is to first avoid and minimize impacts and then require in-kind and equal mitigation to the extent possible. Since the mitigation strategy and goals for forested wetland and non jurisdictional bottomland hardwood forest are the same, it was determined that mapping of the numerous small, interwoven individual wetland locations would not add additional clarification within the project study area for planning purposes. Additional information about wetland considerations is addressed further in this appendix in discussions relating to compliance with Section 404 of the Clean Water Act , including the Evaluation of the proposed project in accordance with the Section 404 (b)(1) Guidelines.

Grasslands

Open grasslands located on drier sites developed from reclaimed mine areas and abandoned row-crop agriculture fields have commonly been used for grazing livestock. The vegetation found on these sites is characteristic of disturbed or old field bottomland pastures. Common grass species include purple threeawn, King Ranch bluestem, sideoats grama, Japanese brome, tumble windmillgrass, bermuda grass, jungle rice, barnyard grass, plains lovegrass, perennial ryegrass, Texas wintergrass, Dallisgrass, annual bluegrass, and Johnson grass. Dominant herbaceous species include giant ragweed, annual sunflower and goldenrod. These old field sites can be expected to continue to succeed to scrub/shrub and eventually bottomland hardwood forests. In field reconnaissance trips, a several sites, noted on old aerial photographs as being an open field, are now covered by a dense stand of green ash or cedar elm saplings.

Open Water Areas

These are bodies of water that retain water on a continuous basis. Many of the open water ponds within the proposed project area are former gravel or other type of excavation pits. A considerable amount of open water is located within the Sleepy Hollow Golf Course as water hazards. In most cases there is little or no emergent vegetation and no evidence of any submersed or floating plants, especially within the pelagial, or open water zone. This lack is due to a combination of reasons. The banks of these water bodies tend to be relatively steep making it difficult for vegetation to become established. A second reason is the continuous presence of water of varying depths prohibits the growth of most plant species which are not able to tolerate prolonged and/or deep water conditions. A final reason is the lack of light penetration needed to support this type of vegetation. Many of these ponds are shaded by a dense cover canopy of surrounding trees. In addition, the water in the ponds located within the flood plain is extremely turbid due to the continual addition and stirring of sediments resulting from rainfall events and runoff. Because the Trinity is an urban river and a main artery for a series of reservoirs, the amount and quality of water it receives is influenced by more factors than just upstream and local rainfall amounts. The discharge of effluent from wastewater treatment plants, watershed runoff from impervious surfaces during storms, and overflows from the series of manmade reservoirs which tie into it are major factors and all contribute to turbidity.

Within densely forested areas, cottonwoods, green ash, and black willows, along with an occasional box elder can be observed growing along the perimeter of these ponds. In more open sites, the dominant vegetation is marsh elder and ragweed.

Land Use and Vegetative Cover Mapping

Several iterations have been conducted during the planning process to map and estimate acreages of vegetative cover and land uses within the study area. One mapped area includes an estimate of the vegetation within what has been termed the "Great Trinity Forest". This area roughly includes the Trinity River main stem flood plain lying between the existing Dallas Floodway and

Interstate Highway 20 crossing and within the White Rock Creek flood plain upstream to Interstate Highway 30. Within this area, approximately 5956 acres in size, 5456 acres (92%) are woodland including bottomland hardwoods, mixed Deciduous, and wetlands/bottomland hardwoods. The remaining 500 acres (8%) are composed of water, grassland, scrub/shrub, and urban areas.

The land use within this area (Table 3) was determined from use of 1992 satellite imagery and boundaries were established from comparison of aerial photos and an estimate of the geographic limits of the Great Trinity Forest as defined above. Vegetative cover types have been verified from field visits, however considerable land use change has occurred around the perimeters of the proposed project area and within portions of the flood plain near the Central Wastewater Treatment plant. Therefore, the acreage figures represent a comprehensive estimate to approximate the overall study area.

TABLE 3
UPPER TRINITY RIVER PROPOSED PROJECT
GREAT TRINITY FOREST LAND COVER ESTIMATE

Trinity Forest LAND COVER Types	Acres	% Cover
Water	233	3.9
Bottomland Hardwoods	4198	70.5
Pasture/Unmanaged Grasslands	121	2.0
Mixed Deciduous	213	3.6
Scrub/Shrub	63	1.1
Agriculture	37	0.6
Low Density Urban & Residential	13	0.2
Urban/Roads/Bare Ground	15	0.3
Bare Ground	3	0.1
Wetlands/Bottomland Hardwoods	1045	17.5
Unclassified/Bare Ground	3	0.1
Managed Grassland	12	0.2
TOTAL	5956	100.1

Additional refinement of the vegetative cover was accomplished by onsite evaluation and mapping of vegetative cover within areas that would be impacted by the foot prints of proposed project features. The mapping included delineation of bottomland hardwoods into essentially two levels of importance based upon their overall values to fish and wildlife resources. The higher quality bottomland hardwood areas generally consisted of those areas with old growth forest which included hard mast trees such as pecan, red oak or burr oak. These higher quality bottomland hardwoods are referenced as Pecan-Oak bottomland hardwoods for the remainder of this report. Medium quality bottomland hardwood consisted of less mature stands of trees lacking hard mast producers and are referred to as Ash-Elm bottomland hardwoods . The Ash-Elm bottomland hardwood areas were found to be dominated by homogenous stands or mixtures of green ash, willow, cottonwood, cedar elm and box elder. Most of these sites were initially delineated by evaluation and comparison of 1960's vintage and later aerial photographs of the area. Field verification was accomplished by field visits and by measurement of forest parameters that were used to model habitat quality. Additional verification was obtained during site visits to identify and quantify tree densities on several plots within the study area. This information was ultimately digitized onto an ortho-photo and used to define the vegetative cover and land use within the areas that would be impacted by alternative project features. The cover mapping used for analysis is shown on Figure 1. Table 4 shows the land cover classification used for evaluation of the locally preferred project, including the chain of wetlands, Lamar and Cadillac levees and associated sumps and the proposed channel realignment to protect Interstate Highway 45.

Table 4
Land Cover Tabulations (Digitized from Ortho-photo)

Type	Acres	Percent		
Pecan-Oak	251.02	18.47		
Ash-Elm	326.46	24.02	Forested Subtotal	
MGFB	496.18	36.51	577.48	42.49%
Urban/Exposed Ground	108.34	7.97		
Landfill/Disturbed	16.58	1.22		
Wetland (CWWTP)	9.09	0.67		
Building	7.58	0.56		
Water	143.69	10.57		
Total	1358.94	100.00		

The general area that would be impacted by the proposed project features contain a smaller area and percentage of bottomland hardwoods than were identified within the general study area, reflecting the planning strategy to locate project features in areas that would minimize impacts to this important resource.

Wildlife Resources

Similar to the plant species of the flood plain, the wildlife species found within the proposed project area vary considerably. As noted above, the proposed project is enclosed within a fully developed metropolitan area and much of the area has been highly impacted by human activities. The degree and extent of the changes in habitat have directly influenced the numbers and species of wildlife found in the area. Predator control, modification of habitat, indiscriminate hunting, use of pesticides, and various forms of air, water, and land pollution have been responsible for modified distribution of fish and wildlife populations throughout the area.

The river channel, wetlands, open water areas, and bottomland hardwood forests support a variety of wildlife species for cover, food, and den or nesting sites. Bird species which were observed or have been reported in the area include migratory warblers, sparrows, meadowlark, mourning dove, crow, red-tailed hawk, red-shoulder hawk, American kestrel, herons, egrets, mallard, wood duck, blue-winged teal, green-winged teal, lesser scaup, grackle, scissor-tailed flycatcher, kingbird, logger-head shrike, black bird, swallows, blue jay, chickadees, downy woodpecker, red-belly woodpecker, and barred owl. Amphibians, reptiles, and mammals common to the area include frogs, toads, snakes, turtles, cottontail rabbit, cotton rat, field mice, opossum, raccoon, bobcat, beaver, nutria, and coyotes.

Aquatic Resources

The main stem of the Trinity River which flows through the proposed Dallas Floodway Extension (DFE) Project area receives drainage from several rapidly urbanizing sections of the Dallas-Fort Worth Metroplex. The effluent from these municipalities has resulted in a historical degradation of water quality as the river flows from west to east. Generally, the aquatic resources in the DFE segment of the river are characteristic of the upper Trinity River Basin, however, the poorer water quality has resulted in a shift from a diverse healthy aquatic fauna to a more pollution tolerant community.

Although several current studies indicate that water quality has been improving in the upper Trinity River, it appears that aquatic organisms are continuing to be contaminated by a wide variety of pollutants of industrial and municipal origin (Arnold 1989, Kleinsasser and Linam 1990, Davis 1991). The water is generally turbid, especially during high flow episodes due to elevated silt loading. The poor water quality in DFE section of the Trinity River can be attributed to low dissolved oxygen concentrations incurred from low flows, high water temperatures, and elevated biochemical oxygen demands (Tidwell 1982, Davis 1984). High concentrations of ammonia-nitrogen and phosphorus also contribute to the poor water quality in the DFE segment of the river.

Habitat for fisheries is scarce in the DFE segment of the Trinity River. The river channel has not been significantly altered, except around the railroad and highway bridge crossings. Bridge pilings provide some colonization areas for aquatic invertebrates and spatial reference points for fishes to congregate. The river channel banks are steep and nude with numerous deadfall logs and debris that have accumulated during high flow periods. The river bed provides little or no structure and is primarily comprised of silty mud. In most areas, a large canopy of cottonwood and willow trees provides fair to good shading of the river's surface.

A low diversity of aquatic invertebrate and fish species characterizes the proposed DFE project area. The invertebrate community is dominated by the more pollution tolerate pulmonate gastropods, chironomids, and tubificid worms. Fish faunal resources in this segment of the Trinity River are primarily the more pollution tolerant species, such as common carp (*Cyprinus carpio*), river carpsucker (*Carpiodes carpio*), longnose gar (*Lepisosteus osseus*), freshwater drum (*Aplodinotus grunniens*), bullhead catfish (*Ictalurus* sp.), gizzard shad (*Dorosoma cepedianum*), mosquitofish (*Gambusia affinis*), and various species of sunfish (*Lepomis* sp.) and shiners (*Notropis* sp). Although few in number due to inadequate aquatic habitat and poor water quality, the sportfish occurring in the proposed project area are largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), crappie (*Pomoxis* sp.) and white bass (*Morone chryops*). A comprehensive listing of fish in the main stem of the Trinity River south of the Metroplex can be found in "Final Regional Environmental Impact Statement for Trinity River & Tributaries, 1987".

Water Quality

Every 2 years, the Texas Natural Resource Conservation Commission (TNRCC) publishes data on field measurements and water chemistry for the waters of the State. The portion of the river which lies in the proposed project area is in the upper part of segment 805 as designated by TNRCC. While the water quality of the Trinity River continues to improve, there still remain 4 areas of concern in segment 805. These are nitrite+nitrate, orthophosphorus, total phosphorus and fecal coliform. These concentrations were outside criteria or screening levels 92.5%, 97.67%, 94.59% and 38% of the time, respectively. Historically, dissolved oxygen levels have been a serious problem but these have shown great improvement and are now rarely lower than the standards criteria of 5.00 mg/l.

Flow rates vary greatly. Typically, the lowest flows are in the dry summer months and highest flows are associated with spring floods. Low flow rates and high temperatures are conditions under which there may be water quality problems such as high algal growth and low dissolved oxygen.

Effluent from several wastewater treatment plants discharge into tributaries of the Trinity River in the Dallas/Fort Worth metroplex. The effluent from the Central Wastewater Treatment Plant (CWWTP), on the uppermost part of the mainstem (segment 805) in the city of Dallas, is discharged into a small lake first before flowing into the Trinity. This plant meets and often exceeds stringent effluent discharge requirements as stated in the discharge permit issued by the state (personal communication, Donna Long, City of Dallas). In the last three years, 15 chronic toxicity tests have been conducted on the organism *Ceriodaphnia dubia* in 100% effluent. All test results were negative. This is an indication that, under present circumstances, the effluent may be used in the wetlands to provide fish and wildlife habitat (personal communication, Jim Davenport, TNRCC - Water Quality Division, Standards and Assessment Section).

THREATENED AND ENDANGERED SPECIES

The following information indicates that several federally protected species may occasionally migrate through the proposed project area. In addition Black-capped vireo is known to nest in southwestern Dallas County along the juniper forested area associated with that area. In addition least tern has been documented nesting within the Southside Waste Water Treatment (SSWWT) facility grounds several miles southeast of the proposed project area. The SSWWT is located across the river from the proposed disposal site for excess clean materials resulting from excavation of materials from the Chain of Wetlands. The site has been investigated by the Corps of Engineers and the U.S. Fish and Wildlife Service and was approved for disposal of dredge material from the White Rock Lake restoration project.

Table 5
FEDERALLY LISTED THREATENED AND ENDANGERED SPECIES WHOSE MIGRATORY CORRIDOR INCLUDES DALLAS COUNTY TEXAS

(Source U.S. Fish and Wildlife Service, March 1993)

American peregrine falcon,	*Falco peregrinus anatum*	Endangered
Arctic peregrine falcon	*Falco peregrinus tundrius*	Threatened
Bald eagle	*Haliaeetus leucocephalus*	Endangered
Black-capped vireo	*Vireo atricapillus*	Endangered
Interior least tern	*Sterna antillarum*	Endangered
Piping plover	*Charadrius melodus*	Threatened
Whooping crane	*Grus americana*	Endangered

ENVIRONMENTAL NEEDS

The Dallas-Fort Worth Metroplex has extensive development within its main core area and expansion continues into surrounding counties. The need to provide for protection against ravaging floods to developed areas has increased as the new development continues to increase runoff from continually increasing areas of impervious surfaces associated with rooftops, parking lots, and highways. In addition local drainage programs tend to increase the speed of runoff thereby necessitating continuing improvement of flood control features. Within the Metroplex, the Corps of Engineers has constructed Lakes Benbrook, Joe Pool, Grapevine, Lewisville, and Ray Roberts which are multipurpose projects providing flood damage reduction benefits to the area. In addition, the Corps has constructed the Fort Worth and Dallas Floodways which are segments with levees and a main flood conveyance channel that provide needed protection for the downtown business districts of the respective cities.

These projects with exception of Joe Pool and Ray Roberts were constructed prior to legislation was enacted requiring environmental review and prior to Corps authorities to mitigate environmental losses. Review of information available indicates that while providing needed flood damage reduction and water supply for the Metroplex, these projects also forever altered the landscape. The most significant losses that occurred were to the bottomland hardwood areas that existed as riparian forested stringers along the main stem river reaches and tributaries. In addition, many small emergent wetland areas along the streams were either inundated and lost or were removed through the grading and leveling process of channel construction in the leveed reaches. Reduction of flooding brought about by these large projects has also increased secondary development throughout the region. Prior to the mid 1970's there were no regulatory processes to protect or require mitigation of any of these wetland losses.

In 1985 the Corps of Engineers began a study to address the impacts of unrelated development projects along the Trinity River and it tributaries in Dallas, Denton, and Tarrant Counties. The Final Regional Environmental Impact Statement completed in 1987 indicated that within the 73,000 acre study area only 570 acres of herbaceous wetlands were identifiable within the 100 year flood plain and 745 acres were within the Standard project flood plain. Even without a definitive historic record of emergent wetlands losses within the area prior to the major Corps construction activities, it is clear much losses have occurred. These losses to wetlands adjacent to the riparian woodlands in the form of scars, seeps and cutoffs also impacted many species of migratory shore birds, wading birds reptiles and amphibians. From a resource protection stand point, it could be easily argued that efforts should be placed on maintaining and improving the integrity of bottomland hardwood forests because of their ecological significance, their visibility and appeal to observers and the long time frame required to reestablish a mature forest. Emergent wetlands also have ecological significance and because they can be established comparatively quicker than forests, the annualized benefits can be quite high. In addition emergent wetlands can be established in conjunction with other proposed project features without compromising flood reduction benefits or actually inducing flood damages.

ALTERNATIVE PLAN FORMULATION

In general, the planning process followed during development of the recommended plan was predicated on following the objective of minimizing impact to bottomland hardwoods. Planning leading to the determination of a 1200 foot wide swale, the National Economic Development Plan (NED), reduced channelization plans during further consideration due to adverse environmental effects. A vegetative management plan was considered but eliminated because it would have seriously diminished stream aquatic, riparian and bottomland hardwood habitats that have high national priority for protection. An array of "swale" alternatives, including, the NED plan, although causing losses to bottomland hardwoods was designed and aligned to avoid the highest quality forested habitats to the extent possible. The swale plans did not receive endorsement by the entire environmental community but appropriate mitigation plans were found to be feasible for the proposals.

The Chain of Wetlands (CoW) alternative alignment was developed from a smaller swale plan around desires expressed by the sponsor following extensive public involvement. A major planning objective by the Corps and sponsor included the commitment to continue avoidance of bottomland hardwood forest particularly high quality forested areas and minimization of impact to all bottomland hardwood forested areas. The CoW alignment within the upper reach has been moved to the west as far as technically and economically justifiable. The alignment of the Cadillac Heights (100-yr and SPF) and SPF Lamar Levees has also been extensively considered and it has been determined that other reasonable alignments would not produce less impacts to important resources. Alternatives evaluated for the I-45 bridge protection included no action, fortifying the piers in the channel and river realignment. Only the realignment was found to provide long term protection.

The final array of alternatives was developed from combination of plans. The locally preferred plan, or LPP, includes the CoW, the Lamar and Cadillac Heights Levees providing standard project flood protection, and the I-45 channel realignment. The apparent Tentative Federally Supportable Plan (TFSP) includes the features of the LPP, except that only 100-yr protection for the Cadillac Heights would be provided.

A non-structural alternative was developed that considers the feasibility of buying residences and businesses with the Cadillac Heights area. The non structural plan was considered only for the areas that previous studies had shown that some level of buy out could be justified. The remainder of the plan named the non structural includes the chain of wetlands and the Lamar Levee. It was found economically justified to acquire structures up to the 10 year flood elevation. Details of that plan are included in the Economic Appendix. Minimal disturbance to existing resources would occur for the non structural element of the proposed project. In the areas where structures would be removed, the soil would be stabilized with grasses. The most likely future use of the area would be as parkland supporting low density recreation.

ENVIRONMENTAL CONSEQUENCES

As was noted in the bottomland vegetation section of this appendix, because of the losses of bottomland hardwood ecosystems in Texas and in the United States, the bottomland forest is of environmental concern in the analysis of the proposed project area. A coordinated effort was made by the Corps of Engineers and the City of Dallas in consultation with state and federal resource agencies to design a flood control project that would be feasible in terms of economics yet minimize the impacts to the valuable bottomland hardwood resources in the proposed project area. The following narrative and graphics show the impacts of the various potential alternatives on the bottomland hardwood forests within the proposed project area.

Micro-Climate Effects

One of the concerns raised by concerned citizens and environmental groups was the impact that removing trees would have on surrounding areas. McPherson, Nowak, and Rowntree (1994) in a report for the U.S. Forest Service document that , by transpiring water, blocking winds, shading surfaces, and modifying storage and exchanges of heat among urban surfaces, trees affect local climate and human thermal comfort. These benefits are also documented in Mapping Micro-Urban Heat Islands Using Satellite Imagery (Lowry and Aniello 1993) for Dallas County, but it must be understood that the microclimate effects of trees to conserve energy and lower temperature are very localized in nature. Without directly being covered by the shade provided by trees or close enough to take advantage of the benefits provided by trees as natural windbreaks, microclimate effects are negligible. Therefore, the removal of trees in conjunction with any of the potential alternatives for the proposed DFE flood control project is expected to have little or no impact on microclimate effects of those trees to surrounding residential, industrial and business neighborhoods.

It is also important to remember that none of the potential alternatives call for the addition of any impervious surfaces which might be expected to add radiant heat thereby increasing local temperatures. The replacement of trees by herbaceous vegetation would not have this effect.

Air Quality

Future Without Project Alternative- The "Future Without Project Alternative" would cause no significant adverse impacts to air quality within the proposed project area. Regional trends in air quality indicate that regulated pollutant levels are slightly increasing. Flooding episodes and flood plain regulations imposed by the City of Dallas within the proposed project area would restrict further urban and commercial development. In the absence of urban and commercial growth, mobile and stationary pollution emitting sources would decrease as would their associated pollutants. Addition of Parkways planned by others along existing and proposed levees could result in increases in pollutant levels.

The development of additional tree canopy in the area would provide beneficial impacts through biogenic removal of regulated gaseous air pollutants. UFORE estimates of pollution removal capabilities with this alternative indicate trees in the entire DFE area would have the capacity to assimilate 13.85 tons/year of carbon monoxide, 12.23 tons/year of sulfur dioxide, 34.30 tons/year of nitrogen dioxide, 80.37 tons/year of PM10, and 151.23 tons/year of ozone or approximately 10.1% of the total capacity of trees in the Dallas, Texas, area. The additional tree canopy that would develop would provide a slight improvement of approximately 4.1% in air pollutant removal capability above the existing conditions (Table 1).

National Economic Development (NED) Alternative- The implementation of the NED alternative would cause minor adverse impacts to the quality of air within the proposed project area. Utilization of diesel-fueled heavy equipment, would result in minimal amounts of exhaust fumes, smoke, and dust during construction activities. There would be no stationary emitting sources and no on site storage of petroleum or petroleum based by-products to cause additional negative impacts to air quality. Disposal of cleared vegetation or other debris by burning during the construction would be accomplished only as permitted by the TNRCC. Required maintenance activities required for the NED alternative would contribute little additional mobile air emissions.

The reduction in tree canopy area from clearing activities for swale development would result in negative impacts through removal of biogenic sources which extract regulated gaseous air pollutants. UFORE estimates of pollution removal capabilities by trees in the entire DFE proposed project area with this alternative implemented, indicate there would be an vegetation assimilation capacity of 12.07 tons/year of carbon monoxide, 10.66 tons/year of sulfur dioxide, 29.89 tons/year of nitrogen dioxide, 70.03 tons/year of PM10, and 131.78 tons/year of ozone or approximately 8.8% of the total capacity of trees in the Dallas, Texas, area. The reduction in tree canopy would decrease the air pollutant removal capability below the existing conditions by 9.2% (Table 1).

The NED plan would call for revegetation of the cleared swale area. The planted vegetation would provide a small amount of air pollutant assimilative capacity and to a limited extent, ameliorate the air quality impacts caused from tree removal.

Locally Preferred Plan (LPP) Alternative - The implementation of the LPP alternative would cause minor adverse impacts to the quality of air within the proposed project area. Utilization of diesel-fueled heavy equipment, would result in minimal amounts of exhaust fumes, smoke, and dust during construction activities. There would be no stationary emitting sources and no on site storage of petroleum or petroleum based by-products to cause negative impacts to air quality. Disposal of cleared vegetation or other debris by burning during the construction would be accomplished only as permitted by the TNRCC. Required maintenance activities required for the LPP alternative would contribute few additional mobile air emissions.

The reduction in tree canopy area from clearing activities for wetlands and levee development would result in negative impacts through removal of biogenic sources which extract regulated gaseous air pollutants. UFORE estimates of pollution removal capabilities of trees in the detailed project area under future conditions as listed in Table 1 indicated there would be an vegetation assimilation capacity of 2.02 tons/year of carbon monoxide, 1.78 tons/year of sulfur dioxide, 4.99 tons/year of nitrogen dioxide, 11.70 tons/year of PM10, and 22.02 tons/year of ozone or approximately 1.5% of the total capacity of trees in the Dallas, Texas, area. The impacts of tree removal to these assimilative capacities as a result of implementing the elements of the LPP Alternative are delineated in Table 5.

Tentative Federally Supportable Plan (TFSP) Alternative - The TFSP alternative is similar in impacts to that of the LPP. The difference between the two alternatives is the size of the Cadillac Heights Levee. Neither of the two Cadillac Heights levee alternatives impact large areas of existing forest and therefore their impacts to air quality are minimal.

Table 5

The impact of proposed project measures on annual removal rates (tons per year) of regulated air pollutants by trees as determined by using the USDA's UFORE[1] computer simulation model.

Site	Carbon Monoxide	Sulfur Dioxide	Nitrogen Dioxide	Particulate Matter (10um)	Ozone
CoW, North	-0.15	-0.14	-0.38	-0.89	-1.67
CoW, South	-0.09	-0.08	-0.21	-0.49	-0.93
Cadillac Heights Levee (SPF)	-0.02	-0.02	-0.06	-0.13	-0.25
Cadillac Heights Levee(100yr)	-0.01	-0.01	-0.01	-0.03	-0.06
Lamar Street Levee	-0.13	-0.11	-0.32	-0.76	-1.42
I- 45 Channel Diversion	-0.02	-0.02	-0.05	-0.13	-0.24
Impact for (LPP)	-0.41	-0.37	-1.02	-2.40	-4.51
Impact for (TFSP)	-0.40	-0.36	-0.97	-2.30	-4.32
Impact for Non Structural Alternative [2]	-0.37	-0.33	-0.91	-2.14	-4.02
Preservation value of proposed Mitigation Area	+2.24	+1.99	+5.58	+13.09	+24.60
Conversion of Grasslands to Forest in TFSP Mitigation Area	+0.55	+0.48	+1.36	+3.18	+5.98
Conversion of Grasslands to Forest in LPP Mitigation Area	+0.57	+0.50	+1.41	+3.30	+6.21

[1] - Urban Forest Effects (UFORE) is the computer model developed by Dr. David J. Nowak of the United States Department of Agriculture (USDA) Forest Service, Northeastern Forest Experiment Station, Syracuse, New York.
[2]-Locally Preferred Project with partial buy out in lieu of Cadillac Heights Levee

In addition, the LPP and TFSP plan would call for development of wetlands and replanting of grasses within the cleared swale and turfing of levee areas with grasses. The new vegetation would also provide a small amount of air pollutant assimilative capacity and to a limited extent, ameliorate the air quality impacts caused from tree removal.

Non-Structural Alternative- Air quality impacts associated with implementing the "Non-structural Alternative" would be very similar to those impacts previously described for the LPP and TFSP. The differences in air quality impacts between the LPP and the Nonstructural Alternative would result from the reduction in construction activity associated with the Cadillac Heights levee. Not building this levee as part of the proposed project would reduce the use of heavy equipment for earth moving activities which may cause minor adverse impacts to the air quality through emission of exhaust fumes, dust, and smoke. This alternative would also allow the tree canopy to remain and develop in the areas where the levee construction would have impacted. The remaining tree canopy would provide air quality benefits through air pollutant removal. the use of heavy equipment for earth moving activities or vegetation clearing, or the elimination of plants which remove pollutants.

Mitigational Areas - The tree canopy in the areas delineated for mitigation would provide beneficial impacts through removal of regulated gaseous air pollutants.

Mitigation plus LPP - The addition of the tree canopy in the mitigational areas to that of the canopy area in the LPP Alternative, would increase the total pollutant removal capability over each area individually.

Mitigation plus TFSP -The additional of tree canopy in the mitigation areas for this plan would also increase the total pollutant removal capacity.

As can be seen, the impacts from development of either the LPP or TFSP to all parameters is minimal. In addition acquisition and preservation of the proposed fish and wildlife mitigation area would greatly exceed the losses from implementation of the proposed project features. The proposal to implement mitigation feature of hastening the conversion of existing grasslands within the mitigation areas to bottomland hardwood forest by intensive tree plantings would result in more gains in air quality purification than would be lost by the proposed project features, individually or cumulatively.

Impacts on Bottomland Hardwood Forests

One of the main concerns of citizens and environmental groups has been the impacts of the various potential alternatives on the bottomland hardwood forests located within the proposed DFE project. Table 6 delineates the impacts for the construction alternatives in terms of tree species and numbers.

Table 6
Bottomland Hardwood Forest Impact Analysis

	NED Plan	CoW	Lamar Levee	Cadillac Levee (SPF)	Cadillac Levee (100-yr)	Non Struct-ural	I-45 Diver-sion	TFSP	LPP
Total Acres of Trees	503.9	89.9	53.3	9.4	2.4	143.2	9.0	154.6	161.6
Total Acres - Pecan-Oak BLH	146.6	5.9	10.6	0.0	0.0	16.5	4.1	20.6	20.6
Total Acres - Ash-Elm BLH	357.3	84.0	42.7	9.4	2.4	126.7	4.9	134	141
Average Number of Trees per Acre-Pecan-Oak	196	196	196	196	196	196	196	196	196
Average Number of Trees per Acre-Ash-Elm	218	218	218	218	218	218	218	218	218
Total Number of Trees Impacted-Pecan-Oak (000's)	28.7	1.1	2.0	0.0	0.0	3.2	0.8	4.0	4.0
Total Number of Trees Impacted-Ash-Elm (000's)	77.9	18.3	9.3	2.0	0.5	27.6	1.1	29.2	30.7
Total Number of Trees Impacted(000's)	106.6	19.4	11.3	2.0	0.5	30.8	1.9	33.2	34.7

Pecan-Oak and Ash-Elm bottomland hardwood forest designations were taken from data derived from vegetation cover and land use maps.
Average number of trees per acre was estimated from data collected in the field. These figures were then used to estimate the number of trees impacted by the various alternatives.

Future Without Project Alternative- The long term survivability of the bottomland hardwood forest within the proposed project area would depend on the City of Dallas' Flood Plain Management Plan and any future development, natural disturbances (e.g.,prolonged flood events, tornados) and encroachment by human activities. Current regulations and public concern indicate however that the bottomland hardwood forest would increase in size and quality over time.

Non-structural Alternative- The small number of trees in the Cadillac Heights area which would be impacted by this alternative would probably not be removed as part of any Corps of Engineer activities, but they could be impacted by any future development and prolonged flooding of the area.

National Economic Development Plan (NED) Alternative- This alternative would have major adverse impacts on the bottomland hardwood forest ecosystem now found in the proposed project area. One hundred forty seven acres of Pecan-Oak and 357 acres of Ash-Elm bottomland hardwoods would be lost and the quality of the surrounding bottomland hardwood habitat would be greatly compromised. Fragmentation of forested habitat often eliminates its suitability for certain species who need a more continuous range in order to survive. It also opens up more fringe area to be inhabited by species who would not normally be found in a bottomland hardwood system. This also leads to losses in bottomland hardwood dwelling species who are then not able to adequately compete against the new invader species.

Locally Preferred Plan (LPP) Alternative- This alternative would impact a portion of the bottomland hardwood forest found within the study area, but the impacts would be located in that portion of the proposed project area that has already seen significant impact by human activities such as gravel, dirt, and topsoil mining, landfills, and years of illegal dumping activities. Another consideration is that the bottomland habitat impacted by the LPP would for the most part be located in an area which is of lesser habitat quality than the NED plan. Implementing the LPP instead of the NED plan would save over 73 percent of the bottomland hardwood acres that have been identify as being within the proposed project area. And perhaps more importantly, over 90 percent of the bottomland hardwood forest acres determined to be high quality (Pecan-Oak bottomland hardwood forest) habitat would be protected. Roughly 50 percent of the land that would be impacted by the LPP would be considered wetlands by U.S. Army Corps of Engineer determinations.

Tentative Federally Supportable Plan (TFSP) Alternative- This alternative is similar in impacts to that of the LPP. The lesser length of the 100- yr Cadillac Levee would eliminate impacts to 7 acres of existing forested lands that would occur with implementation of the LPP.

AQUATIC RESOURCES

Water Quality

Future Without Project Alternative- Water quality in the Trinity River within the segment of the Dallas Floodway Extension (DFE) would continue to improve. In addition to more stringent Federal and state regulations aimed at reducing water pollution, comprehensive watershed management programs in the upper watershed of the Trinity River are being initiated by local governments and municipalities. An objective of the these programs is to restore the river and flood plain back to its natural condition. A functional benefit and output of this program has been an overall improvement in all aspects of water quality throughout the entire Trinity River system, including the DFE segment.

Non-structural Alternative- The water quality of the Trinity River would not be altered as a result of the implementing the nonstructural alternative. Future development or utilization of the areas involving the nonstructural alternative could strongly influence water quality in the DFE segment of the Trinity River.

National Economic Development (NED) Alternative- Water quality impacts resulting from the development of a 1200 foot bottom width overland swale would occur from the removal of trees and soil disturbances. A reduction in number of trees within the flood plain would temporarily increase water turbidity and nutrient loads during construction from rain events. This impact would be temporary and would cease after turfing. Water temperature of temporarily stored waters in the off channel swales could increase slightly because of reduced canopy shading and the decreased dissolved oxygen levels that could result temporarily impact water quality in the River during the first minutes of a flushing event.

Locally Preferred Plan (LPP) and TFSP Alternatives- Placement of levees in the DFE could increase the velocity of river water during flood events, however, the levees would not be constructed without a compensating swale which would tend to balance velocities. The levees would only function during extreme flooding events in which case the velocity increases would be negligible. Sump areas would extend water retention times of storm water runoff, allowing for turbidity reduction and possible contaminant removal prior to entering the Trinity River. During nonflood and no rainfall periods the levees and sumps would not affect water quality in the Trinity River. Temporary impacts to turbidity from runoff during construction could occur.

The chain of wetlands would provide both beneficial and adverse impacts to the water quality of the Trinity River. As proposed, the wetlands would beneficially impact the water quality of the river by assimilating nitrogen, phosphorus, and any heavy metals from the Central Waste Water Treatment Plant stream which would be used to hydrate the wetlands. The wetlands would also provide beneficial filtration and cleanup of wastewater prior to groundwater recharge. During conditions of low sunlight, high water temperature, no wind, and low wetland exchange rate, dissolved oxygen concentrations in the chain of wetlands would be very low and the Biochemical Oxygen Demand (BOD) of the water very high from the organic matter generated. Under these conditions, the water flowing from the wetlands into the Trinity River would provide adverse impacts to the water quality of the river at the point of entry and downstream from oxidation of the wetland organic matter. Construction of the wetland outflow points on the river channel would cause temporary impacts by increasing the turbidity of the water. Channelizing the Trinity River at Interstate 45 bridge would result in a short-term increase in river turbidity. A temporary increase in Biochemical Oxygen Demand (BOD) or Chemical Oxygen Demand (COD) may also occur depending upon the molecular composition of the disturbed river sediment. The reduction in light transmittal from elevated turbidity would temporarily shade oxygen-producing phytoplankton and cause lower dissolved oxygen levels.

Aquatic Habitat, Aquatic Invertebrates, and Fisheries

Future Without Project Alternative- With the development of comprehensive watershed management plans in the upper watershed, the aquatic habitat of the main stem of the Trinity River would continue to improve corresponding to the improvement in the water quality. The diversity and number of aquatic invertebrate and fish species would increase in the DFE segment of the river as the pollution sensitive aquatic organisms return to occupy former niches.

Non-structural Alternative- The condition of the aquatic habitat and fisheries resources following implementation of the proposed nonstructural alternative would not be changed in the DFE segment of the Trinity River. Beneficial or negative impacts to the aquatic habitat, aquatic invertebrates and fishes would be highly dependent on future development of these areas.

National Economic Development (NED) Alternative- Impacts resulting from the development of a 1200 foot bottom width, overland swale would occur from the changes in water quality associated with tree removal and soil disturbances. Temporary decreases in aquatic habitat quality would occur under environmental conditions incurred from the implementation of the NED alternative. It is not anticipated that there would be a significant corresponding reduction in the species diversity of aquatic invertebrates and fish.

Locally Preferred Plan (LPP) and TFSP Alternatives- Placement of levees in the DFE would provide no appreciable positive or negative impacts to aquatic habitat or fisheries resources. Sump areas would improve the water quality characteristics of storm water run-off entering the Trinity River and subsequently enhance the aquatic habitat for aquatic invertebrates and fish.

The chain of wetlands would provide both beneficial and negative impacts to the aquatic habitat and fisheries resources of the Trinity River. The improvement in water quality provided by the chain of wetlands would enhance the aquatic habitat and beneficially impact fish and aquatic invertebrate communities. The chain of wetlands would provide new habitat for fish and aquatic invertebrate species which prefer water velocities lower than the flow rates which occur in the main stem of the river. Rip rap armoring at wetland discharge points on the river would provide substrate for colonization by communities of aquatic invertebrates, and food, refuge, and spawning areas for fish. Rock placement to protect the stream bank at the outfalls would produce a structural bottom feature which would benefit fish by providing a congregational point for bait fish and higher predatory fish species. Aquatic habitat in the wetlands and the river would be adversely impacted if environmental conditions (low sunlight, high water temperatures, no wind, and low wetland exchange rates) which generate poor water quality prevail. Management of the wetlands would occur to minimize any impacts to the main stem river. Construction of the wetland outflow points on the river channel would cause temporary negative impacts to aquatic species not tolerant of elevated turbidity levels.

Channelizing the Trinity River at Interstate 45 bridge would result in a short-term increase in river turbidity and decrease in dissolved oxygen concentrations which would adversely impact the aquatic habitat. This would temporarily impact aquatic invertebrate and fish species not tolerant of elevated turbidity levels or reduced dissolved oxygen concentrations. Moving the river channel to avoid bridge pilings would adversely impact the aquatic habitat by removing a feature which would provide structure for colonization of by aquatic invertebrate communities, and a feeding area and congregational focal point for fish.

CUMULATIVE IMPACTS

This section analyzes the proposed project in the context of current and future trends in the Upper Trinity River Basin. The purpose of this section is to assess the cumulative impacts of the proposed action, when combined with other known actions in the vicinity of the Dallas Floodway Extension area. The proposed action, including environmental mitigation, makes little or no contribution to regional trends that are of concern in assessing cumulative impacts.

Land Use

Urbanization has greatly influenced land use patterns within the Dallas area. Upstream development has also led to land use modification within the floodplain of the Trinity River and major tributaries, such as White Rock Creek. As additional runoff from upstream areas has increased the frequency of flooding within the study area, land use has shifted away from agriculture, except for a few areas of pasture land. Voluntary programs leading to the removal of some residences in the more frequently flooded areas have also influenced land changes. Most abandoned areas have revegetated with grasses, followed by young forests. The proposed project would reduce flooding within the project. The project would directly remove forests that have developed during the past 30 to 40 years; however, these losses would be mitigated resulting in a larger area of preserved and reestablished forests. It is anticipated that some intensification of residential and light industrial development would occur within the area immediately protected by the chain of wetlands and levees.

Cultural and Historic Resources

Any impacts to cultural and historical resources would be mitigated, according to provisions of the National Historic Preservation Act. Therefore, the proposed action would make no contributions to cumulative impacts of the area.

Noise

All noise impacts directly attributable to the project would be temporary in nature. Levees would tend to interfere with the distribution of some noises. Some noise associated with roadway traffic could be redistributed to the area should the Texas Department of Transportation decide to utilize existing and proposed levees for reliever roads.

Climate and Air Quality

The proposed project would have only minor impacts to local temperature and air quality parameters. There would be no measurable impacts to climate. Cumulative impacts to air quality would be insignificant, since environmental mitigation would result in an overall increase in the size of preserved and restored forested areas.

Hydrology and Water Resources

An analysis to determine the impacts of the proposed project to areas downstream of the project indicate negligible effects. Potential peak discharge increases downstream of the project are approximately 1 percent for the 100-year event and 3 percent for the SPF.

Ecological Resources

The most significant resource within the proposed project area has been identified as the bottomland hardwood forest ecosystem located in an area referred to as the "Great Trinity Forest". While the proposed project would impact only a small area of the forest, the proposed environmental mitigation plan could provide a catalyst to ultimate acquisition and management of over 1,000 acres of the area which is either currently forested, or could be converted to bottomland hardwood forest through intensive management. In addition, the proposed environmental restoration project, which includes the development of emergent wetlands, helps reverse the trend of losses to this important resource.

ENVIRONMENTAL RESTORATION

The proposal to modify the flood swale to provide restoration of shallow water and emergent wetlands was developed to provide values to fish and wildlife resources, primarily migratory waterfowl, shore and wading birds that utilize the Trinity River corridor as part of the spring and migratory flights. The wetlands would be managed primarily as moist soil units that would optimize production of insects, seeds, tubers and vegetative structures to support several wildlife species during times of critical energy needs. Evaluation of existing constructed wetland features in the area indicated that it was desirable to consider the possibility to use a permanent water source such as the existing Central Wastewater Treatment Plant effluent to assure that water for flooding the wetland cells would be available when needed for wildlife usage. An analysis comparing construction of the wetlands with and without a dependable water supply was made.

The design for the proposed restoration plans was developed based upon extensive input from U. S. Fish and Wildlife Service (USFWS), literature on wetland development in the Trinity River Basin, and from consultation with other biologists within the Corps of Engineers familiar with development of wetlands within this ecoregion for promotion of fish and wildlife benefits. Aside from development of gradual side slopes and provision of a deep permanent water pool, the major characteristics which promote optimized environmental benefits are the ability to regulate water levels with control structures and ability to provide flooding at proper periods during the year. The wetlands as proposed for the Chain of Wetlands (COW) with control structures and a pumping system designed to deliver water from a continually available source reflect optimized conditions based upon the available local expertise.

Table 7 reflects development of the wetlands without the capability to provide water from a local permanent water source. Based upon existing hydraulic models, it was determined that a flow of approximately 8,000 cubic feet per second would provide overbank flows sufficient to flood the wetlands. Based upon watershed characteristics, it was determined that the overbank flood events would coincide with local rainfall sufficient to fill the wetlands and is thus a good estimator for frequency of flooding without use of a pumping system. Hydraulic and hydrologic analyses indicate that approximately 67 % of the time, there would be sufficient water available under natural conditions during the spring and early summer to flood the wetlands and stimulate initial growth of emergent and moist soil plants along the perimeter of the wetlands. However, it was found that only 5 % of the time a flooding event would occur during August to irrigate and promote optimum seed production of wetland plants. Approximately 40% of the time flooding would occur during the October to January period when food and cover produced by the wetlands vegetation is critical for migratory waterfowl and shorebirds. From these data, the average habitat suitability was adjusted to reflect the effect of reduced flooding on the wetlands. It could additionally be argued that the actual average size of the wetlands would also diminish significantly. Looking at suitability values only, there would remain an increase in average annual habitat units in this alternative but approximately 83 % of the values would be attributed to the grassland portion of the complex and less than 16 % of the values would be attributable to the wetland portion. The average habitat value of the permanent water feature is almost totally lost because of the low frequency of flooding that naturally occurs during the summer months.

The wetland complex as proposed with dependable water supply available (Table 8) provides significant increased fish and wildlife resources values as indicated by the increases in habitat values of the permanent water, emergent wetlands and grassland portions of the complex. The plan provides for development of 123 acres of emergent wetland providing over 117 average annual habitat units and more than triples total resource values over the flood damage reduction swale as it would exist without the proposed emergent wetland complex development alternative. By contrast, the Chain of Wetlands without a dependable source of water would provide for development of only 83 acres of emergent wetland providing only 19 average annual habitat units for the priority emergent wetland resources (see Table 7). This represents an increase of 67% in acres and a 616% increase in average annual habitat units of emergent wetlands attributable to a dependable water source.

COST EFFECTIVENESS AND INCREMENTAL ANALYSIS

While an economic standard has been set that requires a flood damage reduction plan to have economic costs be no more than the economic benefits, a similar scale does not exist for environmental restoration proposals due to the fact that although costs are measured in dollars expended, benefits are measured in terms of environmental outputs such as habitat units, acres etc. that preclude development of a benefit to cost ratio to eliminate undesirable, non supportable project alternatives. Cost effectiveness and incremental analysis techniques as reported by Robinson, et al. 1995, are useful tools for the decision maker to eliminate poor alternatives and to guide the thought process in determining what project alternatives are supportable when environmental output levels continue to increase with increased expenditure of economic resources.

Cost Effectiveness of Emergent Wetland Restoration. The procedures outlined by Robinson, et al. (1995) were followed to evaluate the environmental benefits and costs of the two broad environmental restoration alternatives for the proposed Chain of Wetlands. These alternative management plans include providing necessary water when need to optimize fish and wildlife benefits to the proposed emergent wetland complex. This analysis evaluates the benefits that would be derived from the wetland complex relying on naturally occurring weather events versus a pumped supply to provide water for the wetlands. Output information used in the analysis are derived from Tables 7 and 8. Implementation costs information for the environmental restoration measures was developed by cost estimating. It was determined that no costs from opportunities foregone should be attributable to the proposals. Annual costs were derived using the initial costs of $5,651,253 for the wetlands without dependable water supply and $5,854,112 for the proposed wetlands with a dependable water supply. A 7-1/8% interest rate was used, assuming a 50-year project life and assuming that it would take approximately 1 year to construct the wetlands. An operation and maintenance cost of $50,000 was estimated for the COW with dependable water and $35,000 for the COW without dependable water.

Table 7
Chain of Wetlands Habitat Evaluation, with Water Supply not available for Management

	Upper Swale						Lower Swale					
	Area (acres)		HSI		Habitat units		Area(acres)		HSI		Habitat Units	
	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands
Grassland/ Forbland	105	65.77	0.25	0.56	26.25	36.83	165.99	114.44	0.25	0.56	41.50	64.08
Permanent Water		3.25		0.2	0	0.65		4.93		0.20	0	0.99
Emergent Wetlands		35.98		0.23	0	8.28		46.62		0.23	0	10.72
Total					26.25	45.76					41.50	75.79
Grand Total											67.75	121.55

Notes: "With Flood Control Only" reflects on-site conditions if only the flood control portion of the swale were constructed.
"Projected with Chain of Wetlands" reflects projected conditions with wetland restoration superimposed on flood control project.
"Grand Total" is the sum of the Upper and Lower Swale Values

Table 8
Chain of Wetlands Habitat Evaluation, with Water Supply Available for Management

	Upper Swale						Lower Swale					
	Area (acres)		HSI		Habitat units		Area(acres)		HSI		Habitat Units	
	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands	With Flood Control Only	Projected with Chain of Wetlands
Grassland/ Forbland	105	33.3	0.25	0.90	26.25	29.97	165.99	68.96	0.25	0.90	41.50	62.06
Permanent Water		18.03		0.95	0	17.13		27.40		0.95	0	26.03
Emergent Wetlands		**53.71**		0.95	0	**51.02**		**69.59**		0.95	0	**66.11**
Total					26.25	98.12					41.50	154.20
Grand Total											**67.75**	**252.32**

Notes: "With Flood Control Only" reflects on-site conditions if only the flood control portion of the swale were constructed.
"Projected with Chain of Wetlands" reflects projected conditions with wetland restoration superimposed on flood control project.
"Grand Total" is the sum of the Upper and Lower Swale Values

Pertinent information related to the cost effectiveness for the two action alternatives and the no action alternative are displayed in Table 9. Initial analysis indicates that both action alternatives are cost effective in that both provide benefits and that the slightly more expensive plan with dependable water supply provides higher environmental output than the less expensive plan.

Table 9
Cost Effectiveness of the Chain of Wetlands

	ANNUAL COST	AAHU OUTPUT	INCREMENTAL COST	CHANGE IN OUTPUT AAHU	INCREMENTAL COST/AAHU
No action	0	67.75	N/A	N/A	N/A
No pump station for dependable water	$466,857	121.55	$466,857	+53.8	$8678 / AAHU
With pump station for dependable water	$497,360	252.32	$ 30,503	+130.77	$ 233 / AAHU

The plan without dependable water supply provides a net increase in benefits over the no action alternative at an average annual cost of $8,678 per average annual habitat unit (AAHU), which appears to be more costly on average than would be expected in this ecoregion. The benefits of addition of dependable water supply are clearly demonstrated by the analysis. For an additional annual cost of $30,503, an additional 130.77 AAHUs can be developed. Further, evaluation of the data indicates that the best buy is the alternative providing dependable water enabling optimum management of the wetland complex. The no action plan as well as the alternative providing the swale with the wetlands without the capability to provide water when needed provide habitat, the majority of which is associated with the grassland portion of the complex. This scenario with minimal resource values attributable to the wetlands proper does not provide restoration of priority habitat and should not be considered further. The emergent wetland restoration plan which includes provision of a dependable water supply appears to be justified based upon the analysis conducted.

Incremental Analysis of Emergent Wetlands by Cell

Since both action alternatives are considered to be cost effective, further analysis is necessary to determine the optimum extent of environmental restoration through construction of emergent wetlands that is warranted. As in the analysis used to demonstrate that provision of dependable water was desirable and justifiable, an analysis was conducted to determine if the entire COW was justifiable or if only a portion of the complex should be constructed and managed. The COW as proposed and evaluated could contain from one to seven cells (See Figure 2) that would be connected to the water source, and a series of water distribution and control structures would be used to manage the emergent wetlands for optimum habitat output. For this analysis the uppermost or northern wetland cell was named Cell A and the cells were named in alphabetical order downstream, with the most southerly located cell named Cell G. The following general information provides a breakdown of the size of each wetland complex, including shallow water emergent wetland, deep water and surrounding native grasslands that provide the overall restoration values.

CELL	A	B	C	D	E	F	G
SIZE (ACRES)	12.43	25.04	51.7	15.86	16.22	69.08	80.65

Assumptions made in the analysis were based upon engineering and environmental constraints. The source of the dependable water supply proposed to be used is located near the center of the COW at the Central Wastewater Treatment Plant. The flow of water through the COW as proposed would be upstream from Cell C then gravity fed through Cell B and onto Cell A before exiting the system into the receiving waters of the Trinity River. Downstream the flow would be gravity fed from Cell D through E, F, an G in that order if constructed. From an engineering and environmental perspective it was determined that it would be unreasonable to build wetland cells at either end without the intermediate cells due to the high cost of providing water distribution channels or pipelines along long reaches without providing any corresponding environmental benefits along the water distribution area.

The first costs for construction of each cell were determined based upon quantities of material moved and construction of pump and other water supply costs. Subsequent to the analysis, it was determined that the first costs utilized, which included a cultural resources mitigation cost was in error. However, since the cultural resources mitigation costs were initially applied in proportion to the quantity of material excavated from each cell, the analysis conducted would not be effected. See the main report for the environmental restoration costs attributable to the project. Operation and management costs were estimated for the total proposed project and for each combination of wetland cells evaluated. Economy of scale was taken into consideration during formulation of initial and annual cost estimations. Environmental output benefits determined to be attributable to the project as proposed with water supply available as indicated in Tables 8 and 9 were assigned to the wetland cells based upon their relative size and other features including location and values added due to proximity of other resources within the project area.

Due to the complexity of the analysis, the software program "Automated Procedures for Conducting Cost Effectiveness and Incremental Cost Analyses (Beta Version 2.6) was used. The tabular outputs from the analysis are attached to the end of this appendix. As indicated, the analysis was conducted with only one limitation in alternative measure combinations. This limitation was that Cell B wouldn't be constructed unless Cell C was constructed and that Cell A wouldn't be constructed without Cells C and B. Downstream, the procedure precluded analysis of Cell G without D through F being in place, etc. This limitation, as explained, appears logical in that construction of cells remotely located from the water supply would be inordinately expensive due to the need to develop the water supply along the route without any environmental benefits being developed along the same route. This also reduced the number of possible Cell combinations from 128 to 20 for further evaluation.

Least-cost combinations- Whether by computer or manual analysis, the next step in the process encompasses determining least-cost combinations for each level of output. The first iteration eliminated Plan with combination of Cells B, C, D and E because the Plan with the combination of Cells D, E and F provided the same level of output at a lower annual cost.

Cost-Effective Least-Cost Combinations- This analysis eliminated all other combinations of measures that were not cost effective. The measures eliminated were those for which another measure exists that produces a higher level of output at less cost. The Plans eliminated through this analysis were Cells D and E; Cells C and D; Cells C, D and E; Cells B, C, and D; Cells A, B, and C; Cells A, B, C, D and E; and Cells D, E, F and G. Twelve plans were carried further for the next level of analysis.

Cost-Effective Least-Cost Combinations with Incremental Analysis- This step of the process sorts plans by cost, conducts an incremental analysis based upon incremental cost and incremental output and then subjects the plans to a cost-effective least-cost analysis based upon incremental average cost and incremental outputs. Five more alternative plans were eliminated by this portion of the analysis. Seven plans, including the no action measure, were carried further into the final incremental analysis (Table 10).

Combinations for Final Incremental Analysis- The prior processes of the analysis resulted in the elimination of all plans that are not cost effective. All six of the remaining cost effective action and the no action plans were subjected to a final incremental analysis as shown in Table 10 are cost effective. The plans are sorted and shown by increasing annual cost. It should be noted that each successive plan also shows continuing increasing environmental output.

Table 10
Incremental Analysis, Final Array of Alternatives, for Proposed Chain of Wetlands - Analysis by Cell

PLAN	ANNUAL COST	AAHU OUTPUT	INCREMENTAL COST	INCREMENTAL OUTPUT AAHU	INCREMENTAL COST/AAHU
No action	0	68	N/A	N/A	N/A
Cell D	$ 63,349	75	$ 63,349	+ 7	$9,050
Cell C	$ 94,688	99	$ 31,339	+24	$1,306
Cells D and E	$180,927	135	$ 86,239	+36	$2,396
Cells C, D, E and F	$255,615	166	$ 74,688	+31	$2,409
Cells A, B, C, D, E and F	$332,532	196	$ 76,917	+30	$2,564
Cells A, B, C, D, E, F and G	$497,360	252	$164,828	+56	$2,943

Ecosystem Restoration Plan Selection

The planning goal for ecosystem restoration for the proposed project area was to develop a wetland complex that provides maximum wetland and related deepwater and grassland habitat gains within the confines of the proposed swale area in a cost effective manner. The proposed restoration plan should not cause additional unacceptable impacts within the project area to fish and wildlife resources, nor should it cause impacts to flood damage reduction benefits within the study area or preclude the development of any additional flood damage reduction actions that might be needed in the future. The seven cells that were designed individually meet all criteria except they do not maximize total restoration output of important habitat (emergent wetland) that could be achieved. The cost effectiveness and incremental cost analysis was conducted to assist in making the determination if the plan that does maximize total habitat output (plan with all seven cells) is cost effective and, based upon its incremental cost, should be supported as the recommended environmental restoration plan.

By analysis, it has been determined that the plan with all seven cells is cost effective, as were the other five action plans and these alternatives were carried forward for the final incremental analysis

(Table 10). All seven of the final alternatives are viable alternatives that must be carefully evaluated under the question " is this level of output worth it?" The analysis conducted shows that for the six action plans that remained after prior screening, environmental benefits increased with each successive increment of wetlands added. Additional increments of wetland restoration if designed would likely also continue to show increased output, however, other planning constraints would be exceeded. For example, additional emergent wetlands could be designed for location off the flood control swale but this could only occur at the expense of bottomland hardwood habitat that is nationally recognized for its importance. Restoration activities should not result in damages that would require environmental mitigation. Studies in the upstream area of the existing Dallas Floodway have only recently begun under separate authorities and it would be imprudent to design emergent wetlands in that area prior to completion of necessary engineering studies to determine needs for that reach of the system.

Therefore, within the constraints of this project and planning area, it appears that the development of the complete COW would achieve the goal of maximizing emergent wetland habitat within this area without violating other developed criteria. The remaining question of whether the plan is supportable needs to be further scrutinized. Going beyond the no action alternative is relatively simple in that a determination has been made that environmental needs are present in the basin that can be obtained by project construction. The output of 68 AAHUs for the no action alternative is based upon the native grassland complex that would result from construction of the flood damage reduction swale and would essentially provide no benefits attributable to emergent wetlands, the priority output. The next increment, or the first action proposal, construction of Cell D alone, produces only 7 AAHU at a relatively high cost due to the initial high cost of providing the water supply infrastructure and the relatively small size of the Cell. The next measure, construction of Cell C provides an additional 24 AAHU at a cost of $1306 per AAHU. Additionally, these two increments represent the first in a logical implementation sequence upon which all other cells are dependent.

The remaining alternatives, as listed, continue to provide additional output. Again the average cost of $2,564 per added AAHU for the plan which includes wetland Cells A through F, and intermediate plans are judged to be worth the additional expense to gain the additional environmental output. The final alternative which includes all cells, causes need for additional thought in determining whether it is worth the additional expense in adding Cell G to provide an additional 56 AAHUs at an incremental average cost of $2943. For comparison purposes, an analysis conducted for a similar emergent wetland complex developed on Corps lands for mitigation of another project indicates that the incremental addition of this cell to the plan is warranted. That project was designed by the Corps and implemented with funds from another agency with a need to keep costs as minimal as possible. This analysis, which did not include real estate costs, showed an annual cost of over $3000 per AAHU gained. Under these comparative conditions it would appear that the final increment proposed, which would cost less per AAHU than in the comparative example, is supportable.

Following guidance by Robinson, et al., the tendency to select the plan that minimizes average cost, or in other words, is most efficient in production has been bypassed. Instead a rational decision has been made based upon careful examination of the costs and benefits of all potential combinations of wetland cells. The final array of alternatives were examined in the same manner as if a NED plan were being searched for. In our evaluation, the incremental environmental outputs continued to rise with increased expenditure of economic resources. The cap or limit to development of additional alternatives with more wetlands was based upon environmental constraints that precluded development of additional emergent wetlands.

In addition, very few opportunities of this magnitude exist to develop emergent wetlands as proposed in the COW, particularly when considering the other non-habitat benefits such as water quality, aesthetics and sightseeing and possibly other recreational benefits that could be attributable to the emergent wetland complex features of this multi-objective plan. The increase in habitat that would be obtained by addition of Cell G appears to environmentally, economically, and socially justifiable and it is recommended that the entire wetland complex with Cells A through G be included in the environmental restoration plan.

Fish and Wildlife Impacts and Environmental Mitigation

The District has reviewed the proposed project features and has determined that mitigation sequencing has been appropriately followed. Planning leading to the determination of the NED plan eliminated channelization plans from further consideration due to adverse environmental effects and a vegetative management plan was considered but eliminated because it would have seriously diminished stream aquatic, riparian and bottomland hardwood habitats that have high national priority for protection. An array of "swale" alternatives, including, the NED plan, although causing significant losses to bottomland hardwoods was designed and aligned to avoid the highest quality forested habitats to the extent possible. The swale plans did not receive endorsement by the entire environmental community but appropriate mitigation plans were found to be feasible for the proposals.

The Chain of Wetlands (CoW) alternative alignment was developed from a smaller swale plan around desires expressed by the sponsor following extensive public involvement. A major planning objective by the Corps and sponsor included the commitment to continue avoidance of high quality forested areas and minimization of impact to any bottomland hardwood forested areas. The CoW alignment within the upper reach has been moved to the west as far as technically and economically justifiable. The alignment of the Cadillac Heights and Lamar Levees has also been extensively considered and it has been determined that no other reasonable alignments would produce less impacts to important resources.

Based upon experience and lessons learned dealing with levees in the area has determined that the more gradual slope of the proposed levees, although causing slight additional impact due to a widened foot print is necessary to reduce slumping, possible failure and otherwise high operation and maintenance costs. Any additional adjustments to the proposed project features that would reduce environmental impacts to significant resources have been judged to have immediate or long term costs that are not warranted.

Table 11 provides a breakdown by proposed project feature indicating the extent of impacts to important resources that would occur if the proposed project or feature were implemented.

A large number of broad mitigation alternatives were developed and considered by the planning team. The formulation process consisted of the following sequential steps: avoidance and minimization of impacts, identification of positive project impacts which offset the adverse project impacts, identification of project lands which through various management strategies would achieve some mitigation, identification of adjacent public lands which could be managed for mitigation, identification of adjacent private lands which could be acquired and managed for mitigation, and management and/or acquisition of off-site (not adjacent to the project) public and private lands. The planning team eliminated several of these strategies from detailed consideration by consensus because of their unavailability or inability to meet mitigation objectives. For example, it was determined that intensive management of most project lands (or adjacent public lands) would not significantly increase their habitat values over what would be achieved without intensive management. Hydrologic considerations (conveyance requirements) restricted the use of other project lands, such as the golf course, from revegetation and intensive management to obtain additional mitigative value. The team also considered acquisition and management of lower quality habitats far removed from the project site but eliminated this concept from further consideration because it failed to meet the planning objective of preserving and maintaining habitat values within the urban Trinity River floodplain.

Table 11
Impacts by proposed project feature and for TFSP, LPP, NED and Non Structural Alternatives to Important Resources (In Acres).

	NED	CoW	Lamar Levee	Cadillac Levee (SPF)	Cadillac Levee (100 yr)	Non Structural	I-45 Diversion	TFSP	LPP
Pecan-Oak Bottomland Hardwood	*175.6	5.9	10.6	0.0	0.0	16.5	4.1	20.6	20.6
Ash-Elm Bottomland Hardwood	*427.7	84.0	42.7	9.4	2.4	124.9	4.9	134	141
Mixed Grass Forblands	196.7	125.5	44.5	41.7	10.6	170.0	0.0	180.6	211.7
Open Water	24.3	37.8	4.9	1.0	0.0	42.7	7.6	50.3	51.3

**Includes area affected by habitat fragmentation caused by NED alternative within White Rock Creek floodplain.*

All features of the proposed project have been reviewed to determine what measures could be implemented that would reduce impacts and consequently reduce the need to acquire additional lands for environmental mitigation purposes. The area between the proposed levees that would be acquired for project purposes are currently extensively forested. Within this area the largest area of contiguous highest quality forest is already in public ownership and the long term without the project scenario is that only low density non-intrusive recreation, primarily in the form of undeveloped trails, would exist in the area. Forested areas in private ownership within the study area are currently protected by extensive regulations, Section 404, CDC process, and City ordinance, requiring that losses be mitigated. Non forested areas are currently converting through natural processes to bottomland hardwoods with exception of some mowed areas upstream from and adjacent to the Central Wastewater Treatment Plant and the IH 45 crossing. The future "without project" evaluation, therefore indicates that this area would continue to increase in forest cover and habitat value over time.

Based upon these assumptions, management options to further increase values of proposed project lands were considered, however, it has been determined that minimal gains could be accomplished within the area and there is an overall concern that the area may require slight vegetative management in the future to preserve the hydraulic efficiency of the proposed project. In any event it wouldn't be prudent to expend funds to develop a slight increased habitat value that would have only short term benefits. The HEP, however, does attribute slight value increases as part of the proposed project, thereby lessening the total mitigation requirement.

The potential to use proposed sumps for tree planting was also investigated. It was established that tree plantings could be accomplished, however, there are several constraints that would minimize wildlife value of these efforts to the point that it was not deemed appropriate to develop mitigation measures involving the sumps. Foremost of the considerations is that the sumps would require periodic maintenance to remove accumulations of silt and other materials deposited from runoff. These maintenance activities would require complete disruption of any forest that might develop. With a minimum 75 year time period required for forest maturation, the use of the sumps is unfeasible for fish and wildlife mitigation for bottomland hardwood forests. In addition the sumps would be separated from the riparian zone by the proposed levees which would further act to minimize any values that might be obtained by tree growth. Sumps may may be modified by planting trees around the edges and a few within the center however these plantings would result more in aesthetic than environmental mitigation purposes.

The proposed project reach downstream, in particular the golf course area, was also reviewed to determine if mitigation could be accomplished on proposed project lands. It was determined that planting vegetation on those areas would reduce the hydraulic efficiency to an unacceptable level. The acquired project areas would be maintained as currently vegetated. One area from which the topsoil has been previously removed by others adjacent to the lower reach of the CoW, has been identified as having potential for use as a disposal site for excess material from the proposed project. This site would become multipurpose project lands that have potential for reforestation to meet some of the mitigation requirements. The site was included in detailed mitigation evaluations.

Fish and Wildlife Service Recommended Mitigation Plan Development

Using these assumptions for with and without project conditions, the Corps of Engineers, U.S. Fish and Wildlife Service and Texas Parks and Wildlife Department modeled future with and without project conditions to determine impact to fish and wildlife habitat. The Services Habitat Evaluation Procedures were used to evaluate several plans to satisfy mitigation requirements for bottomland hardwood forest habitats impacted by the proposed project. The Corps provided an analysis of impacts to vegetation cover caused by separable project features. According to our studies the proposed project features of the LPP(the CoW, Lamar levee and sumps, Cadillac Levee)and the I-45 channel diversion would result in impacts to 21 acres of Pecan-Oak forest (High Quality), 141 acres of Ash-Elm (Medium Quality) forest, and 212 acres of mixed grass forbland. The HEP indicated that the LPP and 1-45 channel diversion features would result in losses of 14 Average Annual Habitat Units (AAHU) to Pecan-Oak forest and 91 AAHU to Ash-Elm forest over a 50 year period of analysis when compared to the future without project conditions.

Three potential mitigation tracts were identified which remain in private ownership and were evaluated for their potential to offset the losses to fish and wildlife habitat that would result from implementation of the LPP and the I-45 Diversion. These tracts are located within the Trinity River flood plain near the proposed project (See Figures 2 and 3). These tracts contain grasslands that have potential for conversion to bottomland hardwoods and areas of Ash-Elm and Pecan-Oak bottomland hardwood forested habitat that can be managed to improve their future habitat values.

Using the models for species evaluated, measures were developed to optimize habitat conditions on these tracts through conversion of existing grasslands to bottomland hardwoods and the improvement of existing forest stands. While the largest gains in habitat values over the life of the analysis occurs from grassland conversion, the cost associated with this conversion, including land acquisition is the most expensive per acre. Also within the tracts identified there is a limited amount of grassland available for conversion. Table 12 indicates the costs and average annual benefits associated with the three mitigation plans evaluated. Target mitigation values are based on habitat losses of 14 Average Annual Habitat Units (AAHU) to Pecan-Oak forest and 91 AAHU to Ash-Elm forest.

Table 12
Incremental Mitigation Analysis
Fish and Wildlife Service Recommended Plan

Mitigation Plan Alternative	Average Annual Habitat Units		Mitigation Cost Average Annual at 7 1/8%	Annual Cost / AAHU*
	Pecan-Oak Bottomland Hardwood(HQ)	Ash-Elm Bottomland Hardwood(MQ)		
No Mitigation	0	0	0	--
Plan A	+9	+43	$307,589	$5,915
Plan B	+9	+55	$330,347	$5,162
Plan C	+14	+92	$444,472	$4,193

*Average Annual Habitat Unit

Mitigation Plan A consists of modifying existing habitat at a tract located east of the Trinity River, in a corridor adjacent to Loop 12. The management plan to develop bottomland hardwood habitat consists of converting 86 acres of grassland to bottomland hardwood, preservation of 10 acres of grassland and habitat improvement on 753 acres of existing bottomland hardwood.

Plan B consists of adding an additional tract, a 34 acre area located on the west side of the Trinity, adjacent to the proposed lower Chain of Wetlands. This site is the site identified as potential multipurpose, surplus soil disposal and mitigation area. The management proposal is to convert the entire tract to bottomland hardwood.

Plan C is a combination of Plan B and addition of a 271 acre tract near IH 635, within the flood plain near the southern end of Dallas city limits boundary. Management in this tract would include conversion of 88 acres of grassland to bottomland hardwood and improvement of habitat quality on 173 acres and preservation of an additional 10 acres of grassland. Plan C would consist of a total 1154 acres with prescribed management practices that would fully mitigate projected losses to bottomland hardwoods attributable to the currently proposed project including the I-45 realignment. In addition to providing full mitigation of these resources, Plan C presents the best buy in terms of cost per gain in habitat value. Plans A and B are more costly per gain and do not provide the mitigation required to offset losses.

Table 13 displays the development and management techniques associated with the features to obtain the mitigation potential proposed with mitigation Plan C. These features were used to develop the cost estimates shown in the incremental analysis included in Table 12. Table 14 indicates the calculated proportion of the mitigation required in acres to offset fish and wildlife habitat impacts due to each proposed project measure based upon the US Fish and Wildlife Services recommended mitigation plan. The NED cost was determined during earlier planning.

Table 13

Habitat development features to mitigate impacts to bottomland hardwood the Dallas Floodway Extension-LPP, including CoW, SPF Lamar Levee and sumps, SPF Cadillac Heights Levee, and I-45 Channel Diversion based upon U.S Fish and Wildlife Service planting plans.

A. Acquisition

1. 926 ac BLH
2. 228 Mixed grass/forbland

B. Initial Development

1. Habitat Improvement of existing BLH's
   a. Selective thinning 463 acres.
   b. Mast trees (containerized at rate of 5 trees Per acre on 235 acres) 1175 trees
   c. Tree Planting with site prep 1175 trees
   d. Shear, rake, pile and bed 50 acres
   e. Passerine and squirrel nest boxes, acquire and install 270 boxes

2. Conversion of mixed grassland to BLH's
   a. Shredding/disking 208 acres
   b. Mast trees (containerized at rate of 40 trees /acre On 208 acres) 8320 trees
   c. Fruiting shrubs (containerized at rate of 10 shrubs/acre On 208 acres) 2,080 shrubs
   d. Tree planting with site prep 8,320 trees
   e. Shrub planting with site prep 2080 shrubs
   f. Hardwood seedlings (100 seedlings/acre for 208 acres) 20,800 seedlings
   g. Seedling planting 208 acres
   h. Passerine nest boxes 208 boxes

3. Fencing 6 miles
4. Signs

Table 14

Mitigation required by feature, LPP, Non Structural and NED Alternatives based upon U.S. Fish and Wildlife mitigation planting plan

CoW	635 Ac	$ 3,056,477
Lamar Levee/sump	392 Ac	$ 1,886,833
SPF Cadillac Levee	58 Ac	$ 279,173
100 yr Cadillac Levee	1 4.5 Ac	$ 69,793
I45 Diversion	69 Ac	$ 314,412
NON STRUCTURAL	1027 Ac	$ 4,961,022
LPP	1154 Ac	$ 5,554,607
TFSP	1110.5 Ac	$ 5,327,515
NED	3200 Ac	$14,296,736

Corps Analysis of Other Mitigation Alternatives

Areas remote to project area. An analysis of potential locations to conduct fish and wildlife mitigation was conducted, including potential mitigation sites within the main stem Trinity River and East Fork of the Trinity flood plains. The search included review of existing documented information, interviews with representatives of the City of Dallas and Dallas County. A broad search was conducted based upon known locations of existing or potential bottomland hardwood forest lands within the upper and middle Trinity River basin. The U.S. Fish and Wildlife Service (1991) conducted an inventory of lands within the basin that could be preserved or improved with management. This document was used as a guide to determine the ability of off-project locations to meet general planning mitigation objectives as well as meet requirements to offset losses fish and wildlife habitat as determined through use of the Service's Habitat Evaluation Procedures. The Service's report identified three general locations within the East Fork of the Trinity River Basin downstream of Lake Ray Hubbard containing existing tracts of bottomland hardwood forest and five locations along the main stem of the Trinity River between the confluence of the East Fork of the Trinity River and the upstream limits of Lake Livingston that had potential to be managed to achieve environmental mitigation. In addition numerous agricultural tracts adjacent to the East Fork were identified that could be converted or restored to bottomland hardwood habitat. Currently, these agricultural lands are protected by levees that are owned and maintained by levee districts.

East Fork Trinity River. The potential mitigation sites along the East Fork are approximately 20 straight line miles east of the proposed project location and the potential sites along the main stem are located between 40 and 90 straight line miles south of the proposed project. Subsequent reevaluation of the forested tracts and agricultural properties on the East Fork indicated that the tracts available were either too small to provide the necessary mitigation, were already designated as mitigation for numerous unrelated Section 404 permitted activities in the basin or had such social and economic constraints that they were inappropriate for acquisition and management for environmental mitigation. As an example, the agricultural lands along the East Fork, could be converted to bottomland hardwood, however, for the mitigation lands to function appropriately, the existing privately owned agricultural levees would have to be breached and new levees constructed to provide continued protection to the remaining agricultural lands not incorporated into the environmental mitigation. Assuming that conversion of approximately 500 acres of farmland to bottomland hardwood forest would provide the environmental mitigation to offset losses caused by the proposed project, approximately 4700 feet of existing levee would have to be breached and 14,100 linear feet of new levee designed to meet the existing level of protection. Existing levees usually average about 15 feet in height and have an eight foot top width. Repair costs for the agricultural levees in this area currently average approximately $1,000 per linear foot. Even if economy of scale would result in a reduction in the cost per linear foot to 50% of that required for repair, the new levees could still cost more than $7,000,000, excluding any cultural resource or HTRW investigation or mitigation costs that might be necessary. In addition, productive farm lands could cost as much as flood plain lands within the immediate project area. The alternative of utilizing agricultural lands adjacent to the East Fork, although initially appealing to pursue, was ruled out also because of the high cost for initial acquisition, construction and in addition, a high level of management would be required on the part of the project sponsor at a site located approximately 30 road miles from the proposed project site.

Trinity River Alternatives. Five locations were evaluated within the main stem Trinity River flood plain downstream of Dallas County and three sites within the immediate project area were evaluated for the cost effectiveness of providing the environmental mitigation. All of these sites were identified by the evaluation team including the US Fish and Wildlife Service as having potential for habitat improvement and therefore could provide some or all of the mitigation needed for the proposed project. In evaluation of these tracts, the cost of land acquisition and the cost of providing labor to manage the habitat improvements, including travel costs were utilized to determine if it is more cost effective to acquire lands that have an initial lower cost but higher operation and maintenance or to acquire lands closer to the proposed project that would have a higher initial acquisition cost but reduced operation and maintenance cost due to the proximity to the sponsors center of operation. Labor and material costs to plant or conduct other work to obtain the habitat gains were not included in this analysis, however, the potential sites were evaluated to see from a theoretical standpoint that the site could provide the average annual habitat units of bottomland hardwood forest values determined through use of the Service's Habitat Evaluation Procedures that would be needed to compensate for the proposed project impacts.

The tracts evaluated included the Big Lake site, located in Anderson County. This site is located approximately 100 road miles from the city of Dallas. The tract is approximately 9446 acres in size and it has been reported to be under the ownership of a single owner. It is not know if the owner would willingly sell only a portion of the tract. The tract could provide an estimated 1000 acres of land necessary to provide the necessary mitigation.

The tract located at the confluence of Catfish and Beaver Creeks also located in Anderson County would provide only a portion of the habitat needed to offset losses from the proposed project. The site is 1510 acres in size and is located adjacent to a State Wildlife Management Area, however the existing vegetation of the site is 75% marsh land. The site by itself could not provide the entire mitigation needed because converting existing high value marsh land which is likely jurisdictional wetland to bottomland hardwood forest would not meet policy objectives nor would it be met favorably by environmental agencies. It is unlikely that only the 25% that could be managed for mitigation purposes could be acquired separately. This tract is located approximately 60 road miles from the City of Dallas.

At the confluence of Buffalo and Linn Creeks, in Freestone County, a small 532 acre tract exists that is approximately 74% covered by high value bottomland hardwood forest. The remainder of the tract is in upland forest and agriculture. Even intense management would not result in sufficient habitat improvements to provide the necessary mitigation and it is unknown if only the bottomland hardwood site could be acquired. This tract is also located about 63 miles from the proposed project location.

The Middle Trinity Terrace is a 13,516 acre tract of severely cut-over bottomland hardwood forest comprised almost entirely of cedar elm and sugarberry. Management potential is good for this tract located in Navarro and Henderson Counties. The site is approximately 65 road miles from the proposed project site.

The Hagen bottoms is a 921 acre tract located in Anderson County. This tract is composed of approximately one-half cropland that could be converted to bottomland hardwood forest and the remainder of the tract is shrub swamp and bottomland hardwood forest. The tract appears most favorable in initial composition and comparable in size to the mitigation tract recommended by the U.S. Fish and Wildlife Service in their report on the proposed Dallas Floodway Extension project. The tract is located approximately 95 road miles away from the proposed project area.

The three tracts located adjacent to the main-stem Trinity River adjacent and just downstream of the proposed project combined totals 1154 acres in size . The combined tracts contain approximately 926 acres of bottomland hardwood forest and 228 acres of grassland that could be managed and converted respectively to provide mitigation for the project as proposed. These three sites are located close enough to the project area that operation and management expenses could be handled as an extension of the responsibilities of the sponsor's existing staff. Table 15 shows an estimate of the cost breakdown for the alternative sites including operation and maintenance including labor to oversee the mitigation areas. Labor and materials to do actual site preparation, establishment of the mitigation forest and provision of fencing to protect the mitigation area and acquisition and placement of nest boxes are not included in this analysis which is shown to identify the cost effectiveness of utilizing potential mitigation lands adjacent to the area or to establish the mitigation area at a remote location which would have a lower initial acquisition cost.

Table 15
Cost Effectiveness Analysis of Alternative Mitigation Sites

COST ANALYSIS							
NVESTMENT COST		Big Lake	Catfish/	Buffalo/	Middle Trinity	Hagen	Proposed
			Beaver Crk	Linn Crks	Terrace	Bottoms	for LPP
	FIRST COST	$1,260,000	$1,268,400	$446,880	$1,260,000	$1,768,320	$3,779,52
	ANNUAL INTEREST RATE (decimal)	0.07125	0.07125	0.07125	0.07125	0.07125	0.0712
	PROJECT LIFE (years)	100	100	100	100	100	10
	CONSTRUCTION PERIOD (months)	12	12	12	12	12	1
	INTEREST DURING CONSTRUCTION	$48,117	$48,438	$17,065	$48,117	$67,529	$144,3
	INVESTMENT COST	$1,308,117	$1,316,838	$463,945	$1,308,117	$1,835,849	$3,923,85
VERAGE ANNUAL CHARGES							
	INTEREST	$93,203	$93,825	$33,056	$93,203	$130,804	$279,57
	AMORTIZATION	$96	$96	$34	$96	$134	$28
	OPERATIONS & MAINTENANCE	$216,153	$165,692	$124,904	$207,126	$174,072	$20,00
	REPLACEMENTS	$0	$0	$0	$0	$0	$
	TOTAL ANNUAL CHARGES	$309,452	$259,613	$157,994	$300,425	$305,010	$299,86
NCREMENTAL ANALYSIS							
	AAHU (BLH)GAIN OVER NO ACTION	99.7	25	50	99.7	99.7	99.
	ANNUAL COST/AAHU GAIN	$3,103.83	$10,384.52	$3,159.88	$3,013.29	$3,059.28	$3,007.6

It needs to be made clear that the information developed to compare the cost efficiency of acquiring potential mitigation lands downstream within the Middle Trinity Basin as opposed to acquiring the lands jointly evaluated by the Corps and the U.S. Fish and Wildlife Service and recommended by the U.S. Fish and Wildlife Service, is based upon review of existing information documented during the Lower Trinity River study and does not reflect the degree of technical precision that was obtained during detailed studies of the lands recommended by the U.S. Fish and Wildlife Service. The actual management (tree planting, thinning, fencing, number of nest boxes to be provided) may vary substantially, however, these needs and their subsequent costs cannot be determined without detailed on-site evaluations including field data for the Habitat Evaluation Procedures. It should also be noted that the $20,000 O&M estimated for the District's recommended mitigation plan was developed jointly with the U.S. Fish and Wildlife Service and presumes that due to the proximity of the sites to the sponsor's center of business, that the oversite and routine care of the mitigation features can be handled by currently employed staff as a slight increase in exist duties.

Therefore our review of operation and management responsibilities of an approximate 1000 acre forested wetland mitigation site located within the Trinity flood plain, downstream from Dallas is based upon the difference in land costs and labor and travel costs. After discussion with Corps of Engineer employees representing Real Estate and Operations, it was determined that to reasonably assure that a forested site would respond to prescribed treatments in an manner appropriate to producing fish and wildlife mitigation, an observable physical presence is necessary on-site over the term of the mitigation project life. Fire, disease, vandalism, and timber rustling (firewood, heartwood, saplings, etc.) could devastate a forested mitigation site rapidly unless the property receives continual care and frequent observation. There are a number of ways that this oversite could be achieved.

The options for evaluated for the sponsor who is responsible for O&M include the following :

a. Contract with Texas Parks and Wildlife Department
b. Establish a residence at management area
c. Use existing or hired City of Dallas project manager and hired labor that would travel back and forth.

Based upon past experience, it is highly unlikely that Texas Parks and Wildlife Department would manage a relatively small forested mitigation area. Establishment of a permanent residence would involve additional start up costs and subsequent O&M. In addition, it is anticipated that an on-site manager would still be required to frequently travel to and from Dallas for coordination with other City officials on a frequent basis.

A decision was made to base operations and maintenance costs on having a full time manager and an assistant devoting varying amounts of time to the project. The team would travel back and forth between Dallas and the mitigation site three times per week during construction and in particular during the life of the project to establish a presence in adjacent communities and assure operation and maintenance needs are observed and appropriately addressed. We believe that the information developed adequately and accurately represents the additional current operations and maintenance costs that would be necessary to maintain a forested mitigation site remotely located from the sponsor's center of business.

Of the five remotely located sites economically evaluated, three appear to have potential to provide mitigation for fish and wildlife values, however, the distance away from the Dallas Floodway Extension project impacts ability to successfully manage at a reasonable cost. Of the three having best potential, the Hagen Bottoms Site appears most similar in size and existing vegetative cover breakdowns to the mitigation lands evaluated in Dallas County adjacent to the proposed project. The operations and maintenance costs were estimated for this site based upon three round trips per week plus additional local travel totally 34,320 miles per year. At existing current rates of $0.31 per mile, the mileage costs total $10, 639 per year. Total labor was estimated at $163,433 per year which includes a full time manager at a fully burdened cost of $114,400 per year and an assistant for slightly less than three quarters of a man year at a fully burdened rate of $67,200 per year. Future energy costs and labor costs were not considered but it can safely be presumed that the costs would increase over the life of the mitigation management. Operations and maintenance costs for other sites was calculated from a similar approach.

The results of the evaluation indicates that although land can be acquired at locations remote from the proposed project area at a lower initial cost, the benefits of such a proposal are overcome by the additional operation and management costs during the life of the project. It should be noted that the Catfish/Beaver Creeks area and the Buffalo/Linn Creeks areas do not meet the mitigation (AAHU) requirements to offset losses attributable to the proposed project either singular or when combined with each other. In addition, management of separate tracts so remote from the project site is not desirable from an economic or logistic stand point. The recommended mitigation plan was formulated consistent with project planning objectives and with mitigation policy. Use of mitigation lands in the project study area adjacent to the project causing the damages helps to meet the planning goal of protecting and restoring habitat values within the study area. Further mitigation policy prescribes that a sequence be used in identifying mitigation areas. That sequence calls for first looking for opportunities in project land, then in the immediate project area adjacent to the project causing the damages, and finally if the first options are not available, to look off site (but preferably within the same watershed). While mitigation cannot be accomplished on project lands, the recommended mitigation plan adjacent to the project is cost effective, incrementally justified and fully supported by the resource agencies and project sponsor. It should be also noted that even if the economic evaluation had shown that any of the alternate mitigation sites were slightly more cost effective, the remote sites likely would be found unacceptable to resource agencies and the sponsor. In addition, the proposed removal of trees as part of the project influence many other factors that would not be mitigated by selection of a remote location. For example, Dallas County is in a non-attainment area for ozone, and intensified regulatory requirements are in place currently, that are proposed to be even more strict within the next year. Our analysis indicates that the removal of trees as proposed by our project would have a slight effect on the potential removal of ozone from the local area. Replacement of the trees through the District's proposed fish and wildlife mitigation plan would result in an overall improvement of ozone reducing capability in the study area. Location of the mitigation site in Anderson County would not. As a result of this analysis, it has been determined that acquisition of mitigation lands near to the proposed project as requested by the sponsor and recommended by the Fish and Wildlife Services is economically justifiable.

Habitat Management cost effectiveness

Grassland Conversion to Forest. An almost unlimited combination of tree planting techniques could be evaluated to determine cost effectiveness for various grassland to forest conversion and forest stand improvement techniques. It was determined that only those combinations where it is possible to reliably estimate the effect of the planting combination on the net result in terms of habitat improvement (Habitat Units). An analysis to show cost effectiveness of different planting schemes is presented in Table 16.

Table 16
Vegetation Management Cost Effectiveness

REFORESTATION TECHNIQUES	COST PER ACRE	AVERAGE ANNUAL HABITAT GAIN (AAHU) PER ACRE	COST PER AAHU GAIN
Plan 1. 40 containerized trees and 10 shrubs per acre	$3857	0.71	$5,432
Plan 2. 10 containerized trees, 5 shrubs and 100 seedlings per acre	$1,050	0.65	$1,615
Plan 3. 5 containerized trees, 5 shrubs and 200 seedlings per acre	$ 900	0.67	$1,343
Plan 4. 300 mast tree seedlings and 150 shrub seedlings per acre	$ 500	0.64	$ 781

The analysis indicates that the most cost effective means of forest regeneration within the floodway is derived by following the scheme as outline in Plan 4. Planting of 300 mast tree seedlings and 150 shrub seedlings per acre will provide one average annual habitat unit for every $781 of initial cost investment. However, Plan 1 represents the planting regime recommended by the US Fish and Wildlife Service and was the basis for their recommended mitigation plan of 1154 acres to mitigate the proposed project losses. Since Plan 4 provides only 90 % (0.64/0.71)of the mitigation provided for grassland to forest conversion by Plan 1, an additional 11% of grassland would need to be added to the project to provide the habitat values needed. The Fish and Wildlife Service's recommended mitigation plan contained 228 acres of grassland, an additional 11% increase would result in the need to acquire and convert an additional 25 acres of grassland at an approximate cost of $2500 per acre. The Services plan for converting 208 acres of grassland to bottomland hardwood forest was estimated to cost approximately $624,000 excluding land costs. Addition of 25 acres including land cost and utilizing the mitigation planting technique that appears to be most cost effective for all 233 acres results in a cost to convert grassland to forest of approximately $195,010.

Habitat Improvement of Existing Forest. The Service also recommended in their mitigation plan that 5 containerized mast trees should be planted per acre in lands acquired that contain existing bottomland forest. For several reasons, we have determined that we have determined that planting with bare root seedlings should not be considered as a management option in these existing wooded areas. Shading from existing non-hard-mast trees would preclude their growth and we have determined that no habitat gain would occur from bare root seedlings within the existing forest. The planting with containerized trees at a rate of 5 trees per acre along with appropriate site preparation is recommended for the forested areas that are designated for habitat improvement.

Corps Mitigation Recommendation

Based upon the alternative analyses conducted, it appears that the mitigation plan recommended by the US Fish and Wildlife Service will meet the goal of no net loss of bottomland hardwood habitat. It also appears that location of the mitigation within the Trinity main-stem flood plain near the project is justifiable and appropriate since operation and maintenance costs for sites located farther downstream overcome the benefits of lower initial acquisition cost.

We have determined that the vegetation management plan proposed by the Service in existing forested areas is justifiable; however, it has been determined that planting of bare root mast tree and shrub seedlings is more cost effective than planting containerized trees and shrubs where conversion of grassland to bottomland hardwood forest is proposed. Our analysis indicates that although per acre costs are lower, the average annual habitat gains per acre are only 90% of that achieved by the planting regime recommended by the Service. Therefore an additional 25 acres of grassland should be acquired and converted to bottomland hardwood forest by planting with bare root seedlings. The Corps recommended mitigation plan would result in a significant initial cost savings over that proposed by the US Fish and Wildlife Service and would meet the planning objective of no net loss of bottomland hardwood forest habitat. It is proposed that the additional 25 acres of grassland be acquired adjacent to the area identified on Figure 3 as "Other Public Lands" located between US Highway 175 and the Trinity River and immediately upstream of the mitigation area proposed by the Service that adjoins Loop 12.

Table 17 displays the development and management techniques associated with the mitigation proposed for the LPP as proposed by the Corps. Table 18 shows a breakdown of mitigation required by feature and alternative utilizing the Corps mitigation proposal.

Table 17

Habitat development features to mitigate impacts to bottomland hardwood the Dallas Floodway Extension-LPP, including CoW, Lamar Levee and sumps, Cadillac Heights Levee, and I-45 Channel Diversion based upon Corps of Engineers planting plans.

A. Acquisition

1. 926 acres of Bottomland Hardwood Forest
2. 253 acres of Mixed grass/forbland

B. Initial Development

1. Habitat Improvement of existing BLH's
   a. Selective thinning 463 acres.
   b. Mast trees (containerized at rate of 5 trees Per acre on 235 acres) 1175 trees
   c. Tree Planting with site prep 1175 trees
   d. Shear, rake, pile and bed 50 acres
   e. Passerine and squirrel nest boxes, acquire and install 270 boxes

2. Conversion of mixed grassland to BLH's
   a. Shredding/disking 223 acres
   b. Hardwood seedlings (300 seedlings/acre for 223 acres)
   c. Shrub seedling planting(150 seedlings/acre for 208 acres
   d. Passerine nest boxes 223 boxes

3. Fencing 6 miles
4. Signs

Table 18

Mitigation required by feature, LPP, TFSP and Non Structural Alternatives based upon Corps of Engineers proposed mitigation planting plan.

CoW	649 Ac	$ 2,567,230
Lamar Levee/sump	400 Ac	$ 1,574,600
SPF Cadillac Levee	59 Ac	$ 238,450
100 yr Cadillac Levee	1 5 Ac	$ 25,913
I45 Diversion	71 Ac	$ 279,110
NON STRUCTURAL	1027 Ac	$ 4,420,940
LPP	1179 Ac	$ 4,659,390
TFSP	1135 Ac	$ 4,446,853

Executive Order 11988 - Flood Plain Management

The spirit and intent of Executive Order 11988 have been considered in preparation of this action. There are no feasible alternatives to conducting activities within the 100-year flood plain of the Trinity River and measures have been considered to minimize impacts to the flood plain through project design. Additionally, the City of Dallas currently has several programs for management of the Trinity River 100-year flood plain following proposed project implementation. The City is a participant in the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program and the Community

Rating System (CRS). The City maintains a Corridor Development Certificate from the North Texas Council of Governments, has a Flood Warning System for the Trinity River Basin and a Flood Plain Ordinance which regulates development in the flood plain (Personal Communication: Mr. Loyd Denman, City of Dallas, Department of Flood Plain Management and Erosion Control).

Future flood plain impacts would be controlled through the development of a comprehensive Flood Plain Management Plan (FPMP). An FPMP would be developed by the City which in accordance with Section 202(c) of the Water Resources Development Act of 1996 and the guidance provided by the Secretary of the Army. The FPMP would be developed within one after the signing of the Project Cost Sharing Agreement and implemented within one year after completion of construction of the proposed project.

Section 404 Clean Water Act

The Corps of Engineers has been directed by Congress under Section 404 of the Clean Water Act (33 USC 1344) to regulate the discharge of dredged and fill material into all waters of the United States, including adjacent wetlands. The intent of Section 404 is to protect the nation's waters from indiscriminate discharge of material capable of causing pollution, and to restore and maintain the chemical, physical and biological integrity of these areas. Although the Corps of Engineers does not issue itself permits for proposed activities which would affect waters of the United States the Corps must meet the legal requirements of the Act. Section 404 (r) of the Clean Water Act, waives the requirement to obtain a State Water Quality Certificate provided information on the effects of the discharge of dredged or fill material into waters of the United States, including the application of the Section 404(b)(1) guidelines are included in an environmental impact statement (EIS) on the proposed project and the EIS is submitted to Congress before the actual discharge takes place prior to authorization or appropriation of funds for proposed project construction. A Section 404(b)(1) analysis has been completed and is attached in full as an addendum to this appendix. It is intended to submit the completed GRR and integrated EIS to Congress prior to appropriation of funds for construction occurs.

Sections 9 and 10 Rivers and Harbors Act

Section 9 (33USC 401) and Section 10 (33USC 403) of the Rivers and Harbors Act of 1899 direct the Corps to regulate all work or structures in or affecting the course, condition, or capacity of navigable water of the United States. The main stem Trinity at Dallas is navigable, however, no commercial navigation occurs on the Upper Trinity reach. Recreational use in the form of canoeing and fishing and pleasure boating occurs but to a limited extent and then only during less than flood flow events. The project features proposed would have minimal affect to navigation. The foot print of the Chain of Wetlands would lie on the flood plain adjacent to the main stem. The COW would only function during overbank flow events and during normal operation of the wetlands the hydrologic connections would be to tributary streams. The created wetlands would utilize water from the local waste water treatment plant. Only minimal evaporative losses in water would occur. No impacts to navigational capacity should occur from this feature. The proposed Lamar and Cadillac levees would also lie within the flood plain. Their influence on hydology and hydraulics would also only occur during flood events.

The proposed realignment of the River to protect the I-45 bridge would cause temporary disruption to navigation. The proposed project construction would be phased to allow free flow of the river through the existing channel until the new alignment is almost completed. The lower end of the new channel would then be excavated and connected to the main stem and then the upper connection would be made. Free flow down the new channel would occur quickly and navigation capacity would be restored, prior to backfilling the old channel.

The Corps of Engineers completed an Environmental Impact Statement and a Record of Decision (ROD) in 1988 that addressed the cumulative impacts of a number of unrelated independent proposed actions within the Upper Trinity River basin. The authority for the study was based upon the Corps regulatory requirements. The results of the EIS indicated strongly that there are potential cumulative impacts associated with individual flood plain developments that are both measurable and significant. Public comment and discussion focused on the undesirability of additional regional increases in flood hazards for either the 100-year or Standard Project Flood and that flood plain management should stabilize the flood hazard at existing levels through regulation and efforts of both the Corps and local organizations should be used to reduce flood hazard over the long term. The ROD provided a framework of criteria that would become the basis for the Regulatory Program within the Regional EIS study area. The Regulatory Program includes those actions proposed by the Corps of Engineers that are subject to Section 404, Section 9 or 10 compliance.

Hydraulic criteria applicable to the Dallas Floodway Extension area include that no rise in the 100-year or SPF elevation would be allowed, the maximum allowable loss in storage capacity for the 100-year and SPF discharges will be 0% and 5% respectively, alterations of the flood plain may not create or increase an erosive water velocity on or off site, and the flood plain may be altered only to the extent permitted by equal conveyance reduction on both sides of the channel. The proposed action will also be reviewed on the assumption that adjacent projects would have an equitable chance to be built, such that the cumulative impacts of both will not exceed the common criteria. In addition, since the proposed project includes levees that protect urban development, the minimum design criterion for the top of levee is the SPF plus 4.0, unless a relief system can be designed which would prevent catastrophic failure of the levee system. The ROD also provides criteria for mitigation of unavoidable losses to special aquatic sites including wetlands and guidelines for mitigation of other important resources.

The ROD also provided that variance from the criteria would be made only if public interest factors not accounted for in the Regional EIS overwhelmingly indicated that the "best overall public interest" is served by allowing such variance. During the review of this project proposal by the Corps, other agencies, communities and the public, it will be determined if it meets the ROD criteria or whether resolution of flooding problems of this frequency and magnitude should be deemed as an overriding concern, and if, a variance from the Record of Decision should be allowed as being in "the best overall public interest."

Environmental Justice

Executive Order 12898 provides for review of proposed activities to assess the effect on minority populations and low income populations. The area of potential project impact was screened and it has been determined that the area does contain minority and low income populations. A review of the effects of the proposed project alternatives indicate that all flood control plans, except the combination plan including a non-structural buyout of Cadillac Heights in lieu of a levee, provide significant flood protection for local residents and businesses. The economically feasible buyout of the 25-year flood zone would leave many minority and low income individuals subject to flooding. The proposed Cadillac Heights levee would provide protection from the Standard Project Flood and would reduce adverse economic impacts of repeated flooding in the area. This levee would impact an existing meat packing facility, but the plant could be relocated immediately adjacent to the existing location, thereby minimizing loss of employment opportunities to local residents.

Should the chain of wetlands be built alone, the majority of the economic benefits would accrue upstream within the Central Business District (CBD), with the negative impacts of forest loss occurring within the floodplain adjacent to Cadillac Heights and to the Lamar business area. There would be some flood damage reduction benefits within the immediate area, but not to the same level as provided to the CBD. Other economic benefits from the multi-purpose chain of wetlands project to the minority and low income populations would accrue due to the influx of recreation users of the trail system that would be constructed.

Building the river diversion at IH-45 to protect a major roadway bridge from catastrophic failure would benefit all people and would not be of detriment to any populations. The Tentative Federally Supportable Plan and the Locally Preferred Plan, including the environmental restoration of emergent wetlands, environmental mitigation, and a recreational trail would also provide benefits to the local area. Another benefit of the overall project is the clean-up of accumulations of trash and debris within the projected lands and some of the hazardous and toxic wastes in the project footprint. The proposed project would not result in disproportionate impacts to minority or low income populations. Recognizing the overall balance of benefits and impacts that would occur from the proposed project. It has been determined that implementation of either the TFSP or the LPP along with the river realignment would be in compliance with the intent and spirit of Executive Order 12898.

Table 2
Vegetation Species List

Trees — Common Name	Genus/species
Boxelder	*Acer negundo var. negundo*
Virginia redcedar	*Juniperus virginiana*
Persimmon	*Diospyros virginiana*
Eastern redbud	*Cercis canadensis var. candensis*
Honey locust	*Gleditsia triacanthos*
Eve's necklace	*Sophora affinis*
Bur oak	*Quercus macrocarpa var. macrocarpa*
Shumard red oak	*Quercus shumardii var. shumardii*
Texas buckeye	*Aesculus arguta*
Pecan	*Carya illionensis*
Osage orange	*Maclura pomifera*
White mulberry	*Morus alba*
Red mulberry	*Morus rubra*
American ash	*Fraxinus americana*
Pennsylvania ash	*Fraxinus pennsylvanica*
Texas ash	*Fraxinus texensis*
Green hawthorn	*Crataegus viridis*
Eastern cottonwood	*Populus deltoides ssp. deltoides*
Black willow	*Salix nigra*
Western soapberry	*Sapindus saponaria var. drummondii*
Wooly bumelia, Chittamwood	*Sideroxylon lanuginosa ssp. oblongfolia*
Sugar hackberry	*Celtis laevigata var. laevigata*
American elm	*Ulmus americana var. ameriacana*
Cedar elm	*Ulmus crassifolia*

Shrubs/Vines — Common Name	Genus/species
Oakleaf poison oak/Poison ivy	*Toxicodendron pubescens*
Possumhaw	*Ilex decidua*
Wooly dutchman's pipe	*Aristochia tomentosa*
Smooth swallow wort	*Cynanchum laeve*
Anglepod milkvine	*Gonolobus gonocarpus*
Japanese honeysuckle	*Lonicera japonica*
American elderberry	*Sambucus canadensis var. canadensis*
Coralberry	*Symphoricarpus orbicularis*
Burning bush	*Evonymus atropurpurea*
Sharppod morningglory	*Ipomoea codatotriloba var. codatotriloba*
Roughleaf dogwood	*Cornus drummondii*
Drooping melonette	*Melothria pendula var. pendula*
Swamp privet	*Forestiera acuminata*
Smooth elbowbush	*Forestiera pubescens var. glabrifolia*
Thinleaf privet	*Ligustrum quihoui*
Chinese privet	*Ligustrum sinense*
Maypop	*Passiflora incarnata*
Yellow passionflower	*Passiflora lutea*
Purple leatherflower	*Clematis pitcheri var. pitcheri*
Southern dewberry	*Rubus trivalis*
Balloonvine	*Cardiospermum halicacabum*
Greenbrier	*Smilax bona-nox*
Greenbrier	*Smilax tamnoides*
Common greenbrier	*Smilax rotundifolia*
Peppervine	*Ampelopsis arborea*
Heartleaf peppervine	*Ampelopsis cordata*
Virginia creeper	*Parthenocissus quinquefolia*
Summer grape	*Vitis aestivalis*
Mustang grape	*Vitis mustangensis*

Herbaceous Species — Common Name	Genus/species
Dicliptera	*Dicliptera brachiata*
Limestone ruellia	*Ruellia strepens*
Hairy tonguetube	*Siphonoglossa pilosella*
Alligator weed	*Alternanthera philoxeroides*
Palmer amaranth	*Amaranthus palmeri*
Berlandier amaranth	*Amaranthus polygonoides*
Tamarix amaranth	*Amaranthus rudis*
Canada sanicle	*Sanicula canadensis var. canadensis*
Cluster sanicle	*Sanicula odorata*
Hedge-parsley	*Torilus arvensis*
Golden alexander	*Zizia aurea*
Common ragweed	*Ambrosia artemiisifolia*
Western ragweed	*Ambrosia psilostachya*
Giant ragweed	*Ambrosia trifida var. texana*
Tall aster	*Aster prealtus var prealtus*
Hierba del Marrano	*Aster subulatus var. ligulatus*
Roosevelt weed	*Baccharis neglecta*
Devil's beggar ticks	*Bidens frondosa*
American basketflower	*Centaurea americana*
Texas thistle	*Cirsium texanum*
Prostrate lawnflower	*Calyptocarpus vialis*
Horsetail conyza	*Conyza canadensis var. canadensis*
Clasping coneflower	*Dracopis amplexicaulis*
Yerba de tago	*Eclipta prosrata*
Late eupatorium	*Eupatorium serotinum*
Broadleaf camphorweed	*Heterotheca subaxillaris var. latifolia*
Old plainsman	*Hymenopappus scabiosaeus var. corymbosus*
Marshelder	*Iva annua*
Louisiana lettuce	*Lactuca ludoviciana*
Prickly lettuce	*Lactuca serriola*

False ragweed	*Parthenium hysterophorus*
Sawleaf daisy	*Prionopsis ciliata*
Manystem false dandelion	*Pyrrhopappus pauciflorus*
Prairie coneflower	*Ratibida columnifera*
Brown-eyed Susan	*Rudbeckia hirta var. pulcherrima*
Scabrous goldenrod	*Solidago canadensis var. scabra*
Prickly sowthistle	*Sonchus asper*
Common sowthistle	*onchus oleraceus*
Yellow salsify	*Tragopogon dubius*
Baldwin ironweed	*Vernonia baldwinii ssp. baldwinii*
Cocklebur	*Xanthium strumarium var. canadense*
Shepard's purse	*Capsella bursa-pastoris*
Virginia peppergrass	*Lepidium virginicum var. virginicum*
Clasping Venus.lookingglass	*Triodanis perfoliata var. perfoliata*
Sleepy catchfly	*Silene antirrhina*
Chickweed	*Stellaria media*
Lambsquarters	*Chenopodium album var. album*
Pitseed goosefoot	*Chenopodium berlandieri var. berlandieri*
Narrow dayflower	*Commelina erecta var. augustifolia*
Texas bindweed	*Convolvulus equitans*
Carolina ponyfoot	*Dichondra carolinensis*
Cherokee sedge	*Carex cherokeensis*
Emory sedge	*Carex emoryi*
Sawgrass	*Cladium jamaicense*
Taperleaf flatsedge	*Cyperus acuminatus*
Largespike spikerush	*Eleocharis palustris*
Western umbrellagrass	*Fuirena simplex*
Spotted spurge	*Chamaesyce maculata*
Prostrate spurge	*Chamaesyce prostrata*
Mat spurge	*Chamaesyce serpens*
Toothed spurge	*Euphorbia dentata*

Fern acacia	*Acacia angustissima var. Hirta*
Prairie senna	*Chamaecrista fasciculata*
Illinois bundleflower	*Desmanthus illinoensis*
Velvet bundleflower	*Desmanthus velutinus*
Western scarlet pea	*Indigofera miniata var. leptosepala*
Low peavine	*Lathyrus pusillus*
Black medic	*Medicago lupulina*
Buttonclover	*Medicago orbicularis*
White sweetclover	*Melilotus albus*
Sourclover	*Melilotus indicus*
Yellow sweetclover	*Melilotus officinalis*
Filaree	*Erodium cicutarium*
Carolina geranium	*Geranium carolinianum*
Swordleaf blue-eyed grass	*Sisyrinchium chilense*
Henbit	*Lamium amplexicaule*
Purple deadnettle	*Lamium purpureum*
Lemon beebalm	*Monarda citriodora var. citriodora*
Dotted beebalm	*Monarda punctata var. intermedia*
Wood sage	*Teucrium canadense var. canadense*
Wild onion	*Allium canadense var. caradense*
False garlic	*Nothoscordum bivalve*
Low winecup	*Callirhoe involucrata var. involucrata*
Carolina modiola	*Modiola caroliniana*
Spreading spiderling	*Boerhavia diffusa*
Lizardtail gaura	*Guara parviflora*
Roadside gaura	*Guara suffulta ssp. suffulta*
Common evening primrose	*Oenothera biennis ssp. centralis*
Cutleaf evening primrose	*Oenothera laciniata*
Roundleaf evening primrose	*Oenothera rhombipetala*
Showy primrose	*Oenothera speciosa*
Stemless primrose	*Oenothera triloba*

Dillen oxalis	*Oxalis dillenii ssp. dillenii*
White pricklypoppy	*Argemone albiflora ssp. texana*
Pokeberry	*Phytilacca americana var. americana*
Pigeonberry	*Rivina humilis*
Redseed plantain	*Plantago rhodosperma*
Purple threeawn	*Aristida purpurea var. purpurea*
King Ranch bluestem	*Bothriochloa ischaemum var. songarica*
Sideoats grama	*Bouteloua curtipendula var. curtipendula*
Japanese brome	*Bromus japonicus*
Common sandbur	*Cenchrus carolinianus*
Broadleaf woodoats	*Chasmanthuim latifolium*
Tumble windmillgrass	*Chloris vericillata*
Bermudagrass	*Cynodon dactylon*
Wooly rosettegrass	*Dichanthelium acuminatum var. acuminatum*
Jungle rice	*Echinichloa colona*
Barnyardgrass	*Echinichloa crus-galli var. crus-galli*
Barnyardgrass	*Echinichloa crus-pavonis var. macera*
Plains lovegrass	*Eragrostis intermedia*
Canadian wildrye	*Elymus canadensis*
Perennial ryegrass	*Lolium perenne ssp. perenne*
Texas wintergrass	*Nassella leucotricha*
Dallisgrass	*Paspalum dilatatum*
Annual bluegrass	*Poa annua*
Johnsongrass	*Sorghum halepense*
Prostrate knotweed	*Polygonum aviculare*
Swamp smartweed	*Polygonum hydropiperoides var. hydropiperoides*
Pensylvania smartweed	*Polygonum pensylvanicum*
Dotted smartweed	*Polygonum punctatum*
Curly dock	*Rumex crispus*
Fiddle dock	*Rumex pulcher*
Ten-petal anemone	*Anemone berlandieri*

White avens	*Geum canadense var. texanus*
Cleavers	*Galium aparine*
Beach groundcherry	*Physalis cinerascens var. cinerascens*
Clammy groundcherry	*Physalis heterophylla var. heterophylla*
Virginia groundcherry	*Physalis virginiana var. virginiana*
Black nightshade	*Solanum ptycanthum*
Southern cattail	*Typha domingensis*
Heartleaf nettle	*Urtica chamaedryoides var. chamaedryoides*
Prairie verbena	*Glandularia bipinnatifida var. bipinnatifida*
Sawtooth frogfruit	*Phyla incisa*
Slender verbena	*Verbena halei*
American germander	*Teucrium canadense*
Missouri violet	*Viola sororia var. missouriensis*

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EVALUATION OF THE
CHAIN OF WETLANDS PLUS LEVEES PLAN
OF THE DALLAS FLOODWAY EXTENSION
IN ACCORDANCE WITH
SECTION 404(b)(1) GUIDELINES

I. PROJECT DESCRIPTION. See basic report

A. Location. See basic report

B. General Description. See basic report

C. Authority and Purpose. This document fulfills the requirements of Section 404 (b)(1) of the Clean Water Act.

D. General Description of Dredged or Fill Material.

(1) General Characteristics of Material. The study area is in the Trinity-Urban land complex which consists of deep, nearly level, somewhat poorly drained soils and Urban land on flood plains. Urban land consists of fill material, and clayey material spread up to 3 feet deep on the flood plains. The Trinity soil is moderately alkaline, very dark, gray clay 30 inches thick. The clay becomes black to a depth of 48 inches and becomes a dark grayish brown clay to a depth of 80 inches. Urban land makes up approximately 20 % of the soil, the Trinity soil makes up approximately 60% and the remaining 20% is comprised of the Frio, Gowen and Ovan soils. (Maxim report of Sept. 1990). In 1995, Maxim Technologies, Inc. tested soil and sediment samples from the river and overbank in an area between the Corinth Street viaduct and the AT&SF railroad bridge. Five soil borings from the right descending bank were obtained by drilling to 20 feet below surface grade. Core lengths ranged from 1.8 to 3.4 feet. All samples contained tan and gray clayey sand(SC), sand (SP) and sand and gravel (SP) to the top of limestone at 7 to 8 feet; these samples also contained petroleum hydrocarbon odors. The odors appeared to decrease with increasing distance from upstream pump discharge points.

(2) Quantity of Material. About 3.2 million cu. yds. of material are proposed to be excavated at the site to create the swale, a series of wetlands, sumps on the protected side of the Lamar Street levee, and levee inspection trenches. The amount of fill which would be required to construct two levees and several wetland control structures is about 1.3 million cu. yds. The amount of material for disposal is, therefore, approximately 1.9 million cu. yds. The material excavated for the new channel is proposed to be used to fill the old channel portion. It is not expected that there would be any excess material from the realignment portion of the project. Approximately 479,000 cubic yards of this material will be disposed on in a class I non-hazardous landfill. In addition, approximately 11,722 cubic yards of concrete would be used to construct the hike and bike trail described in Appendix I, Recreation.

(3) Source of material. The overbank on the right descending side of the river would be the source of the excavated material for the swale and the realigned channel in the flood plain. This includes floodplain lands, two closed sludge landfills and a closed municipal landfill. Excavation would also take place on the protected side of the Lamar Street levee to create sumps.

E. Description of the Proposed Discharge Site. Much of the excavated material would go into the proposed levees. Contaminated soil and old landfill material would be disposed of in an appropriate landfill. Material excavated for the new channel would be used to fill in the old channel.

Disposal of clean fill would be within a 1000 +/- acre site in the City of Dallas bounded by Post Oak Road, Pleasant Run Road, East Wintergreen Street, and Cottonwood Creek. A portion of it is presently being mined for sand and gravel. It contains some moist sites but is out of the 100-year flood plain and is not jurisdictional.

F. Description of Disposal Method. Material would be transported by haul truck from point of excavation to the levee construction site or the old channel bed. Contaminated material would also be hauled by truck for disposal in appropriate landfills. The clean fill would be dumped at the proposed levee site and the excess would be placed at an approved disposal site located out of the flood plain in south Dallas County and graded.

II. FACTUAL DETERMINATIONS.

A. Physical Substrate Determinations.

(1) Substrate Elevation and Slope. The new channel would be at the same elevation as the bypassed segment (371' MSL) and, as is the case in the existing channel bed, it would be at zero slope.

(2) Sediment Type. The sediments in the study area of the Trinity River flood plain are described as alluvium floodplain deposits including indistinct low terrace deposits; gravel, sand, silt, silty clay and organic matter (Maxim, 1990). The new channel bed would be constructed by excavating 25 feet of overbank down to 371' MSL. Boring samples taken in 1980 by the Corps of Engineers show that at that level the soil consists of calcareous clay with sand.

(3) Dredged/Fill Material Movement. Much of the excavated material would be used in the construction of the levees. Some excess clean topsoil would be used as fill in one of the mitigation areas. Material from the new channel excavation would be used as fill for the old channel bed. Contaminated excavated material would be transported by haul truck to a suitable landfill. Minor amounts of fill may be required to stabilize the subgrade for the proposed recreation trails.

(4) Physical Effects on Benthos.

The benthic organisms in the present channel bed would be buried when the channel realignment takes place, but this is a relatively small area. The newly dug channel diversion would likely be repopulated, after a period of stabilization, with the same types of organisms as those which presently exist at the site.

(5) Other Effects. None.

(6) Actions Taken to Minimize Impacts.

(a) The swale alignment has been chosen to impact as little forested area as possible and still provide effective flood control.

(b) The two outflows from the wetlands to the creeks have been designed to prevent erosion at the discharge site. Water would flow from the wetlands through an underground 36" pipe, down a gradual slope and into the creeks below the water surface level.

(c) When the new channel portion is finished and ready to be flooded, it would be filled from the downstream end in order to avoid erosion from high flow rates and turbulence. This would also minimize the amount of sediment which would be carried downstream.

(d) It would be necessary to completely excavate the new channel before the old channel can be filled in. In order to have available the maximum land area for stockpiling the excavated material, the rechannelization construction would precede the construction of the wetlands. In this way, forested areas and grasslands would not be impacted unnecessarily.

(e) A portion of the Linfield Landfill would be excavated when the lower swale is constructed. The remainder would be sealed off with a slurry wall.

B. Water Circulation, Fluctuation and Salinity Determinations.

(1) Water.

(a) Salinity. Not applicable.

(b) Water Chemistry. The portion of the Trinity River in the study area is part of segment 805 as designated by the Texas Natural Resource Conservation Commission (TNRCC). It extends 100 miles "from a point immediately upstream of the confluence of the Cedar Creek reservoir discharge canal in Henderson/Navarro County to a point immediately upstream of the confluence of Elm Fork Trinity River in Dallas County". 1996 water quality information on segment 805 of the Trinity River is as follows (TNRCC, 1996):

- water temperature range: 7.90-33.50 C
- *DO: 4.70-11.60 mg/l
- pH: 6.80-8.20
- chloride: 10.00-201.00 mg/l
- sulfate: 24.00-126.00 mg/l
- specific conductance: 230.00-854.00 μmhos
- TDS: 207.35-555.10 mg/l
- ammonia: 0.02-0.76 mg/l
- *nitrates and nitrites: 0.60-11.83 mg/l
- *orthophosphorus: 0.10-3.69 mg/l
- *total phosphorus: 0.05-9.06 mg/l
- chlorophyll a: 1.00- 23.50 μg/l
- *fecal coliform: 10.00-8900.00 #/100 ml

* indicates areas of concern

These data have shown gradual improvement over time, and, in the last two years, particularly in dissolved oxygen. Passage of the CWWTP effluent through the chain of wetlands can improve the water quality by acting as a sink for the nutrients nitrogen and phosphorus. Tarrant County Water Control and Improvement District (TCWCID) evaluated water quality improvement in a small constructed wetland (4 acres) and reported removal of an average of 90% of nitrogen and 88% of phosphorus (Darryl Andrews TCWCID). Typically, fecal coliform values are reduced as well in water flowing through wetlands.

(c) Clarity. There would be a temporary increase in turbidity when the new channel portion is opened to flow from the river; however, it would be backfilled from the downstream end to minimize erosion and prevent adverse impacts from a high sediment load.

(d) Color. Not applicable.

(e) Odor. Not applicable to realignment project. In the wetlands, possible odor problems might develop.

(f) Taste. Not applicable.

(g) Dissolved Gas Levels. TNRCC (1996) Trinity River segment 805 data reports a dissolved oxygen range of 4.70-11.60 mg/l. USGS has a Continuous Automated Monitoring System (CAMS) in place on the West Fork, East Fork and mainstem Trinity River. The DO is expected to be the same in the river waters after the channel realignment. The DO of the water flowing into the river from the wetlands can be at kept at acceptable levels with constant flow (using the pumping system) if necessary.

(h) Nutrients. Not applicable to realignment project. The nitrates/nitrites water quality screening level used by TNRCC is 1.0 mg/L. In the 1996 TNRCC Water Quality Inventory report, this value was reported to have been exceeded 92.5% of the time for segment 0805. A similar situation exists for phosphorus.

The screening level for orthophosphorous is 0.10 mg/L and for total phosphorus is 0.20 mg/L. These values were exceeded 97.67% and 94.59% of the time respectively. High concentrations of these nutrients are one of several reasons this segment of the Trinity River is classified by the TNRCC as "water quality limited". Although the chain of wetlands has not been designed, nor would it function, as a water quality improvement site, wetland vegetation would become established in the wetland cells and nutrient removal would result as a passive feature of the wetlands complex. The removal of some of these nutrients by wetlands would have a positive effect on the overall water quality in this portion of the river.

(i) Eutrophication. Not applicable to channel realignment. Wetlands would be managed to minimize accumulation of organic materials that would affect water quality.

(j) Others as Appropriate.

(2) Current Patterns and Circulation.

(a) Current Patterns and Flow. The present flow pattern of the river would be changed in a portion of the channel bed. A 3400 linear foot segment of the present river channel under the IH-45 bridge is proposed to be relocated 150 feet to the west in order to reroute flow away from bridge piers in the channel bed. These piers trap debris and impede flow. Flow rates and current patterns would not be changed significantly; however, flow would no longer be impeded by debris accumulation at the bridge piers.

b) Velocity. Normal flows would not be affected by the discharge of dredged or fill material should this project be implemented. The new portion of the channel bed in the realignment project has been designed to be similar to the existing reach in order to maintain present water velocities.

(c) Stratification. Not applicable.

(d) Hydrologic Regime. The chain of wetlands proposed for construction on the west side of the river is a new feature for this area; however, the presence of these wetlands would not significantly change the hydrology of the river either at this location or downstream. Even though the channel would be realigned under the IH-45 bridge, the new channel segment was designed with physical features similar to the old portion so that the hydrology would not change.

(3) Normal Water Level Fluctuations. Nothing in this proposed action would affect normal water level fluctuations. Only extreme floodflows would be affected.

(4) Salinity Gradients. Not applicable.

(5) **Actions That Would be Taken to Minimize Impacts.** In order to prevent a high sediment load from the new channel bed, it would be allowed to backfill first, then the upstream plug would be removed to complete the rerouting of the water. The old channel bed segment would then be plugged and filled with material excavated from the new channel. In this way, there would be little additional turbidity carried downstream from the construction site.

C. Suspended Particulate/Turbidity Determinations.

(1) Expected Changes in Suspended Particulates and Turbidity Levels in Vicinity of Disposal Site. There would be temporary increases in suspended particulates and turbidity levels when the new channel portion is constructed. These increases, however, would be of short duration and at levels tolerable to aquatic organisms downstream. Construction design and phasing have been planned to minimize turbulence and generation of suspended particulates.

Turbidity in the river waters is not expected to change as a result of the wetland construction. Wetlands are typically a sink for suspended particles, however, effluent from the CWWTP is already very clear (average 1.3 NTU) so the discharged water to the creek would not contribute to turbidity.

(2) Effects on Chemical and Physical Properties of the Water Column.

(a) Light Penetration. Realignment of the channel would produce temporarily turbid conditions in the new channel portion and downstream from it, but particulates should settle out again shortly after construction is completed. There would be a relatively short period of decreased light penetration but, because these waters are somewhat turbid under normal circumstances, no adverse effects are expected.

(b) Dissolved Oxygen. Insignificant from standpoint of turbidity in realigned channel and in wetlands. The increased turbidity would be of short duration and would not affect oxygen content.

(c) Toxic Metals and Organics. No release of toxic substances would occur from the realignment of the channel bed. Soil borings taken from this area show no contaminants. The soil to be excavated for the new channel would be used to fill in the old channel portion.
Much of the swale would be located where there are old capped landfills or other sites of contaminated material. (For example, Lagoon E, a closed and capped CWWTP sludge pit; Linfield landfill, closed and capped; Dallas Demolition open dump area; another open area reportedly containing old battery casings; and, the Southern Pacific property adjacent to the Linfield landfill). This material would be removed completely and disposed of at an-as-yet-to-be-designated landfill. Measures would also be taken to prevent leakage of contaminants from these areas into the swale/wetlands area. Such measures would involve, for example, construction of slurry walls to reseal the Linfield landfill.

(d) Pathogens. Not applicable to channel realignment. The Trinity River channel water exceeds the TNRCC standards criteria for fecal coliform bacteria (400 CFU/100 ml) 36% of the time. Wetlands remove coliform bacteria from wastewater through sedimentation and other mechanisms (D.A. Hammer, 1989 p. 332); therefore, water which passes through these constructed wetlands, whether from the wastewater treatment plant or from runoff, would undergo some improvement in coliform content. Neither the channel realignment nor the construction of the sumps would contribute to or create a problem with pathogens.

(e) Aesthetics. This segment of the Trinity River is normally turbid. The increase in turbidity due to the channel realignment would have a negligible and temporary impact on aesthetics. The planned wetlands and recreational areas would ultimately greatly improve the aesthetics of this region of the flood plain.

(f) Others as Appropriate. None.

(3) Effects on Biota

(a) Primary Production, Photosynthesis. There could be a temporary decrease in algal growth during the channel realignment. Construction would produce a short period of high turbidity which would result in reduced light penetration. This situation would be of short duration, however, and have no significant impact. The potential for high algal growth exists for the wetlands. If the high nutrient treatment plant effluent is used to fill them and is left standing (not flowing), conditions would be favorable for high rates of growth in warm temperatures. Water management features of the wetlands such as pumps and weirs, however, provide means for controlling water levels and flow and can be used to prevent buildups of algae.

(b) Suspension/Filter Feeders. Insignificant.

(c) Sight Feeders. Insignificant.

(4) Actions Taken to Minimize Impacts. Silt screens and silt curtains would be used to minimize suspended soil content in the river.

D. Contaminant Determinations. The channel realignment would not involve sediment removal, only sediment burial. The material to be excavated for the new channel has been determined to contain no contaminants. This material would be used to fill in the old channel bed; therefore, realignment construction would present no contaminant problems.

The swale construction for the upper and lower wetlands would intrude on several contaminated or landfill areas. These include a closed sludge lagoon at the CWWTP, a Southern Pacific RR dump, and the Linfield Landfill. Contaminated material would be completely removed and disposed of at an appropriate landfill. Where the swale would only slightly impinge on a contaminated area such as at the Linfield Landfill, the remaining contaminated material would be resealed.

Sumps would be constructed on the protected side of the Lamar Street levee. This area is and has been highly industrial. Any known contaminated areas would be avoided as sump sites. If any previously unknown contamination is encountered during construction of the sumps, measures would be taken to clean the area or seal off the contaminated volume.

E. Aquatic Ecosystem and Organism Determinations.

(1) Effects on Plankton. Insignificant in the channel realignment. The potential exists for high algal growth in standing water in the wetlands, however, with a rain event water would flow and flush out the algae. In addition, the wetlands would have a water level management system with water levels able to be controlled by concrete weirs at the outlets of each wetland cell. This feature, coupled with the pumping system proposed at the outflow of the CWWTP, would make possible flushing out of the wetland cells if necessary. There would be no overall effect on river plankton from the wetland discharge waters.

(2) Effects on Benthos. Not applicable to wetlands. The benthic organisms in the old channel bed would be buried during the realignment construction. Since this is a relatively short segment (3400 linear feet), it is expected that the same types of organisms would repopulate the new segment shortly after construction is completed. The overall impact would be insignificant.

(3) Effects on Nekton. Insignificant.

(4) Effects on Aquatic Food Web. Insignificant.

(5) Effects on Special Aquatic Sites. Special aquatic sites in the project area, in the form of forested wetlands, would be affected by construction. Other special aquatic site would be constructed, in the form of emergent wetlands. These sites are expected to provide 1) expanded fish and wildlife habitat, 2) natural area buffers and, 3) improved water quality through reduction of nutrients and sediments. The Chain of Wetlands swale would develop a mixture of emergent wetlands, permanent open water and grasslands. These wetlands, in conjunction with the adjacent bottomland hardwood forests and development of native grasslands, have been designed to provide resting and feeding habitat for migrating waterfowl and other waterbirds. Urban tolerant birds would also benefit from the restored wetlands.

(a) Sanctuaries and Refuges. No significant impact.

(b) Wetlands. Some forested wetlands would be removed by construction of the swale, levees and associated sumps, and channel realignment. This information is discussed in the main report text. All wetlands would be mitigated if the proposed project is implemented.

(c) Mudflats. Not significant.

(d) Vegetated Shallows. Not Applicable.

(e) Coral Reefs. Not Applicable.

(f) Riffle and Pool Complexes. Not Applicable.

(6) Threatened and Endangered Species. No threatened or endangered species would be impacted.

(7) Other Wildlife. No significant impacts to other wildlife are expected.

(8) Actions to Minimize Impacts.

f. Proposed Disposal Site Determinations.

(1) Mixing Zone Determination. Downstream of the new channel bed there is the possibility of a temporary increase in sediment load due to erosion. Boring samples in this area show that it would be primarily clay with some sand.

(2) Determination of Compliance with Applicable Water Quality Standards. Through telephone conversations with Jim Davenport in the Standards and Information Group of TNRCC, it has been determined that this project would not exceed applicable water quality standards of the State of Texas as they exist at the present time.

(3) Potential Effects on Human Use Characteristics.

(a) Municipal and Private Water Supply. The initial filling of the wetland cells would temporarily divert a large quantity of effluent from the river. This process could take 3-4 weeks. It might be most advantageous to fill the wetlands during the spring in order to take advantage of rain events. Rain water would also dilute the effluent resulting in the impoundment of water not as rich in nutrients. It is not anticipated that any part of this project would have any adverse effects on a water supply.

(b) Recreational and Commercial Fisheries. This portion of the mainstem of the Trinity has been under a Texas Department of Health aquatic life closure since January 1990 due to elevated levels of chlordane; therefore, fish consumption is prohibited. The affected reach extends 19 miles from the upper limit of the segment to IH 20 downstream from Dallas. This project would have no effect on consumable aquatic organisms.

(c) Water Related Recreation. According to the TNRCC, contact recreation use such as swimming is not supported at the present time in the vicinity of the project area. There is no other water related recreation at the present time.

(d) Aesthetics. The aesthetic aspects of this project are of primary concern. Project plans call for full mitigation of all forests, grasslands, wetlands etc. An extensive effort has been put into a plan to develop recreational facilities for a large portion of the study area. Included in this plan are nature trails, equestrian trails, canoe launch sites, etc. At present, there are no recreational facilities other than a small number of parks.

(e) Parks, National and Historical Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves. Not Applicable.

g. Determination of Cumulative Effects on the Aquatic Ecosystem. None

h. Determination of Secondary Effects on the Aquatic Ecosystem. None

III. Findings of Compliance or Non-Compliance with the Restrictions on Discharge.

a. No adaptations of the Section 404(b)(1) guidelines were made relative to this evaluation.

b. The purpose of the Dallas Floodway Extension Project is to reduce flood damages to local residences and businesses. The Chain of Wetlands Plus Levees Plan has been proposed to provide greater flood protection to the current study area, immediately downstream of the existing Dallas Floodway. Other alternatives to this plan include the no-action, the non-structural plan, the NED Plan and the Chain of Wetlands Plan. The no-action is not practicable due to public pressure to provide greater flood protection to the current study area. The non-structural plan, which would involve buyouts of residences and businesses in the 10-year flood plain in the Cadillac Heights community does not meet project objectives. The NED Plan was controversial because of its adverse impacts on environmental resources within the area and did not have public support. The Chain of Wetlands Plan, without the levees, minimized the environmental impacts, addressed aesthetic concerns, but did not provide flood protection in the study area comparable to that of the Central Business District which is protected by the existing Dallas Floodway levees.

c. The proposed disposal of fill material at the Floodway Extension Project in Dallas, Texas would not violate any applicable State water quality standards. The proposed project would not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.

d. The proposed project would not affect any federally listed threatened or endangered species or their critical habitat.

e. Neither the Locally Preferred Plan (LPP) nor the Tentative Federally Supportable Plan (TFSP) would result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish and wildlife. The life stages of aquatic life would not be adversely affected nor would life stages of other wildlife. For the LPP, a total of approximately 425 acres would be impacted by the project at the sites for the north and south swales, the 2 levees and the channel realignment. Included would be impacts to 20.62 acres of Pecan- Oak bottomland hardwood forested area, 141.06 acres of Ash-Elm bottomland hardwoods forest and 211.60 acres of mixed grasses and forbs, and 51.3 acres of open water. Mitigation plans would require approximately 1179 acres. This includes acquisition and management of 926 acres of existing forested area, and conversion of 223 acres of existing grassland to bottomland hardwood forest and, preservation of 30 acres of mixed grass forbland. See main appendix text for mitigation details. Mitigation for the TFSP would require approximately 1135 acres with proportional mitigation features to that of the LPP.

f. Appropriate steps to minimize potential adverse impacts of the project on aquatic ecosystems include: designing the new channel bed to the approximate dimensions of the old channel in order to maintain similar water velocities and flow; flooding the new channel from the downstream end in order to prevent a large sediment load from being carried downstream when the new channel is opened; and, developing a storm water pollution prevention plan to be implemented during the construction activities to minimize erosion and sedimentation.

g. On the basis of the guidelines, the proposed disposal site for the discharge of fill material is specified as complying with the requirement of these guidelines.

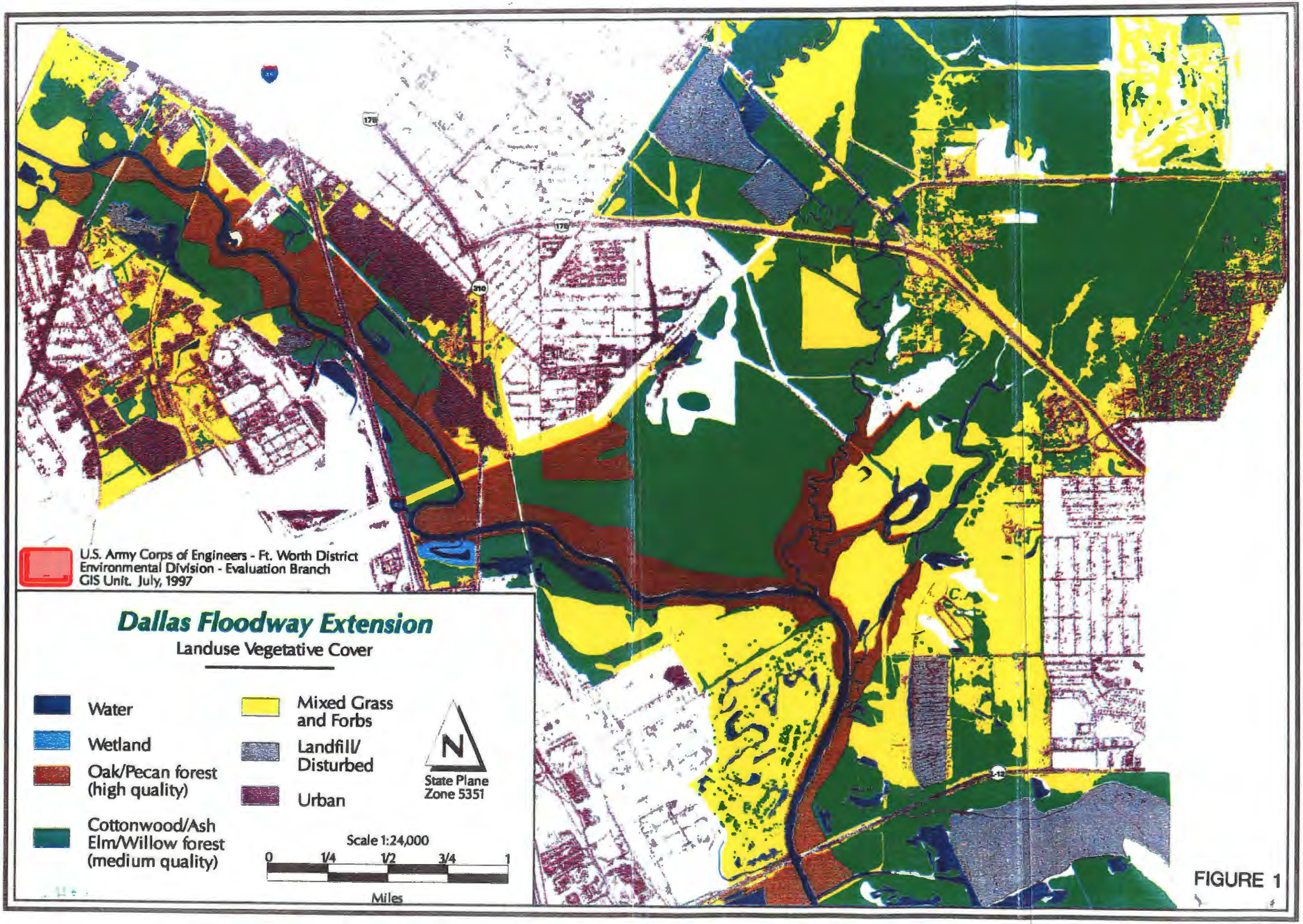
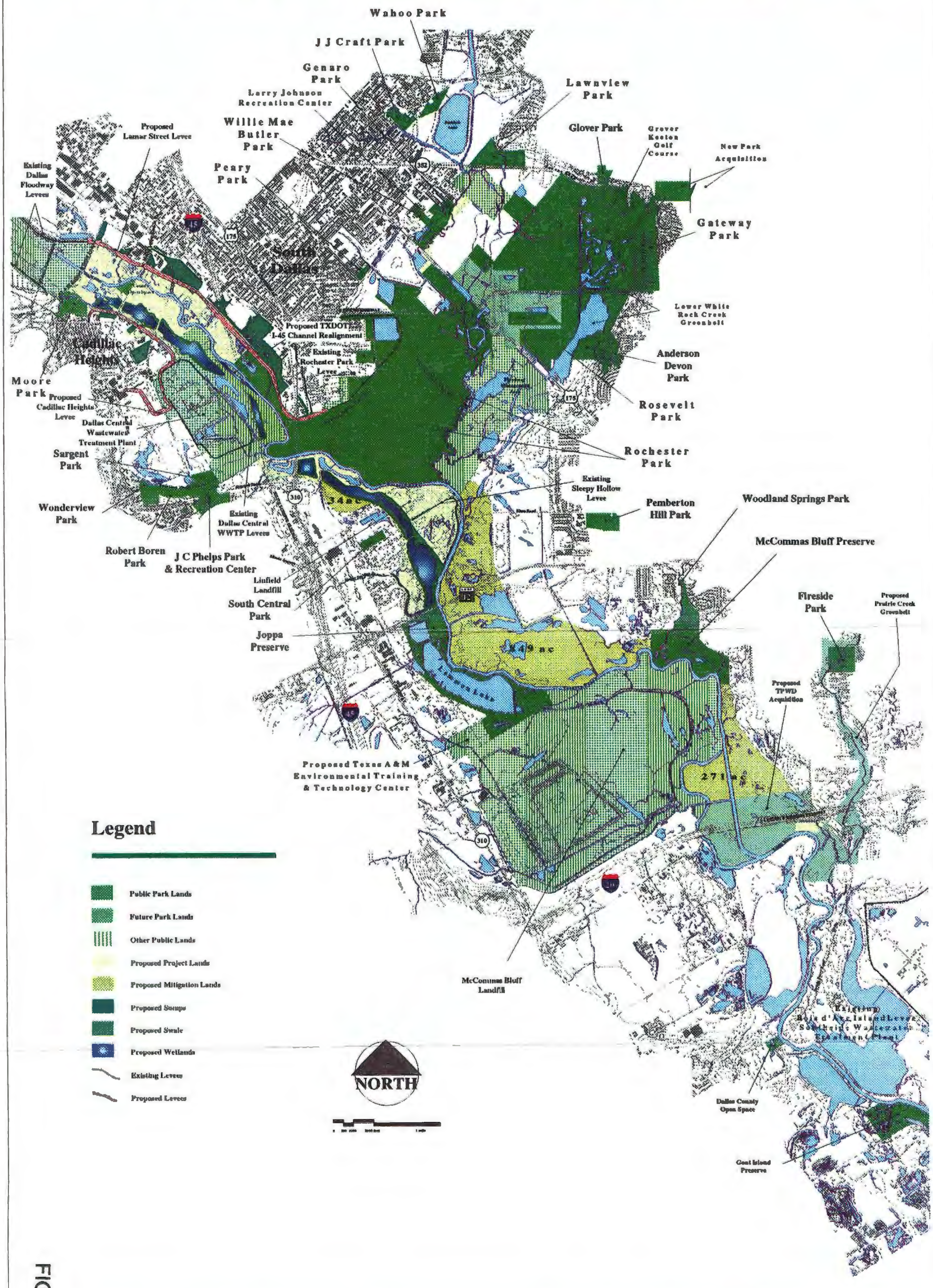

U.S. Army Corps of Engineers - Ft. Worth District
Environmental Division - Evaluation Branch
GIS Unit. July, 1997
Dallas Floodway Extension
Landuse Vegetative Cover
Water
Wetland
Oak/Pecan forest (high quality)
Cottonwood/Ash Elm/Willow forest (medium quality)
Mixed Grass and Forbs
Landfill/ Disturbed
Urban
N
State Plane Zone 5351
Scale 1:24,000
0
1/4
1/2
3/4
1
Miles
175
310

FIGURE 1

DALLAS FLOODWAY EXTENSION

PROJECT LANDS AND OPEN SPACE



U.S. ARMY CORPS OF ENGINEERS

FIGURE 2

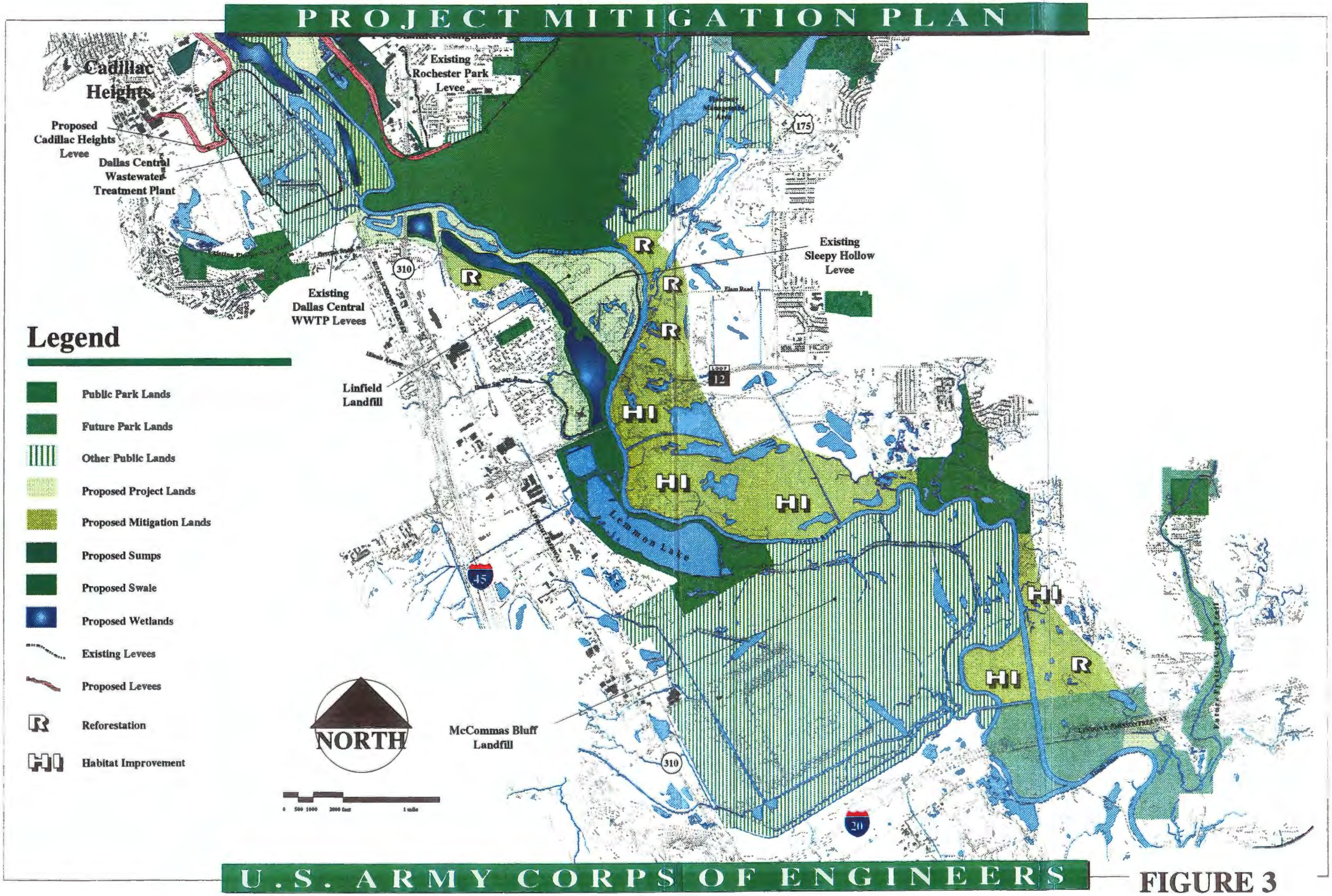

PROJECT MITIGATION PLAN
Cadillac Heights
Proposed Cadillac Heights Levee
Dallas Central Wastewater Treatment Plant
Existing Rochester Park Levee
175
310
Existing Dallas Central WWTP Levees
Existing Sleepy Hollow Levee
Elam Road
Loop 12
Linfield Landfill
Lemmon Lake
45
McCommas Bluff Landfill
310
20
R
HI
NORTH
Legend
Public Park Lands
Future Park Lands
Other Public Lands
Proposed Project Lands
Proposed Mitigation Lands
Proposed Sumps
Proposed Swale
Proposed Wetlands
Existing Levees
Proposed Levees
Reforestation
Habitat Improvement
U.S. ARMY CORPS OF ENGINEERS

FIGURE 3