US Army Corps
of Engineers
Fort Worth District

GENERAL REEVALUATION REPORT AND INTEGRATED ENVIRONMENTAL IMPACT STATEMENT

DALLAS FLOODWAY EXTENSION

TRINITY RIVER BASIN, TEXAS

VOLUME I

FEBRUARY 1999

GENERAL REEVALUATION REPORT
AND
INTEGRATED
ENVIRONMENTAL IMPACT STATEMENT

SYLLABUS

SUMMARY

This General Reevaluation Report presents the results of investigations conducted to identify water and water related land resource needs of the Dallas Floodway Extension floodplain within the Trinity River Basin in the city limits of Dallas, Texas. The report is a comprehensive reevaluation of an authorized project and of the current flood control, environmental restoration, and recreation needs. The Authorized Plan was one of five local flood protection projects authorized for construction by Section 301 of the Rivers and Harbors Act (Public Law 89-298), approved on October 12, 1965, as part of a basinwide plan of improvement for the Trinity River and Tributaries, Texas. The authorized plan of improvement consisted of a combination flood control channel and floodway levees which would provide a Standard Project Flood (SPF) level of protection with a design flow capacity of 270,000 cubic feet per second. The plan consisted of a 22-mile levee and floodway system with a 9.1 mile residual channel along the Trinity River, 4.1 miles of channel improvements along White Rock Creek, and 5.4 miles of channel improvements to divert Five Mile Creek.

In accordance with 33 CFR Parts 230 and 325 (ER200-2-2), "Environmental Quality; Procedures for Implementing the National Environmental Policy Act (NEPA)," dated 3 February 1988, the Environmental Impact Statement is integrated into this report. These studies were conducted under the authority of Section 301 of the Rivers and Harbors Act of 1965.

Historic flooding and damages were investigated and details of their effects are included in this report. The project study area extended along the Trinity River from the end of the existing Dallas Floodway to the north and extending southwest to the confluence of Five Mile Creek, a distance of approximately 9.5 miles. The entire area experienced severe property damages in May 1989 and May 1990 flood events. A total of 2,550 structures are located within the existing hydrologic condition Standard Project Floodplain of the study area downstream of the existing Dallas Floodway. Based on October 1998 prices, these structures are estimated to sustain equivalent annual damages of approximately $6.8 million. In addition, over 10,500 structures are located within the existing Standard Project Floodplain of the existing Dallas Floodway just upstream of the primary study area. Based on October 1998 prices, these structures are estimated to sustain equivalent annual damages of approximately $13.6 million.

A wide range of structural and non-structural flood control measures evolved from the analysis of available economic, environmental, engineering, and social data during the course of this study. Non-structural alternatives included flood proofing, relocation, and permanent evacuation. The structural alternatives analyzed during the preliminary screening included channelization, clearing and grubbing, detention dams, swales, levees and combination plans. Additionally, several variations of the final concept were analyzed to insure that the solution was properly located and sized to provide the highest net annual benefits.

The construction of two 1,200-foot bottom width swales were found to produce the greatest net benefits. The proposed swales, extending from upstream at the end of the existing Dallas Floodway downstream to approximately 2,000 feet below Loop 12, are separated at Interstate Highway (IH) 45. This plan was identified as the National Economic Development (NED) Plan.

Public opposition to the environmental impacts which the NED Plan would cause to the forested areas along the Trinity River prompted the city to request investigation of less environmentally detrimental alternatives. The Chain of Wetlands Plan emerged as the initial Locally

Preferred Plan (LPP), and was formally adopted by the Dallas City Council on August 28, 1996, with the caveat that the addition of levees to the plan would be further investigated. This plan included smaller swales, located as far west of the river as engineeringly and economically feasible to avoid the most pristine bottomland hardwood areas closer to the river, and included excavated wetlands and vegetative plantings added as environmental restoration features within the footprint of the swales. Recreation facilities compatible with the regional recreation master plan were added to this plan.

A comparative analysis between the NED Plan and the Chain of Wetlands Plan showed that the chain of wetlands would provide fewer net benefits than the NED Plan, but would also have a lower estimated first cost. From an environmental standpoint, the NED Plan would require acquisition of approximately 3,200 acres for mitigation, while the chain of wetlands would require only about 650 acres of mitigation. Based on these findings, and on the expected difficulty in implementing the NED Plan from a public acceptability standpoint, the chain of wetlands was designated as the first increment of the Federally Supportable Plan, in lieu of the NED Plan. The Cadillac Heights and Lamar levees were then investigated for possible inclusion in the Federally Supportable Plan.

The Chain of Wetlands Plus Levees Plan, which included SPF levees protecting the Lamar and Cadillac Heights areas, in addition to the features of the Chain of Wetlands Plan, emerged to meet the needs of the local sponsor, providing much needed flood protection to the neighborhoods within the study area comparable to the protection provided to the Central Business District by the existing Dallas Floodway. This plan was adopted as the final LPP by the Dallas City Council on March 26, 1997. Recreation facilities were also added to this plan.

Congressional legislation, passed in October 1996, in the form of the Water Resources Development Act (WRDA) of 1996, provided for credit toward the non-Federal share of the total project costs for the advanced construction of the portions of the Central Wastewater Treatment Plant Levee and the Rochester Park Levee deemed compatible with the authorized project. These non-Federal levees were constructed by the city following the devastating floods of 1989 and 1990. The total cost of this construction was approximately $27.0 million; however, the portion deemed compatible with the Recommended Plan was estimated at approximately $23.1 million. Of this amount, approximately $0.9 million was spent for lands, easement, rights-of-way and disposal areas (LERRD), which would be creditable to the sponsor as part of the overall LERRD requirements. Therefore, a maximum of approximately $22.2 million was creditable to the sponsor as compatible construction costs under the provisions of WRDA 1996.

In the April 1998 draft of this report, the Federally Supportable Plan (FSP) was identified as a plan that, except for the levee protecting the Cadillac Heights neighborhood, would provide a Standard Project Flood (SPF) level of protection at a high degree of reliability. In this plan, the Cadillac Heights Levee would only provide protection from the flood that would have a 1.0 percent chance of exceedance in any one year, with a 34.0 percent reliability. Upon further analysis, it was determined that the FSP is that plan that provides SPF protection for the entire Dallas Floodway Extension project for the following reasons. First, the alternative levee for the Cadillac Heights neighborhood would not meet the Federal Emergency Management Agency standards for protecting the area from a flood that would have a 1.0 percent chance of exceedance in any one year, nor would it provide an acceptable level of reliability, particularly when compared with other project elements. Second, the alternative levee for Cadillac Heights would allow continued damages in this area from major, although infrequent floods (greater than the flood that would have a 1.0 percent chance of exceedance in any one year), due to the construction of other project levees. Finally, Congress has already authorized the project, including the Cadillac Heights Levee, at a SPF level of protection. For the reasons noted above, the project providing a consistent SPF level of protection is the Federally Supportable Plan, and is therefore the Recommended Plan. The report has been modified to reflect this decision-making process as follows:

DALLAS FLOODWAY EXTENSION

TRINITY RIVER BASIN, TEXAS

GENERAL REEVALUATION REPORT
AND
INTEGRATED
ENVIRONMENTAL IMPACT STATEMENT

Prepared by

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February 1999
(Revised: 13 August 1999)

GENERAL REEVALUATION REPORT
AND
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ENVIRONMENTAL IMPACT STATEMENT

Responsible Agencies: The responsible lead agency is the U.S. Army Corps of Engineers, Fort Worth District.

Abstract: This document focuses on the portion of the Trinity River which flows through the southeast sector of the city of Dallas, Texas. The purpose of this study is to reevaluate the feasibility of implementing a previously authorized flood control project. This document addresses the economic and environmental feasibility and impacts of the authorized plan, and reformulated alternatives and recommendations. The flood control alternatives and recommendations previously developed by the Corps were reevaluated based on the current level of economic development and ecological value. As a result, a wide array of structural and non-structural alternatives were developed and investigated by the Fort Worth District. Based on the investigations performed, construction of an off-channel flood control swale incorporating environmental restoration in the form of a chain of wetlands, Standard Project Flood (SPF) levees on both sides of the river, and recreation facilities was found to be the best alternative for the study area, and is the Recommended Plan for this portion the Trinity River Basin. The term "Standard Project Flood" or "SPF", as used throughout this document, is defined as the flood that may be expected from the most severe combination of meteorologic and hydrologic conditions that are considered to be reasonably characteristic of the geographical region involved, excluding extremely rare combinations. The SPF usually has a 0.3 to 0.08 percent probability of being equaled or exceeded in any year, and is usually between 40 and 60 percent of a Probable Maximum Flood (PMF). The SPF represents a "standard " against which the degree of protection for a project may be judged and compared with protection provided at similar projects in other localities. For this project site, the SPF has a 0.125 percent probability of exceedance.

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Note: This report includes an integrated environmental impact statement (EIS) within the report text; paragraphs required for compliance with the National Environmental Policy Act (NEPA) are noted by an asterisk in the Table of Contents.

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LIST OF ACRONYMS

AAHU	Average Annual Habitat Units
ASA(CW)	Assistant Secretary of the Army (Civil Works)
BCR	Benefit-to-Cost Ratio
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DFE	Dallas Floodway Extension
EIS	Environmental Impact Statement
FSP	Federally Supportable Plan
HQUSACE	Headquarters, United States Army Corps of Engineers
HTRW	Hazardous, Toxic and Radiological Waste
LPP	Locally Preferred Plan
NCTCOG	North Central Texas Council of Governments
NED	National Economic Development
NEPA	National Environmental Policy Act
SWD	Southwestern Division (Corps of Engineers)
TNRCC	Texas Natural Resource Conservation Commission
TORP	Texas Outdoor Recreation Plan
UFORE	Urban Forest Effects (U.S. Department of Agriculture Model)
USFWS	United States Fish and Wildlife Service
WRDA	Water Resources Development Act

- Throughout Chapter 4, the plan identified as the Federally Supportable Plan (FSP) in the draft report has been renamed as the Tentative Federally Supportable Plan (TFSP).

- In Chapter 5, following the optimization analyses for the Cadillac Heights and Lamar levees, and following the "BASIS FOR REQUEST FOR EXCEPTION" section, a new section entitled "ASA(CW) DECISION REGARDING REQUEST FOR EXCEPTION" has been inserted. This new section presents the pertinent data utilized in this decision-making process and identifies the project providing a consistent SPF level of protection as the Federally Supportable Plan. This plan is subsequently designated as the Recommended Plan.

- Chapter 6 presents final detailed information for the Recommended Plan, incorporating the revisions made per comments received since the release of the draft GRR/EIS, and updating costs to reflect October 1998 price levels and the current Federal interest rate of 6-7/8%.

An environmental mitigation plan for the Recommended Plan would involve acquisition of 1,179 acres in additional project lands. This plan would include acquisition, improvement and management of 926 acres of bottomland hardwood, and acquisition of 253 acres of mixed grassland/forbland, of which 223 acres would be aggressively converted to bottomland hardwood forest while the remaining 30 acres would be managed as grassland. The mitigation plan was estimated to cost approximately $4.7 million.

Environmental restoration features include the addition of 123 acres of emergent wetlands within the excavated flood control swale at an estimated cost of approximately $5.6 million. This restoration plan would provide an increase of 184 average annual habitat units (AAHU) at a cost per AAHU of $2,532.

The recreation component of the Recommended Plan would include construction of 18 miles of hike/bike trail, 8.5 miles of natural surface equestrian trail, 5 miles of natural surface nature trail, picnic areas and rest stop areas. Seven access areas are proposed, one of which would require no modifications. Three of the remaining six would be located at existing parks or areas with adequate parking facilities and would require minimal modifications. Three new access areas are also proposed. The total cost of the recreation facilities was estimated at approximately $5.4 million.

The original Dallas Floodway Extension project, authorized in 1965, contained levee, channel, and lake features designed to provide SPF protection to both the northern and southern portions of the city of Dallas. The current Recommended Plan provides for similar outputs at a lower total project cost. The current estimated cost of the authorized improvements to the Dallas Floodway Extension area, at October 1998 price levels, would be $202.7 million. Total annual benefits for the authorized project are estimated at $13.2 million. Under current economic conditions, the authorized project has negative net benefits of $3.0 million, with a BCR of 0.82. Comparatively, the Recommended Plan, as presented herein, would have an estimate first cost of approximately $127.2 million, and would yield total annual benefits of approximately $19.1 million, net annual benefits of $9.8 million, and a BCR of 2.06.

It has been recommended in this document that the non-Federal sponsor be authorized credit, in accordance with Section 351 of WRDA 1996, for the advanced non-Federal construction of the Central Wastewater Treatment Plant Levee upgrade and the portion of the Rochester Park Levee compatible with the Recommended Plan. The preliminary estimate for this compatible construction, subject to an audit for reasonableness, allocability, and allowability, is approximately $22.2 million. The Federal and non-Federal cost apportionments for the Recommended Plan are estimated at $83.6 million (65.7%) and $43.6 million (34.3%), respectively. The aforementioned credit in the amount of approximately $22.2 million was applied toward the non-Federal share of the flood control project costs.

CHAPTER 1

INTRODUCTION

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INTRODUCTION

This General Reevaluation Report and integrated Environmental Impact Statement documents the results of a comprehensive reevaluation of the authorized Dallas Floodway Extension Project located in the Trinity River Basin, Texas. These analyses update all pertinent information and reevaluate the water resource needs of the study area based on current hydrologic, economic and environmental conditions and criteria.

PROJECT AUTHORITY

Authority for construction of water resource development features described in the Comprehensive Survey Report on Trinity River and Tributaries, Texas (reprinted as House Document 276/89/1) is contained in Section 301 of the Rivers and Harbors Act approved 27 October 1965 (Public Law 89-298).

The authority granted by the resolution is commonly known as the Trinity River and Tributaries Basinwide Study Authority. All studies conducted under this authority serve as an interim response to the basinwide authority, and do not close out the granting authority.

THE AUTHORIZED PLAN

The Dallas Floodway Extension is one of five local flood protection projects authorized for construction in 1965 as part of a basinwide plan of improvement for the Trinity River and Tributaries, Texas. The authorized plan of improvement consisted of a combination flood control channel and floodway levees which would provide a Standard Project Flood (SPF) level of protection. The plan consisted of a 22-mile levee and floodway system with a 9.1 mile residual channel along the Trinity River, 4.1 miles of channel improvements along White Rock Creek, and 5.4 miles of channel improvements to divert Five Mile Creek. Figure 1-1 depicts the features of this plan.

A General Design Memorandum (GDM), which assessed the plan in greater detail, was completed in 1981. In 1985, however, work on the Dallas Floodway Extension Project was suspended following a failed city of Dallas bond election aimed at providing support for the project. Final approval of the 1981 GDM was discontinued, resulting in the retention of the 1965 plan as the authorized plan.

PARTICIPANTS AND COORDINATION

This reevaluation was conducted by the Fort Worth District, U.S. Army Corps of Engineers, and utilized a multi-disciplined team analysis concept. Coordination was maintained during the study with state and local government officials and agencies, the news media, local interest groups and citizens in the Dallas area. The regional office of the Natural Resources Conservation Service (NRCS), formerly known as the Soil Conservation Service, furnished applicable soil information and elevation data. Landfill information was obtained from the Texas Natural Resource Conservation Commission (TNRCC). The Federal Emergency Management Agency was also consulted for pertinent floodplain information. Direct coordination was maintained with the Texas State Historic Preservation Officer and the U.S. Fish and Wildlife Service in accordance with the National Historic Preservation Act and the Fish and Wildlife Coordination Act.

The Texas Department of Transportation provided bridge profiles and future transportation project information which could impact the study area. The Environmental Protection Agency and the Texas Parks and Wildlife Department were also consulted. Local coordination efforts involved the Dallas County Tax Appraisal District, Dallas County Open Space, and the City of Dallas Public Works, Parks and Recreation, Sanitation, and Water Utilities Departments.

STUDY PURPOSE AND NEED

The primary purpose of this study was to respond to a request by the city of Dallas to re-activate the authorized Dallas Floodway Extension Project. Following the severe flood event of 1989, the city of Dallas requested reactivation of the authorized Dallas Floodway Extension project. The project was reactivated in 1990 under the provision that a general reevaluation be conducted prior to construction. This reevaluation was required due to new environmental and economic criteria, as well as significant land use changes within the study area. Specifically, the new criteria and changes include:

New Criteria:

- No net loss of wetlands
- Chief of Engineers Strategic Directive for Environmental Engineering
- Corps primary mission includes Environmental Protection
- Undeveloped lands cannot be used to justify a Federal project
- Project evaluation based on a risk and uncertainty analysis

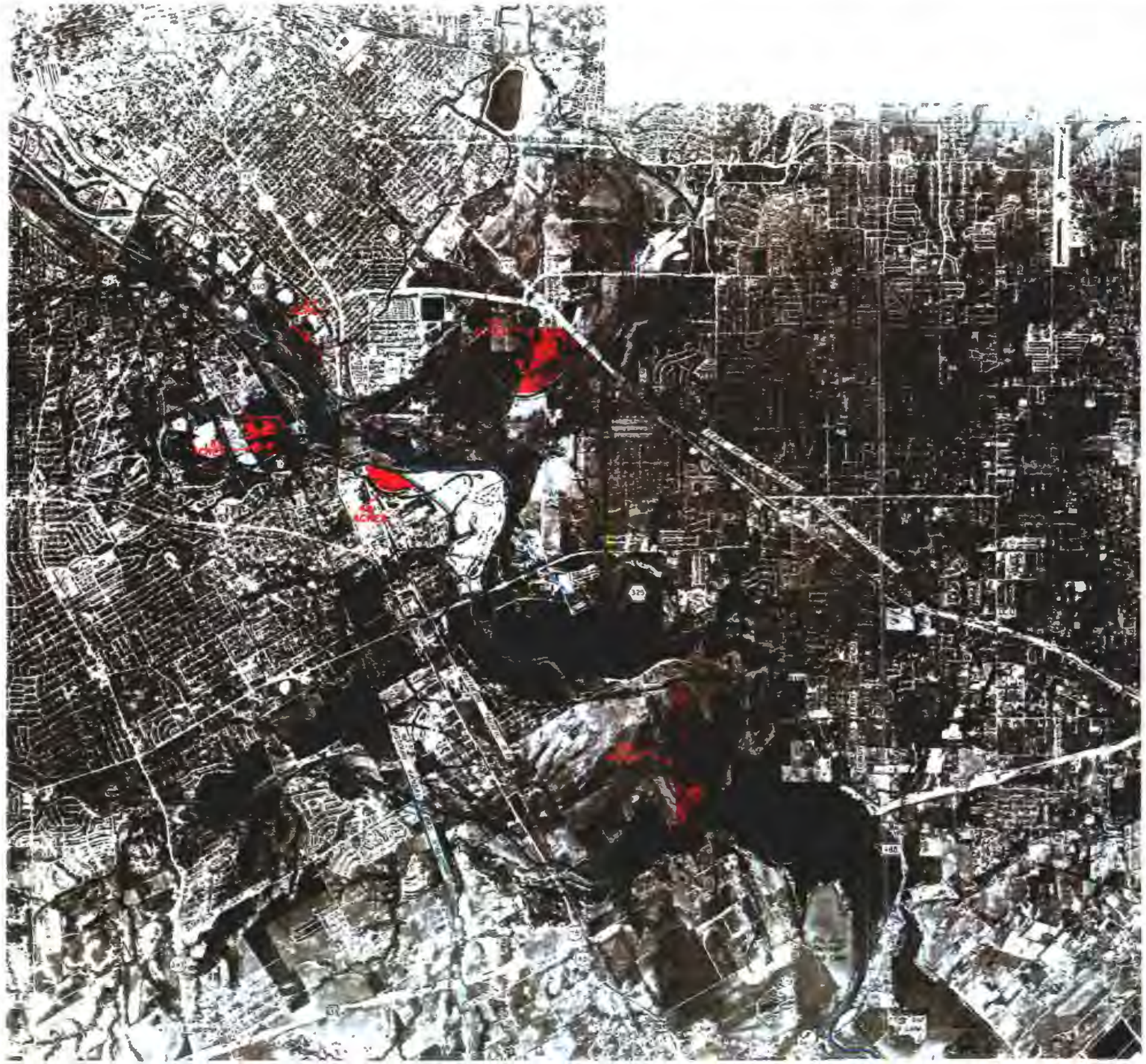
Land Use Changes:

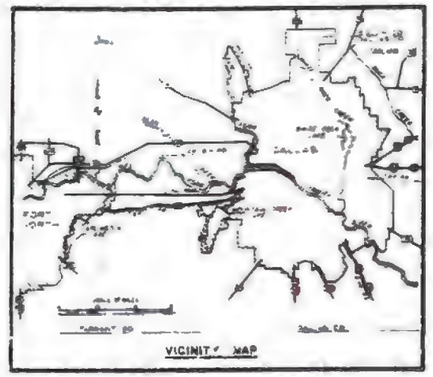
- Acquisition and removal of residential structures in the Roosevelt Heights and Floral Farms subdivisions
- Construction of the Rochester Park Levee
- Raising of Central Wastewater Treatment Plant Levee

The modified project resulting from most recent reevaluations was designed according to current economic, environmental and design criteria.

PRIOR STUDIES AND REPORTS

Numerous studies have been conducted regarding flooding and emergency streambank erosion, water quality and water resource development within the Trinity River watershed. The following paragraphs provide pertinent information on previous studies and reports prepared by the Corps of Engineers and other Federal and State agencies which address water resource development within the Trinity River Watershed.





LEGEND

- SPF RESIDUAL CHANNEL
- LEVEE ALIGNMENT
- EXISTING RIVER CHANNEL
- SUMP AREA
- 320 CHANNEL MILE
- 490 RIVER MILE
- HIGH WATER LINE (MAX. OF RECORD)
- GREENBELTS AND PARKS
- PROJECT ASSOCIATED
- OTHERS - EXISTING AND PROPOSED

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

1965 AUTHORIZED PLAN

FIGURE 1-1

Water Resources Development in Texas, 1971, 1981, 1988, 1989, 1991, and 1995. These reports were prepared by the Fort Worth District, Corps of Engineers. They provide current information about water resources activities conducted under the direction of the Secretary of the Army and the United States Congress. The information in these booklets have been consolidated to illustrate the role of the Corps in navigation, planning, construction, and operation of projects for flood control, hurricane flood protection, municipal and industrial waster supply, recreation, and other beneficial uses. Each booklet describes projects completed, under construction, or in the planning stage, and cites the specific authorization of Congress.

Report on Flooding, April - May 1990. This report provides a summary of the flood damages experienced and effectiveness of Fort Worth District projects between April and May of 1990. This report contains general information regarding storms and their impacts, a description of the rainfall and river basins that experienced heavy losses, flood losses sustained in the respective counties and cities significantly affected by the storm, and estimates of damages prevented by existing Corps of Engineers projects.

The Trinity River and all of its tributaries were above flood stage or bankfull stage for most of this time period. Flooding was experienced by private and public properties in the Dallas Fort Worth Metroplex. On May 2, 1990, the President declared the State of Texas a major disaster area because of the severe thunderstorms, flooding, and tornadoes that began in April and continued through early June 1990. Sixty-eight counties, with a total population exceeding five million and covering an area of almost 48,000 square miles, were declared as Disaster Areas.

Report on Flooding, May - June 1989. This report contains general information on the storms (and their resultant impacts) that occurred 3-5 May, 16-18 May, and 1-15 June 1989 in the Upper Trinity River Basin. Field investigations by Corps personnel were conducted primarily for making preliminary damage appraisals, determining high water marks, and obtaining stream flow data for selected rivers and streams. Urban reconnaissance surveys were conducted in the cities of Arlington, Burleson, Cleburne, Corsicana, Dallas, DeSoto, Duncanville, Euless, Everman, Fort Worth, Gainesville, Grand Prairie, Kennedale, Irving, Mansfield, Mesquite, Rendon, Watauga, and White Settlement, Texas. Field investigations were not conducted for approximately 75 additional counties that reported flooding. Information solicited included details on evacuation and flood fighting activities, damage estimates for private and public properties, agricultural damages, etc. A review of various local documents showed that flood related deaths numbered approximately 25.

Dallas Floodway Reconnaissance Report, February 1989. This study presents the results of a reconnaissance level investigation conducted on the Dallas Floodway under authority of Section 216, Public Law 91-611, in response to local concerns. Since completion of the floodway in 1959, substantial development has occurred in the upstream reaches of the Elm Fork and the West Fork of the Trinity River, causing a significant increase in the flood flows downstream. A structural plan was found to be economically feasible. The plan would entail enlarging the bottom width of approximately 49,000 feet of channel from 50 feet to 200 feet. Total first cost for this project was estimated at $45.5 million, with an average annual cost (including operation and maintenance) of $4.7 million. Total annual benefits were $5.1 million, yielding a benefit-to-cost ratio (BCR) of 1.1. Information from this report was used in the Upper Trinity River Basin reconnaissance study.

Upper Trinity River Basin, Reconnaissance Report, March 1989. This study presents the results of a reconnaissance level study conducted on the Upper Trinity River Basin under authority of United States Senate Committee on Environment and Public Works

Resolution, dated April 22, 1988, in response to local concerns. Based on the thirteen structural alternatives investigated, and the social and environmental impacts of each of these alternatives, eleven viable flood control projects were identified. These structural alternatives consisted of two detention structures, one channel modification plan, six levee enhancements, and two channel modification and levee combination plans.

Trinity River Project, Texas, Phase I General Design Memorandum, October 1981. This study investigated the following: (1) a multi-purpose channel from Fort Worth to Liberty, Texas; (2) the Tennessee Colony Lake; and (3) the Dallas Floodway Extension. The recommendations of this report included:

- The bottom width of the multi-purpose channel should be reduced from 320 to 200 feet. The narrower bottom width plan would produce a BCR of 1.8, and reduce adverse effects on the nearby marsh and commercial fisheries. This plan was recommended for approval.

- The Tennessee Colony Lake should be deferred until substantial amounts of lignite discovered at the site are removed.

- The Dallas Floodway Extension would provide Standard Project flood protection to about 98 percent of the residential and commercial units over a distance of 9.1 miles. About 5,000 acres would be preserved as greenbelt-open space-recreational area, with almost 2,000 acres of land in the protected area that would be of potential industrial development. Some additional flood control features are as follows:

    - Realignment and enlargement of the channel
    - Realignment and enlargement of tributary channels through levee areas
    - Construction of a parallel levees through low lying areas
    - Provision of interior drainage facilities
    - Provision of recreation facilities and greenbelt
    - Filling of areas outside levee areas with spoil material
    - Modification of bridges and construction of new roads
    - Acquisition of rights-of-way

Due to a lack of local sponsorship, action on approval of the Dallas Floodway Extension project, as proposed in this GDM, was not pursued.

Trinity River Project, Texas, Habitat Mitigation Report, December 1981. This report includes habitat and associated economic evaluations, and addresses habitat losses and mitigation requirements associated with the Multiple Purpose Channel to River Mile 45. The evaluations presented in this report indicate that the acquisition of approximately 11,700 acres of lands adjacent to Wallisville Lake lands is reasonable and justified to mitigate for terrestrial habitat losses caused by the Multiple Purpose Channel. Further, it is recommended that the project authorization be modified to include fee simple acquisition of the identified 11,700-acre mitigation area. This mitigation was subsequently authorized by the Water Resources Development Act of 1986.

Trinity River Project, Texas, Project Design Memorandum No. 4, Phase 1 General Design Memorandum, August 1974. The subject memorandum and accompanying Environmental Impact Statement presented a current update and re-analysis of the water resource plan. The memorandum covers that portion of the main stem of the Trinity River from the existing Fort Worth Floodway (River Mile 551.45) to Trinity Bay. Elements of the Trinity River Project recommended in this report included: a multiple-purpose lake at Tennessee Colony; an urban floodway on the West Fork between Dallas and Fort Worth; an extension of the existing Dallas Floodway downstream to Five Mile Creek; and a multiple-purpose channel from Fort Worth to Trinity Bay. This memorandum recommended that the economically justified plan be approved as a basis for further advanced planning

and possible construction of the project. The estimated initial Federal construction cost of this recommended Trinity River Project (including navigation features) amounted to over $1.6 billion. Because of the failure of a March 1973 bond election for the Trinity Basin project funding by the TRA, Congress directed that no further study or planning of navigation features for the Trinity River Project be undertaken. The initial Federal construction cost of the Trinity River Project with deferral of navigation was estimated at $517.7 million.

Comprehensive Survey Report on Trinity River and Tributaries, Texas, June 1962. The report recommended a comprehensive plan for the development and control of the water and related land resources in the basin. The plan included five flood control projects, a multi-purpose channel, and four multi-purpose lakes. Flood control measures for the Dallas Floodway Extension included a total of 22 miles of levees and a 9-mile, 200-foot bottom width relief channel. The total estimated cost of the proposed plan was $101,000,000 (1962 price levels) with a BCR of 1.6. The estimated Federal share was $52,900,000. This plan of improvement consisted of 11 segments:

- Five local flood protection projects: West Fork Floodway, Elm Fork Floodway, Dallas Floodway Extension, Duck Creek Channel Improvements, and Liberty Levee.
- Four multiple-purpose lakes (Lakeview, Roanoke, Aubrey, and Tennessee Colony).
- A multiple-purpose channel along the Trinity River from the Houston Ship Channel to Fort Worth, Texas.
- A water conveyance system from Tennessee Colony Lake to Benbrook Lake for the improvement of water quality.

OTHER STUDIES AND REPORTS

Flood Insurance Study, Dallas County, Texas. Conducted for FEMA. This study investigated and revised data on the existence and severity of county-wide flood hazards, including the city of Dallas. The updated technical flood risk data was used to develop flood insurance rate maps, establish actuarial rates and promote sound floodplain management in conjunction with the guidelines of the National Flood Insurance Program.

Texas Water Commission, Trinity River Basin Study, September 1992. This study was mandated by the state of Texas Legislature (Senate Bill 1543), and was sponsored by State Senator Carl Parker. The Texas Water Commission was directed to investigate the flooding problems in the Trinity River Basin. Alternatives which were to be investigated by this study were: Pre-release of water in reservoirs, county regulations, reservoir operations, flood insurance programs, flood emergency operations, land treatment and watershed improvement.

The report concluded that the existing flood control programs can be responsive to a state policy when one exists. Alternative approaches to the traditional flood control programs are yet to be fully utilized by the State. Many of these alternatives take advantage of the natural flood plain characteristics that can moderate flood effects. Therefore, rather than creating vast new programs, the report concluded the opportunity exists to bring these existing efforts together to develop more effective approaches to flooding in Texas and the Trinity River Basin.

Water for Texas, Today and Tomorrow, December 1990. This report was prepared by the Texas Water Development Board, Austin, Texas. The report updates and presents the 50-year plan for the state of Texas. This summary document presents the current and

prospective water uses, identifies water supplies, and estimates facility needs and costs. The plan also describes water problems and opportunities, outlines significant environmental concerns and water issues, and offers program and policy recommendations.

The Texas Statewide Inventory of Flood Protection Needs, May 1990. This report was compiled to provide an up-to-date, community-specific inventory of flooding problems and solutions for 756 cities and towns in Texas that could be incorporated into the revised state water plan. This inventory contains data from Corps of Engineers planning studies and National Flood Insurance Program (NFIP).

Water for Texas, November 1984. This two-volume report was prepared by the Department of Water Resources, Austin, Texas. Volume one, A Comprehensive Plan for the Future, of the amended 1969 Texas Water Plan is an executive summary that sets forth planned actions and policy recommendations. Volume II, Technical Appendix, is a technical document that provides details of current water development and use, projected future water supply and treatment needs, and potentially developable water supplies to meet future water needs in each river and coastal basin of the state.

The Texas Water Plan, November 1968. Prepared by the Texas Water Development Board. The report outlines a flexible guide for the orderly development, conservation, and wise management of the State's water resources to meet the needs of the state to the year 2020. The plan includes the possibilities of importing large quantities of surplus water from the Mississippi River's lower reaches to areas of greatest need in Texas.

Table 1-1 provides a chronological list of additional studies and reports by non-Federal agencies, i.e., State and local agencies, for the Trinity River watershed and the relevant aspects of the Dallas Floodway Extension.

Table 1-1
Studies and Reports by Non-Federal Agencies

STUDY	AGENCY	DATE
Upper Trinity River Basin Comprehensive Sewerage Plan	North Central Texas Council of Governments (NCTCOG)	1970
North Central Texas Regional Water Supply Study	NCTCOG	1974
Water Quality Management Plan for the Trinity River Basin	Trinity River Authority (TRA)	1974
Long Range Water Supply	City of Dallas	1975
Gauging Our Water Supply	NCTCOG	1976
Trinity River Basin Master Plan	TRA	1977
Priorities for Clean Water	NCTCOG	1978
1978 Annual Water Quality Management Plan for North Central Texas	NCTCOG	1978
Non-Point Sources	NCTCOG	1978

NATIONAL ENVIRONMENTAL POLICY ACT REQUIREMENTS

The National Environmental Policy Act of 1969 (NEPA), as amended, is the nation's charter for environmental protection. NEPA establishes policy, sets goals, and provides means for carrying out the policy. Section 102 (2) of the Act includes a provision to prepare a detailed statement - Environmental Impact Statement (EIS) - on the effects of the proposed Federal action. The Federal regulations for implementing the procedural provisions of NEPA were published by the Council on Environmental Quality (CEQ) in the Code of Federal Regulations (CFR) as 40 CFR Parts 1500-1508 (43 Federal Register 55978-56007, November 29, 1978).

Corps regulations permit an EIS to be a self-standing document or an integration of NEPA required discussions in the text of the report. Regarding the environmental nature of the Dallas Floodway Extension study area and in the interest of reducing paperwork, costs, and redundancies the Corps elected to integrate these documents. Sections in this integrated report that include NEPA required discussions are marked with an asterisk in the Table of Contents to assist readers in identifying such material. The document addresses alternatives evaluated to address flood damage reduction and environmental restoration in the Dallas Floodway Extension study area and discloses the direct, indirect and cumulative impacts of the proposed project, and those of interrelated projects, to the extent that they can be reasonably foreseen.

CHAPTER 2

DESCRIPTIVE OVERVIEW

CHAPTER 2
DESCRIPTIVE OVERVIEW

This chapter provides a general description of the Trinity River Watershed, the city of Dallas, Texas, and the primary study area under current conditions. The pertinent information includes climatology, physiography, geology, sociological, environmental, cultural and recreation data.

TRINITY RIVER WATERSHED

The Trinity River Basin lies in the eastern portion of the State of Texas, and is bounded on the north by the Red River Basin, on the east by the Neches and Sabine River Basins, on the west by the Brazos River Basin and on the south by the San Jacinto River Basin. The basin, with an overall length of about 360 miles and a maximum width in the headwaters of about 100 miles, extends along a northwest-southeast axis from Archer County to the northwest to Chambers County and continues in a southeasterly direction until it empties into the Gulf of Mexico at Trinity Bay near Galveston. The total drainage area of the basin encompasses more than 17,900 square miles.

The Trinity River, in the vicinity of the study area, is composed of four branches, the Clear, West, Elm and East Forks. The headwaters of each are located north and west of Dallas and Fort Worth and converge within the Metroplex. Specifically, the main stem of the Trinity River is formed in Dallas by the confluence of the West Fork and Elm Fork. The West Fork extends approximately 209 miles from Archer County and flows in a southeasterly direction to the city of Fort Worth where it is joined by the Clear Fork. The river continues in an easterly direction another 53 miles to its junction with the Elm Fork in Dallas. The Elm Fork rises in Montague County and flows in a southeasterly direction to join the West Fork and form the Trinity River at Dallas. The East Fork, although not specifically within the study area, rises in Grayson County from the northeast and flows southward to join the Trinity River 20 miles southeast of Dallas.

Within the area described above, the Trinity River Basin is influenced by more than 2,500 minor flow retarding structures and twelve major reservoirs. The Corps of Engineers constructed six of these reservoirs, including Benbrook, Joe Pool, Ray Roberts, Lewisville, Lavon and Grapevine. Other major Corps of Engineers flood control projects include the Dallas and Fort Worth Floodways. Non-Federal lakes influencing the basin include Amon Carter, Bridgeport, Eagle Mountain, Weatherford, Arlington, Mountain Creek, White Rock, and Ray Hubbard. These flood control, recreation, hydropower and water conservation projects are shown in figure 2-1.

The Trinity is considered an urban river in all respects. It is significantly influenced by the amount of water it receives from watershed runoff, overflows from surrounding man-made reservoirs, and the controlled discharge of effluent from the sewage treatment plants.

The area hydrologically modeled in this study consisted of the entire drainage area upstream of the point where Five Mile Creek flows into the Trinity River near the intersection of the Trinity River and Interstate Highway 20 (about 10 miles southeast of downtown Dallas). This drainage area is shown in figure 2-2. The total drainage area at that point is approximately 6,275 square miles and lies within the Dallas/Fort Worth Metropolitan area. The total drainage areas of the Trinity River at the Elm Fork-West Fork confluence and at the Dallas Gage are 6,081 and 6,106 square miles, respectively. The terrain elevation varies from 1,200 feet National Geodetic Vertical Datum (NGVD) at the headwaters of the West Fork of the Trinity River approximately 35 miles south-southwest of Wichita Falls, Texas, to 380 feet NGVD at the confluence of Five Mile Creek and the Trinity River.

The Trinity River in the study reach is characterized as a main channel with an average depth of about 30 feet, a top width of about 200 feet and an average discharge of about 2,000 cubic feet per second (cfs) over the period of record from 1955 to 1992. The overbanks are generally very wide relative to the broad channel. The river channel has an average bottom slope of about 2.6 feet per mile and has proven to be very stable.

THE CITY OF DALLAS

The city of Dallas is located in Dallas County in north central Texas and serves as the county seat. The city is 35 miles east of Fort Worth and 245 miles north-northwest of Houston. Dallas has expanded to a highly diversified city since its incorporation in 1846, and is now the second largest city in the state of Texas. Dallas is a city of commerce, transportation, banking, retail and wholesale trade, conventions and trade shows. With its centralized location, Dallas is a favorite destination for tourists and has become one of the nation's busiest transportation hubs, being served by one of the world's busiest airports, Dallas Fort Worth International.

Dallas' diversified economy began as an agricultural trade center in the 1840's and has progressed into the wholesale and retail market center of the southwest. This economic strength fueled growth in banking, insurance, data processing, and electronic components which account for a major portion of the Dallas economy. In addition, Dallas is home to more than thirty-two Fortune 500 corporate headquarters, the World Trade Center, the Dallas Convention Center, Dallas International Market Hall, the Infomart and Reunion Arena. The county has 22 colleges and universities, 34 hospitals, 22 libraries and 68 banks.

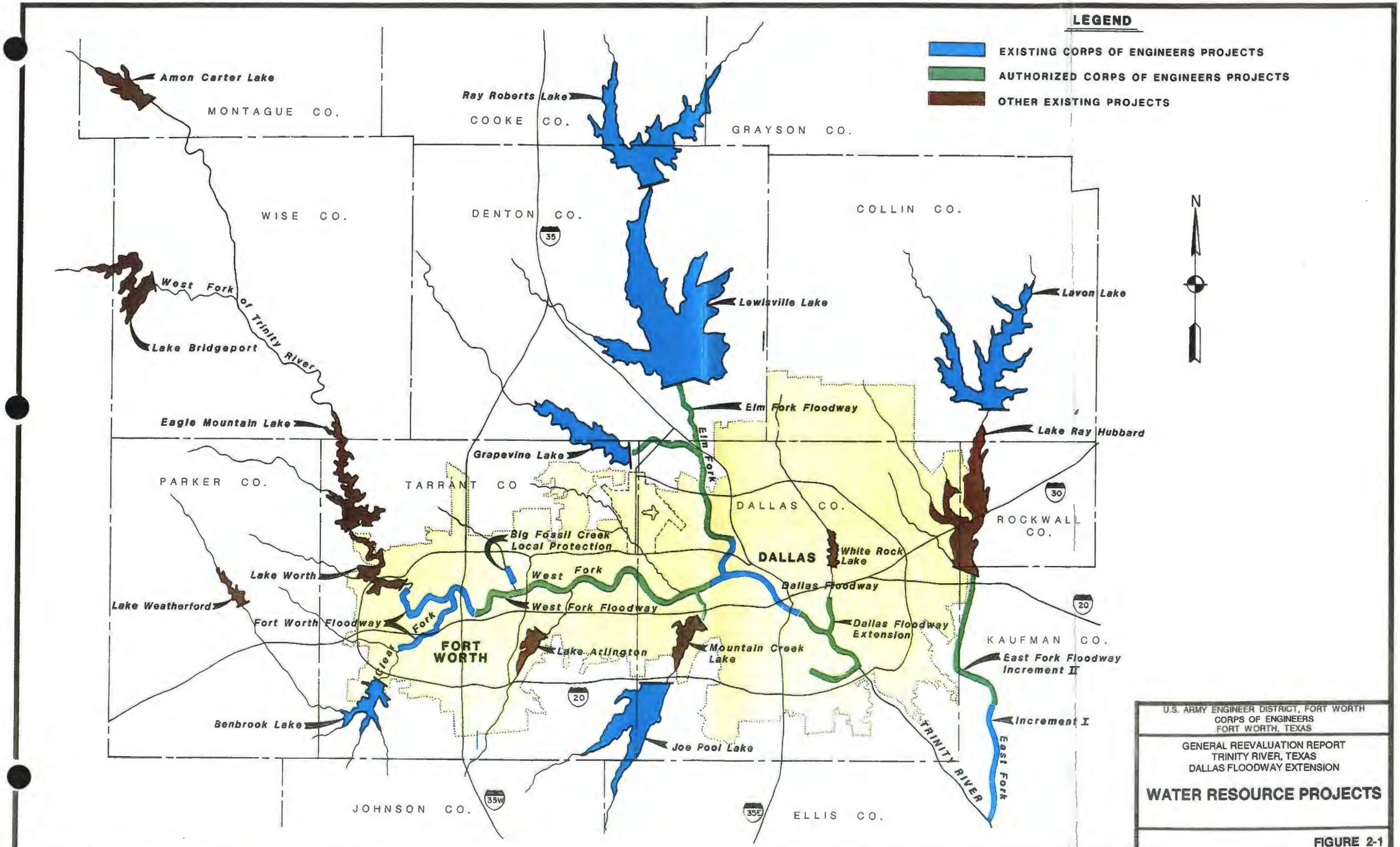
The Trinity River's original name, La Santisma Trinidad (the Most Holy Trinity), is derived from the convergence of three branches which come together in Dallas. The river flows easterly through a significant portion of the city of Dallas and influences land use in both the northern and southern sectors.

STUDY AREA

The study area is located in the southern sector of Dallas, southeast of the downtown area. Specifically, the study area investigated can be defined as that portion of the Trinity River between the confluence of Five-Mile Creek, near the intersection of the Trinity River and Interstate Highway 20 (about 10 miles southeast of downtown Dallas) and the downstream end of the existing Dallas Floodway Levee System and bounded by the SPF limits. The study area also includes the White Rock Creek tributary between IH-30 from the northeast to its confluence with the Trinity River. The entire study area is located within the corporate city limits of Dallas, Texas. A map of the study area is shown in figure 2-3.

CLIMATOLOGY

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 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 mean relative humidity is 65 percent with an average temperature of 65.8°Fahrenheit. The average first freeze date in the fall is November 13, while the average last freeze date in the spring is March 23.



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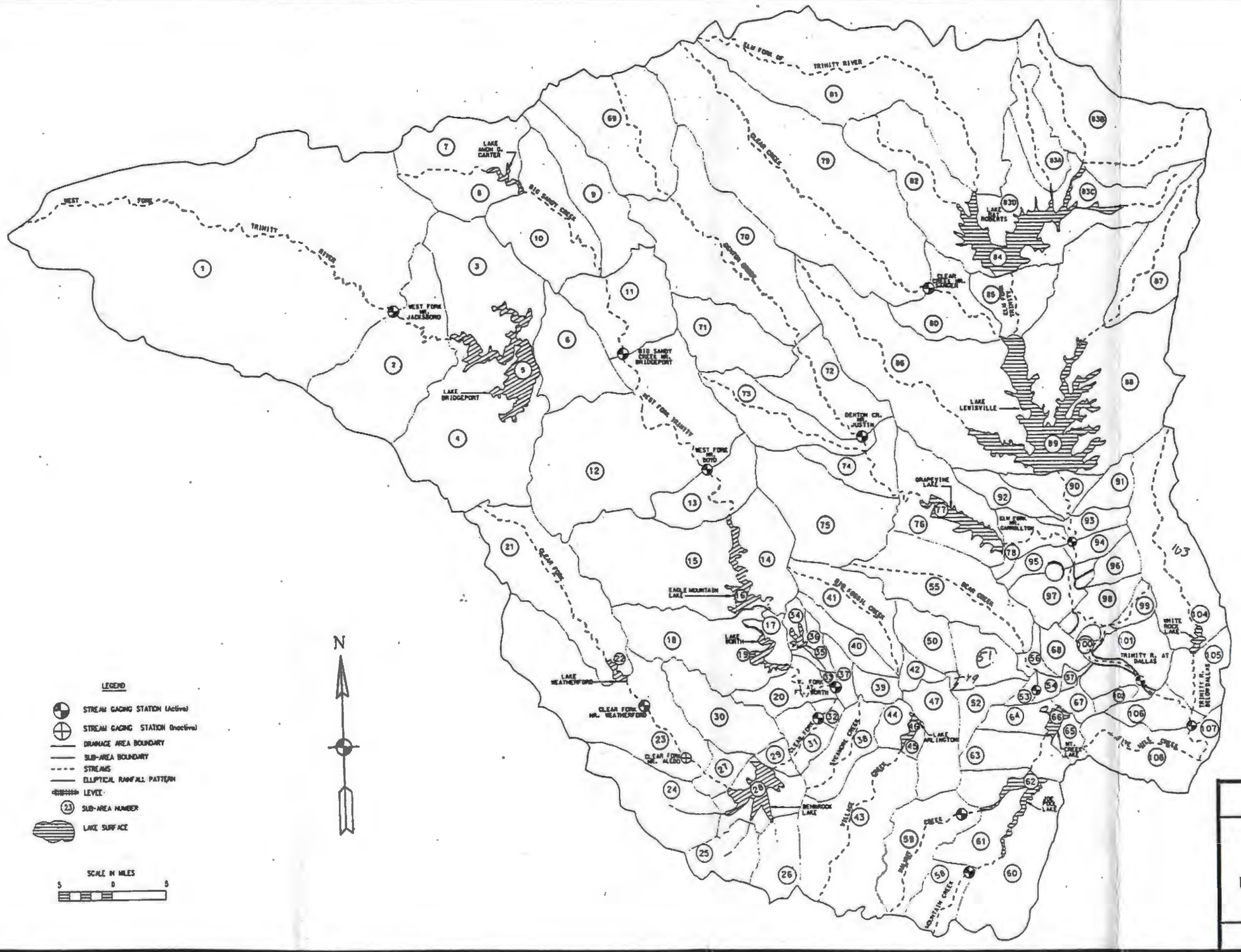
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

WATER RESOURCE PROJECTS

FIGURE 2-1



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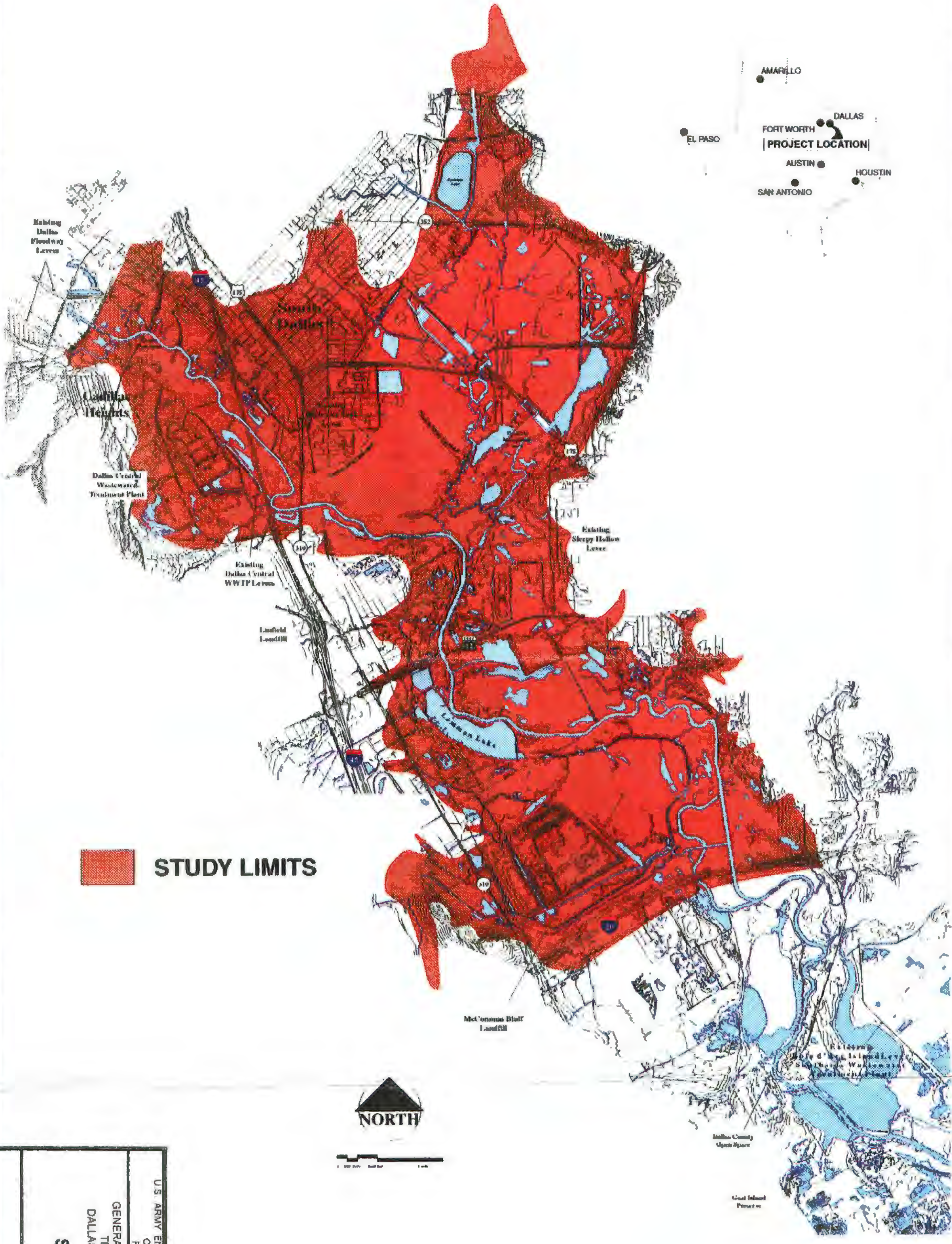
UPPER TRINITY RIVER BASIN

FIGURE 2-2



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STUDY AREA

FIGURE 2-3

Generally, the major storms experienced in the study area are produced by heavy rainfall from frontal-type storms which 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 are more prevalent in spring and summer months. Table 2-1 presents a summary of climatological statistics for the city of Dallas.

Table 2-1
Climatological Statistics for Dallas, Texas
(Based on 109 years of Record)

RAINFALL	
Average Annual (1987-1996)	37.88 inches
Maximum Annual (1991)	53.54 inches
Minimum Annual (1921)	17.91 inches
Maximum 24-Hour (September 1932)	9.57 inches
TEMPERATURE	
Average Daily	65.8 °F
Daily Maximum (June 1980)	115 °F
Daily Minimum (December 1989)	-1 °F
RELATIVE HUMIDITY	
Average Daily	65 percent

The prevailing winds for this area are from the south or southeast, except during portions of the winter months. During this time, occasional high pressure polar air masses from the northwest result in north winds over most of the area.

BASIN PHYSIOGRAPHY AND GEOLOGY

The Trinity River Basin, situated in east central Texas, encompasses more than 17,900 square miles, and includes all or portions of 38 counties. Altitudes range from 1,500 feet above mean sea level in upper extreme reaches of the basin to sea level at the mouth in Trinity Bay. The gradient of the river decreases from almost 4.0 feet per mile to about 0.8 feet per mile toward the mouth. The basin is situated within two physiographic provinces, the Central Lowland province in the headwaters, with rock outcrops indicative of the Pennsylvanian and Permian age, and the Coastal Plain province, which includes varying outcrops throughout the basin. In the extreme upper basin, moderately rugged eastward-facing escarpments and stream valleys with narrow and steep-sided floodplains are indicative of a newly forming erosional cycle. The topography changes to primarily flat to gently rolling in the mid-basin prairies and Cross Timbers regions, becomes gently rolling to hilly through the East Texas timber belt, and then gradually levels out to very flat treeless areas (in uplands) in the Coastal Prairie.

STUDY AREA PHYSIOGRAPHY AND GEOLOGY

The Dallas Floodway Extension study area is located within the northernmost section of the Gulf Coastal Plains, which is characterized by essentially flat lying to gently dipping unconsolidated terrace and flood plain deposits. All physiographic features within this area were formed during the Cenozoic Era. Fluvial terrace deposits and alluvial deposits of the Quaternary Age occupy the floodplain area of the Trinity River. These deposits consist of gravel, sand, silt, and clay deposits.

The underlying bedrock consists of the lower and middle members of the Austin Chalk Formation, a chalky limestone with thin bentonitic beds scattered in the lower part. Within the study area, the Austin Formation has an estimated thickness of 300 feet to 700 feet and gently dips to the southeast.

Geologic structural features within the project area do not pose a significant threat to the integrity of the project. However, Paleozoic formations of the Ouachita series of Oklahoma extend south into this region and, at great depth, underlie the Cretaceous rocks exposed at the surface. The Ouachita series is characterized by intense folding and faulting. Normal and reverse faults north and east of Dallas, as well as the famous Balcones fault zone to the south, have been correlated with this regional structural feature. Regardless of these features, any seismic risk within the project area is considered to be minimal. Additionally, this project is located within zone "zero" on the seismic risk map of the United States, indicating no damage is expected as a result of earthquake activity. It is anticipated that all excavations can be accomplished with conventional earth moving equipment.

EXISTING DALLAS FLOODWAY LEVEES

The existing Dallas Floodway Levee System is a federally sponsored project currently maintained by the city of Dallas. The Dallas Floodway Extension study initially had a primary focus to evaluate current conditions and proposed improvements for those areas downstream of the Dallas Floodway that are susceptible to flood damages up to and including the SPF event. However, due to changes in the floodplain and the backwater effects on the downstream end of the Dallas Floodway Levees, the risk of overtopping of these levees has become a major consideration. Therefore, the Dallas Floodway Levee System is included in this investigation. The design of the Dallas Floodway Levees was based on construction of the levee crest to the SPF flood water surface elevation plus four feet of freeboard. The SPF flood elevations used to establish the original design grade of the levees were computed using hand backwater calculations. Subsequent studies, using an LRD-1 hydraulic model, confirmed the original SPF flood elevations. The HEC-2 hydraulic model compiled for this study, updated for current conditions, computes higher water surfaces downstream of the Dallas Floodway than those computed with the earlier model.

The downstream end of the Dallas Floodway levees is located near the abandoned Atchison, Topeka, and Santa Fe (AT&SF) Railroad bridge. The East Levee has a terminal section extending perpendicular to the river along the AT&SF Railroad tracks and directly beneath the newly constructed DART Rail Line bridge to high ground. A portion of this extension of the East Levee is earth embankment with a design crest elevation of 425.2, while the remainder is a concrete floodwall up to 7 feet in height extending to the high ground limit. The concrete floodwall portion of the levee has a design crest elevation of 423.0 and includes two integral stoplog closure sections. One of these stoplog structures provides passage for a dual track Southern Pacific Railroad line. The other stoplog structure formerly served the same purpose, but the tracks have been removed as part of the construction of the DART Rail line bridge. For the purpose of this study, the stoplog structures have been assumed to be in place prior to the occurrence of a major flood event and reliable up to the floodwall design crest elevation of 423.0.

A topographic survey compiled from aerial photographs taken in February of 1991 indicated that a length of about 600 feet of the East Levee embankment near the AT&SF Railroad bridge had degraded to an elevation of about 422.0. The West Levee, at the same location along the river, has not degraded significantly below the design grade elevation of 425.2. The survey also indicated that other portions of both the East and West Levee crests have degraded below the design grade, but this location on the East Levee was the most critical. The city has restored the East Levee design grade at the AT&SF Railroad with work

completed during 1996. The city initiated additional work within the Dallas Floodway in late 1998 to address other levee crest deficiencies upstream. In light of the city's progress and continued efforts to restore levee design grade, the overtopping elevation chosen to be used in this analysis for the Dallas Floodway East Levee was based on the crest elevation of the concrete floodwall of 423.0. The current hydraulic study computed a baseline conditions SPF water surface elevation at the AT&SF Railroad bridge of 426.0, and a 500-year water surface elevation of 422.4. This analysis indicates that under current conditions, the occurrence of an approximate 500-year flood event would overtop the concrete floodwall portion of the East Levee.

EXISTING ROCHESTER PARK LEVEE

The Rochester Park Levee was constructed during the time this study was performed and has been hydraulically modelled in the baseline conditions hydraulic model. The design of the levee was based on the SPF water surface from previous hydraulic analysis plus four feet of freeboard which yielded a design elevation of 417.0. This elevation was computed by the earlier LRD-1 hydraulic model discussed above and was used for the entire levee crest without allowance for the slope of the hydraulic grade line from the portion of the levee farthest downstream to the upstream end of the levee. The upstream end of the Rochester Park Levee terminates at a natural ground elevation of 415.5. Based on the earlier hydraulic study, this elevation provided about two feet of freeboard above the SPF water surface at that location. As originally designed, flood discharges exceeding the design capacity of the levee system would initially enter the protected area at the upstream end of the levee, across broad natural ground areas at an elevation lower than the levee crest, thus preventing a catastrophic failure of the levee. However, as more detailed topographic mapping became available, it was determined that farther upstream from the end of the levee, at Hatcher Street and South Central Expressway, the underpass would allow flood waters to enter the areas protected by the Rochester Park Levee at an elevation lower than at the area near the upstream end of the levee. The elevation at the underpass above which flood waters would begin to inundate those areas protected by the Rochester Park Levee north of the C.F. Hawn Freeway is estimated to be 413.0 and the elevation above which flood waters would begin to inundate those areas south of the C.F. Hawn Freeway is estimated to be 414.5. The current hydraulic study computed a 100-year water surface elevation at Hatcher Street, under baseline conditions of 412.0, and a 500-year water surface elevation of 418.1. Based on this analysis, the current level of protection provided by the Rochester Park Levee is approximately the 110 -year flood event. This approximate evaluation of level of protection is used primarily to show the difference between the results of this study and the previous hydraulic analysis that was used for the design of the levee system. The location of this levee is shown on figure 2-4.

EXISTING CENTRAL WASTEWATER TREATMENT PLANT LEVEE

The Central Wastewater Treatment Plant (CWWTP) is located on the right overbank of the Trinity River between the Missouri-Kansas-Texas Railroad bridge and the Interstate Highway 45 bridge. It is protected from flooding by a ring levee system that surrounds the main structures of the treatment plant. The levee survived the flood of 1990 without overtopping, but required emergency repairs during the flood. The city of Dallas has since implemented a plan, designed by the engineering firm of Albert H. Halff & Associates, Inc. of Dallas, to upgrade the CWWTP Levee and other plant facilities to comply with Texas Water Commission requirements to provide 100-year flood protection plus three feet of freeboard. The results of the hydraulic analysis used to establish the design levee crest elevation of 415.0 compares very closely with the water surface profiles presented in this report. This elevation was used to estimate the CWWTP levee level of protection at approximately the 140-year flood event. This levee is shown in figure 2-4.

EXISTING SLEEPY HOLLOW COUNTRY CLUB LEVEE

The Sleepy Hollow Country Club Golf Course is located between the Linfield Landfill and the Loop 12 bridge on the right bank of Trinity River. A small levee approximately 10 feet in height is located along the right bank of the river channel and provides about a 10-year level of protection for the golf course based on observance of recent flood events and analysis of recent topographic data. For flows less than a 10-year frequency event, the levee encroaches upon the main bridge opening of the Loop 12 bridge for about 50 percent of its length. The Loop 12 highway crossing of the floodplain consists of two additional relief bridges that are not affected by the golf course levee.

ENVIRONMENTAL SETTING

GENERAL

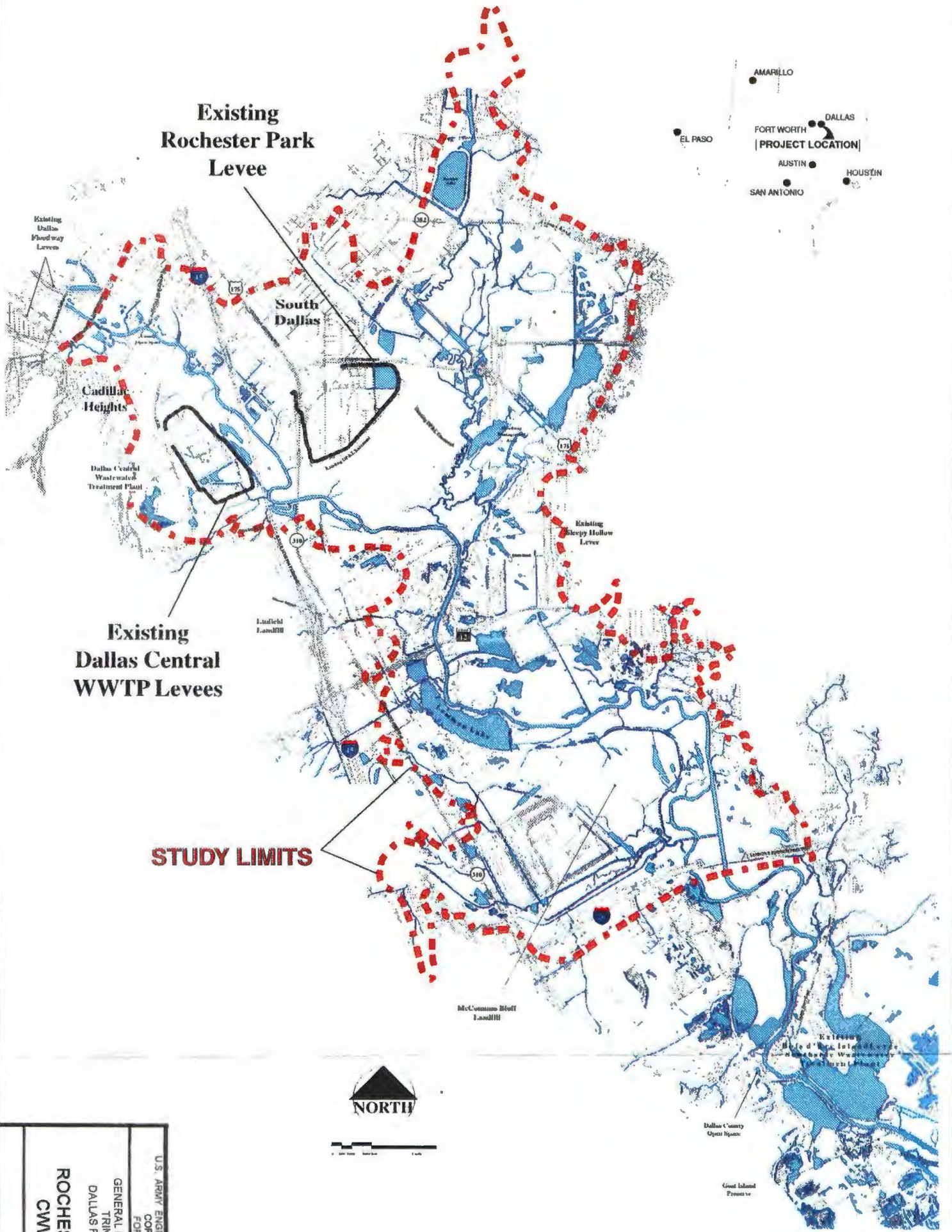
Of major concern, environmentally, to this study are the floodplain areas adjacent to the river. The study area is located within a fully developed metropolitan area, and the environmental setting varies significantly. Located immediately upstream of the study area is the Dallas Floodway Project, which was constructed with Federal funds in 1957 and consists of a channel and levee system that extends from Mountain Creek to the Atchison, Topeka, and Santa Fe (AT&SF) Railroad bridge. Since the construction of this project, the environmental characteristics of the area have been significantly modified, although some riparian vegetation and wildlife habitat have reestablished naturally. From the AT&SF Railroad bridge downstream to the Interstate Highway 20 Trinity River crossing, the topography consists mainly of bottomland hardwoods, scattered wetlands, open water areas, gravel pits, and open fields which are used for grazing livestock. The project area is within an area known as the "Great Trinity Forest", which roughly encompasses the Trinity River mainstem floodplain between the existing Dallas Floodway and the IH-20 crossing, and the White Rock Creek floodplain from the confluence with the Trinity River upstream to IH-30. A summary of the environmental setting is provided below. The complete analysis is provided in Appendix F.

AIR QUALITY

The project study area is located within the Environmental Protection Agency's Air Quality Region (AQCR) 215 for Texas, which consists of 19 counties, including Dallas, Denton and Tarrant. AQCR 215 is classified as a serious non-attainment area for ozone and attainment/unclassifiable for other National Ambient Air Quality Standards including lead, sulfur dioxide, nitrogen dioxide, carbon monoxide, and particulate matter of aerodynamic shape less than or equal to 10 micrometers in diameter.

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 were as follows: lead - 0.03 micrograms per cubic meter ($\mu g/m^3$); PM10 - 29 $\mu g/m^3$; carbon monoxide - 0.75 parts per million (ppm); sulfur dioxide - 0.003 ppm; ozone - 0.0023 ppm; and, nitrogen dioxide - 0.017 ppm.

Trees influence air quality. Direct effects are generally more local in nature, while indirect effects may be more generalized. Trees lower local air temperatures by shading and transpiration. Trees may also alter air flows which, depending on the location of the trees and adjacent buildings, may either reduce energy use or increase it. A dense forest or row of trees upwind of a building may cause a heat island to form around the building during the summer time by blocking off air flow. A windbreak upwind of a building during the winter, however, may result in reduced heating requirements. Energy use, in turn, affects air quality on a regional basis by influencing the extent of fossil fuel use. Living trees can either directly remove or contribute to atmospheric pollution. Generally, the benefits of trees outweigh their detrimental impacts. Quantification of their effects on removal of air pollutants has been measured, and models developed, which have application to the project area. Estimates of the annual pollution removal rates of trees within the study area were developed using the United States Department of Agriculture's Urban Forest Effects (UFORE)



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ROCHESTER PARK AND CWWTP LEVEES

FIGURE 2-4

program. It is assumed that herbaceous vegetation also has some pollutant uptake capabilities since they are functionally similar to trees. However, due to a lack of published materials describing these pollutant removal coefficients, herbaceous vegetation was not included in this analysis. Table 2-2 provides a summary of the total current pollution removal rates of trees within the Great Trinity Forest, the city of Dallas, and the detailed project area (under existing conditions and future without-project conditions).

Table 2-2
Air Pollution Removal Rates By Trees
(Tons / Year)

Area	Carbon Monoxide	Sulfur Dioxide	Nitrogen Dioxide	Particulate Matter (10 µm)	Ozone
Existing Great Trinity Forest	13.30	11.74	32.93	77.16	145.19
Existing City of Dallas	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-Project	2.02	1.78	4.99	11.70	22.02

WATER QUALITY

The portion of the Trinity River in which the proposed project lies is designated by the TNRCC as segment 805. While the water quality of the Trinity River continues to improve, four areas of concern remain in this segment. According to tests conducted every two years by the TNRCC, nitrite+nitrate, orthophosphorus, total phosphorus and fecal coliform concentrations were outside criteria or screening levels 92.5%, 97.67%, 94.59%, and 38% of the time, respectively. Dissolved oxygen levels have historically been considered a serious problem but have shown great improvement and are now rarely lower than the standards criteria of 5.0 milligrams per liter. Low flow rates and high temperatures, typical in the dry summer months, create conditions under which water quality problems such as high algal growth and low dissolved oxygen levels may exist.

The Texas Department of Health issued an aquatic life closure for a stretch of the Trinity River in January 1990 due to elevated levels of chlordane in fish tissue. This 66-mile stretch of the Trinity River, denoted as Segment 806, extends from Fort Worth to IH-20 in southern Dallas County, which includes the DFE project area. Fishing can be conducted, but no taking of fish is currently allowed. In addition, the TNRCC does not support contact recreation within the waters of Segment 806 due to continued water quality violations discussed in the above paragraphs.

Effluent from several wastewater treatment plants discharge into the Trinity and tributaries throughout the Dallas / Fort Worth Metroplex. The Central Wastewater Treatment Plant (CWWTP) in Dallas meets and often exceeds stringent requirements as stated in the discharge permits issued by the state. In the last three years, 15 chronic toxicity tests have been conducted for the organism *Ceriodaphnia dubia* in 100% effluent. All tests results have been negative, indicating that the effluent may be used to provide fish and wildlife habitat.

VEGETATIVE COVER

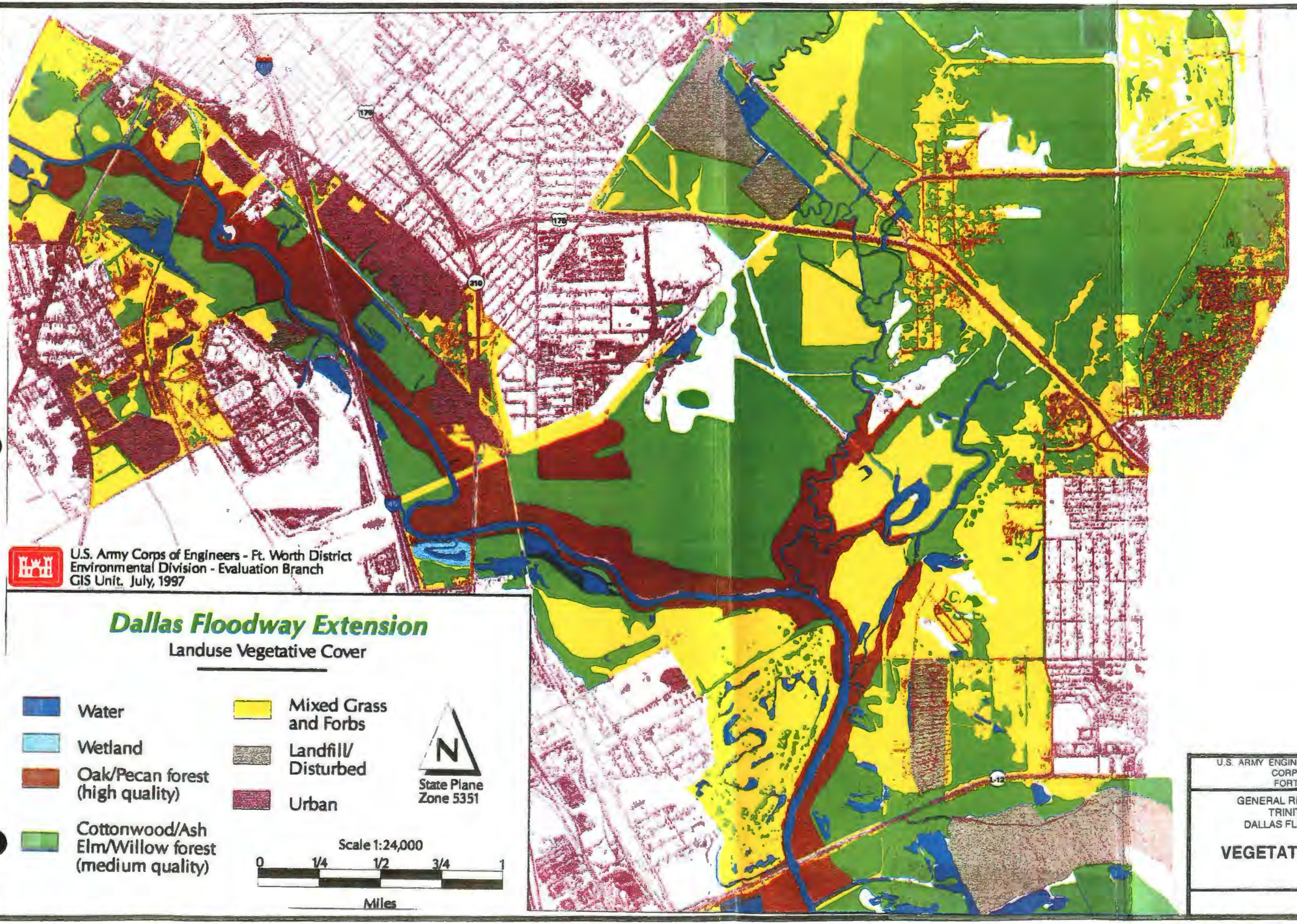
General

The proposed project is located in the Blackland Prairies vegetative ecoregion, and the predominant soil is classified as frequently flooded Trinity Clay. Tree species common to this area include- elms, sugarberry, pecan, oak, black willow, cottonwood, and osage orange.

The "Great Trinity Forest", as defined above, encompasses approximately 5,956 acres, of which 5,456 acres are woodland and include bottomland hardwoods, mixed Deciduous, and wetlands/bottomland hardwoods. The remaining 500 acres are composed of water, grassland, scrub/shrub, and urban areas. Table 2-3 shows the vegetative/land cover types, by number of acres and percent of total cover, within the Great Trinity Forest. A vegetative cover map is shown in figure 2-5.

Table 2-3
Types of Vegetative/Land Cover Within the Great Trinity Forest

Type of Cover	Acres	Percent of Total Cover
Bottomland Hardwoods	4,198	70.5
Wetlands/Bottomland Hardwoods	1,045	17.5
Water	233	3.9
Mixed Deciduous	213	3.6
Pasture/Unmanaged Grasslands	121	2.0
Scrub/Shrub	63	1.1
Agriculture	37	0.6
Urban/Roads/Bare Ground	15	0.3
Low Density Urban & Residential	13	0.2
Managed Grassland	12	0.2
Unclassified/Bare Ground	3	0.1
Bare Ground	3	0.1
TOTAL	**5,956**	**100**



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

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VEGETATIVE COVER MAP

FIGURE 2-5

Bottomland Vegetation

Bottomlands occur in the transition zone between aquatic and upland ecosystems, and bottomland hardwoods are considered to be Texas' most diverse ecosystem. Within the Dallas Floodway, the dominant species is black willow and cottonwood. Downstream from the AT&SF Railroad bridge to the Dallas County line, the dominant tree species are mature black willow, cedar elm, sugarberry, green ash, pecan, American elm, box elder, cottonwood, red mulberry, and osage orange. The dominant understory shrubs, woody vegetation and vine species consist of immature tree species of the same type mentioned above, along with western soapberry, swamp privet, common greenbrier, honeysuckle, and poison ivy. In areas of dense canopy cover, the dominant herbaceous groundcover species include poison ivy, wild onion, violets, Virginia creeper, and Canadian wild rye. 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, ragweed and sedges.

Wetland Vegetation

Wetlands are defined as those areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support, under normal circumstances, a prevalence of vegetation typically adapted to life in saturated soil conditions. Common diagnostic features of wetlands are hydric soils and hydrophytic vegetation. The wetlands located in the study area are scattered throughout the flood plain in isolated depressions or very low gradient drainages, and contain marsh elder, ragweed, cottonwoods, green ash, and black willows, with occasional box elders. Rapid growth of invading cottonwood, green ash and willows has resulted in a rapid conversion of emergent wetlands to bottomland hardwood wetlands during the recent past.

Grasslands

Open grasslands developed from reclaimed mine areas and abandoned agriculture fields are commonly used as grazing lands for livestock, with vegetation characteristic of disturbed 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, while dominant herbaceous species include giant ragweek, annual sunflower and goldenrod. These open areas are expected to eventually succeed to bottomland hardwood forests, based on a comparison of historic and recent photographs.

FISH AND WILDLIFE RESOURCES

Similar to the plant species of the flood plain, fish and wildlife species vary considerably within the study area. Influence of man, his developments and residual wastes have brought about significant changes in the habitat, food supplies and, thus, resident populations of fish and wildlife resources. Predator control, indiscriminate hunting, use of pesticides, and various forms of air, water, and land pollution has been responsible for modified distribution of fish and wildlife populations throughout the area. The surviving fish and wildlife live in a modified natural habitat within the immediate influence of an encroaching urban complex.

Fish (Aquatic) Resources

In addition to the mainstem of the Trinity River, adjacent wetlands and open water areas support a variety of fish species. Within the mainstem of the river, concerns about the quality of the fishery habitat include turbidity and oxygen-demanding pollutants, which interact to produce lowered dissolved oxygen concentrations. Physical habitat for fisheries is scarce, particularly in the channelized reaches within the existing Dallas Floodway upstream of the project area. Several studies verify that stream fisheries have improved during the last twenty years, due primarily to improved water quality resulting from improved waste water treatment. Sportfish present in the study area include largemouth bass, channel catfish, crappie, and

white bass. Other species which tend to be more tolerant of moderate levels of nutrients and lower dissolved oxygen present in the area include common carp, river carpsucker, longnose gar, freshwater drum, several species of shiners, and bullhead catfish. Non-sport species found in the study area that are less tolerant to pollutants include gizzard shad, mosquitofish, and several sunfish species.

Wildlife Resources

The river channel, wetlands, open water areas, and forested areas support a variety of wildlife species for cover, food, and nesting areas. Bird species which have been reported or observed within the study area, include migratory warblers and sparrows, meadowlark, mourning dove, crow, red-tailed 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 birds and swallows. A major heron rookery exists within a heavily wooded area along Rector Road west of the Central Wastewater Treatment Plant. At least five species of birds have been observed nesting in the rookery. Amphibians, reptiles, and mammals which are common to the area include frogs and toads, snakes, turtles, cottontail rabbit, cotton rat, field mice, opossum, raccoon, bobcat, beaver, nutria and coyotes.

THREATENED AND ENDANGERED SPECIES

Table 2-4 provides a list of federally protected species that may occasionally migrate through the project area.

Table 2-4
Federally Listed Threatened and Endangered Species Whose Migratory Corridor Includes Dallas County, Texas

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

(Source: U.S. Fish and Wildlife Service, June 1997)

CULTURAL RESOURCES

The cultural resources under consideration in the project area may be identified as archaeological sites and architectural or structural elements in the landscape that are at least 50 years of age. The Dallas Floodway Extension (DFE) study area or area of potential effect (APE) has been defined as that terrain along the Trinity River between the Corinth Street Viaduct and U.S. Interstate 635 falling within the SPF floodplain. The proposed project footprint is that portion of the APE which is scheduled to be directly impacted by terrain modification and construction activity. Once archaeological deposits are extensively disturbed, reconstruction or rehabilitation of the evidence to explain past behavior is extremely limited to

absent. The material remains (artifactual data) of prehistoric and historic archaeological sites make up the record of the human past, and it is the analyses and interpretation of the contextual relationships between the artifactual remains which provides us with our window to the past. Evidence indicates that the inception of human activity in the project area likely dates to around 12,000 years ago. Prehistoric exploitation of the riverine system lasted until the early 1800s.

Historically, the Trinity River may have been visited by Luis de Moscoso de Alvorado between 1541 and 1545, as he led the survivors of the Hernando de Soto Expedition back to Mexico following de Soto's death on the Mississippi River in 1541. Later, the area came under the domain of Spain, which was competing with the French to the north for land entitlement. By 1823 the area was under the rule of the Republic of Mexico until Texas won independence in 1836. John Neely Bryan established a post at Dallas 1842, and some early settlers arrived in the project area by 1844, such as William Perry Overton and family. Dallas County was organized in 1846, and less than a year later in 1847, another settler in the area, William Brown Miller, started the first ferry service across the Trinity River at the large meander in the middle of the project area.

To date there are 41 archaeological sites known within or immediately adjacent to the DFE Study Area, which includes seven that are outside of the APE and seven that are only partially within the APE. Fourteen of the sites are reportedly within the project footprint, six of which have been destroyed by development. Of the remaining eight archaeological sites, seven are prehistoric, while the eighth is an old City of Dallas dump dating between ca. 1890 and 1940. Generally, prehistoric sites within the study area will represent riverine habitats exploitation. A typical site may consist of large occupational horizons composed of small activity-specific loci such as molluscan (Naiad) exploitation sites. These sites, many of which have not been extensively examined, may have been repeatedly revisited either seasonally or throughout a season by an undetermined population.

The Late Prehistoric period, which includes all ceramic-bearing culture groups, are most frequently identified at sites in the project area and footprint, although Late Archaic occupations are also recorded in modest numbers, while Early and Middle Archaic components are less frequently encountered. One explanation provided assumes that older sites are deeply buried. For example, at the Aubrey Site, a Paleoindian occupation located upstream on the Elm Fork of the Trinity River, intact and in situ cultural materials were recovered more than eight meters below the current flood plain surface. This condition indicates that early prehistoric sites in the mainstem portion of the Trinity River incorporating the project area may be at least as deep. Prehistoric sites positioned within floodplains may be subjected to massive erosional or depositional forces. In addition, during stable periods with little sediment movement, the surviving deposits will be subjected to extensive weathering through soil formation processes, which generally have greatest expression in floodplain settings.

Archaeological sites that are either located on old fill deposits (terraces) in the modern floodplain are positioned on benches or finger ridges along the lower edge of the Pleistocene valley wall, will likely present a more compressed soil stratigraphic sequence. These kinds of locations rely on overland flow deposition or sheetwash erosion as a means of covering or deflating archaeological deposits. However, they generally provide nearly flat surfaces where the context of cultural remains may remain relatively intact, even during times of local sediment gain or loss. These deposits are not as thick as those in active river bottoms. As in the floodplain, soil development during stable depositional periods is moderately well expressed on these bench and finger ridge features. However, bio-turbation due to such agents as roots, bugs and burrowing animals, becomes a more important factor in assessing artifactual distributions in the thinner deposits.

The edge of the 100-year flood stage is between the current channel and the valley wall. It may be considered roughly synonymous with the Late Holocene floodplain margin. Topographic settings, such as knolls and flood plain rises, in this portion of the upland bottom may likely contain buried prehistoric deposits. As noted above, these areas are stable and receive sediment from the valley wall. In addition, these areas are likely to have topographic features that formed old surfaces and were later buried. As the City of Dallas expanded rapidly during the second and third quarter of the 20th century, much of this area was impacted

by the development of light industry and manufacturing, as well as residential enclaves. In addition, sand and gravel quarrying, as well as waste disposal, have had a major impact on the area.

A total of 748 architectural resources or buildings and structures were identified in the APE, 49 of which are in the project footprint. However, 43 of the 49 structures are either destroyed, not historic or have poor integrity. A complete listing of the historic and prehistoric sites, as well as the architectural inventory, for the area of potential effect and project footprint area is provided in Appendix H.

HAZARDOUS, TOXIC AND RADIOLOGICAL WASTE (HTRW)

In 1993, a study titled "Initial Assessment for the Evaluation of Hazardous and Toxic Wastes" was conducted by Albert H. Halff Associates, Inc. The objective of the study was to research existing areas of HTRW contamination, and to identify suspect or previously unknown HTRW sites located within the Dallas Floodway Extension project area. In the report, nine areas of suspected HTRW contamination were identified, which represented the original areas of concern and thus formed the basis of subsequent Corps HTRW site investigations and project decisions.

Follow-up investigations were conducted by several different firms. Environmental Sciences and Engineering conducted a feasibility level site investigation at a number of these sites. Freese and Nichols investigated Linfield Landfill and one of the adjacent gravel pits. Geo-Marine conducted further feasibility level site investigations and developed cost estimates for this report. Tetra Tech NUS conducted an additional site investigation at Linfield Landfill. Results of these five studies, plus results of Corps of Engineers efforts in interviewing local residents and officials, searching regulatory agency files for studies conducted by others, and visually inspecting the project area increased the number of areas with suspected HTRW contamination to the 14 listed below, which are described in more detail in Appendix J of this report.

1. Praxair (formerly Linde Gas) - Acetylene gas manufacturing / packaging facility
2. Tri-Gas / Occidental Chemicals - Industrial gas facility and active silicate plant
3. Dallas Public Schools (formerly Proctor and Gamble)
4. Trinity Recycling (now Okon Metals) - Metals recycling facility
5. Various Gravel Pits - Near Trinity Recycling, near IH-45, ponded area near Dixie Metals, and ponded area near Linfield Landfill
6. Valley Steel & W.E. Grace Manufacturing Company - Industrial facilities
7. Dallas Demolition Company
8. Vacant Land Near Dal-Chrome
9. Energy Conversion Systems & Darling International
10. Vacant Land North of Central Wastewater Treatment Plan
11. Municipal Sludge Disposal Lagoon E
12. Union Pacific Railroad Landfill - Located northeast of Linfield Landfill
13. Linfield Landfill
14. Open Dump Near Linfield Landfill - Located due west of Linfield Landfill

SOCIO-ECONOMIC CONDITIONS

The Bureau of the Census reports the population for the city of Dallas as 904,100 persons in 1980 and 1,007,600 persons in 1990, while the North Central Texas Council of Governments shows the 1997 population at 1,052,300. These figures account for more than 80 percent of the population in Dallas County, and show an annual growth rate of over 10 percent.

Over this ten-year period, employment in the service industry has increased almost 50 percent, highlighting a significant shift from a manufacturing-based economy to a service related economy. Non-farm employment increased almost four percent between 1990 and 1994, while the construction industry led the job growth figures in 1994 with an increase of over 10 percent.

The D/FW area is one of the nation's leading distribution centers, generating a significant demand for warehouse space. The Metroplex is also an established transportation center for the nation. The Dallas Fort Worth International Airport covers 17,500 acres and was designed to meet the future needs of the entire North Texas area. The Metroplex exhibits positive growth trends that are anticipated to continue into the future. The location and climate are pleasant.

Due to the location of the Cadillac Heights residential neighborhood in relation to the downstream end of the existing Floodway and the potential impacts of any flood damage reduction project in this area, a comparison of socio-economic data for this neighborhood and the city of Dallas as a whole is presented in table 2-5. The majority of the data represents 1990 Census Bureau data. Unemployment figures for the city of Dallas, in 1994, were reported at 5.3 percent. In 1996, this rate decreased to 3.9 percent, and is currently reported at 3.6 percent. Local industries and employment are well diversified and unemployment rates are lower than the State average. Per capita income for 1995 was estimated at $18,180, with an average salary of about $30,000.

Table 2-5
Comparative Socio-Economic Data -
Cadillac Heights vs. City of Dallas

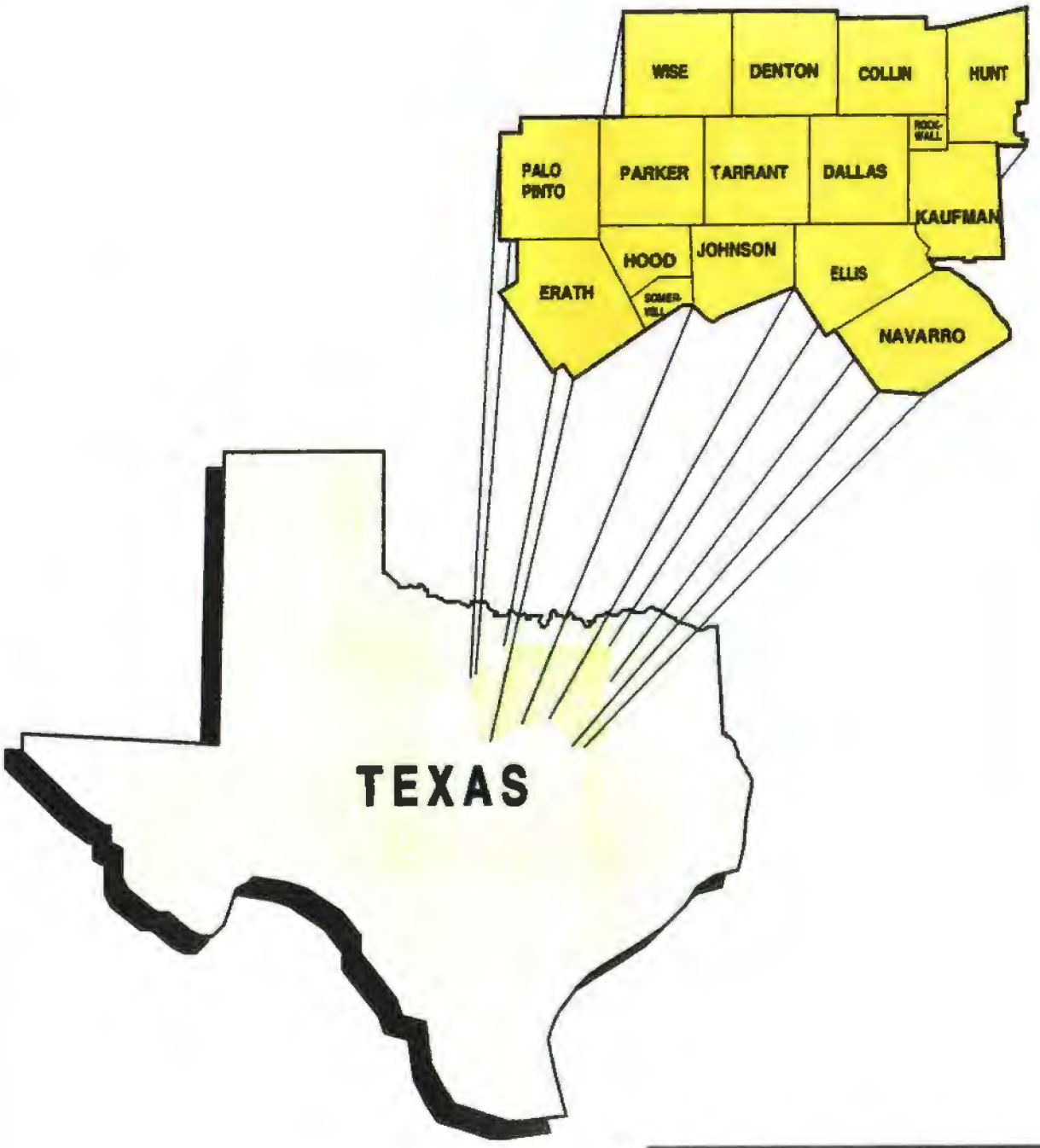
	Cadillac Heights	City of Dallas
Number of Homes	416	479,622
High / Low Price of Homes	$53,500 / $3,960	$11,949,900 / NA
Average Appraised Value	$17,500	$64,700
Percent Homeowners	51.5%	44.1%
Percent Single-Family Units	64.9%	47.5%
Percent Multi-Family Units	31.0%	50.4%
Number of Persons	1,168	1,052,300
Percent Persons Under 18	35.5%	25.0%
Percent Persons Over 65	6.8%	9.7%
Total Percent Hispanic	58.0%	20.3%
Total Percent Black	40.9%	29.5%
Total Percent White	1.0%	47.7%
Total Percent Without High School Degree	73.4%	26.5%
Total Percent Unemployed	9.1%	7.4%
Average Income	$15,089	$27,489
Percent Households on Public Assistance	35.4%	5.7%
Number of Persons Below Poverty Level	46.6%	17.8%

RECREATIONAL RESOURCES

REGIONAL RESOURCES

The 1990 Texas Outdoor Recreation Plan (TORP), prepared by the Texas Parks and Wildlife Department (TPWD), identifies existing recreational facilities, usage trends, and projected recreational needs for 23 regions within the state. The Dallas Floodway Extension is located within a 16-county area designated in the TORP as Region 4, shown in figure 2-6.

Region 4 has experienced several years of rapid population growth. With 336.6 people per square mile, the density of Region 4 is surpassed only by the Houston region. Many of the small towns and rural areas within Region 4 have become part of the rapidly expanding metropolitan area as people have moved



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

REGION 4 - TORP

FIGURE 2-6

from the heavily populated cities to the suburbs. People in these urbanizing areas are finding open space increasingly scarce. The region now ranks twenty-first out of twenty-three regions in recreation land per thousand populations.

Residents of Region 4 are generally worse off than the state as a whole in recreational facility supply. Of 19 commonly used facilities or designated resources, 13 have a below average supply. The supply of baseball fields, swimming pools, and campsites is among the lowest in the state. A complete listing of region four facilities is provided in Appendix I. State parks located within a one hour drive of the study area include Lewisville Lake State Park and Cedar Hill State Park at Joe Pool Lake. The Texas Legislature has authorized the acquisition of approximately 1,500 acres along the Trinity River within the study area for a future low density recreational area to be named Trinity River State Park. Funding sources for acquisition of all of these lands, however, have not been identified.

Residents in the Metroplex need not drive far to find recreational waters because many of the state's major reservoirs are located in the metropolitan area. A total of 232,581 surface acres gives the region more lake acres than all regions except Deep East Texas; however, the large numbers of people residing in the region make the suitable surface acres per thousand population still fall below the state average.

With so many reservoirs in the area, the value of the free-flowing sections of the region's rivers increases as they become more rare. Public agencies within Region 4 are taking a fresh look at the valuable natural resources along these long neglected streams. Many cities have identified linear corridor resources within their jurisdictions which are highly desirable for recreation. Sites within the Trinity River floodplain are among those most actively studied. Nine cities and three counties within the region are participating with North Central Texas Council of Governments in the development of a *Common Vision* to protect the resources within this corridor. Goals include the development of a regional construction permit system and cooperation in the creation of a linear greenbelt of parks and trails along and adjacent to the river and its tributaries.

LOCAL RESOURCES

More than 6,000 acres of existing parks, open spaces, natural areas, and cemeteries are available for present or future public use within an 80 square mile section of the county that includes the study area. These public and private lands and facilities provide recreational opportunities for residents of the Metroplex, especially those who are unable to travel to recreational sites outside the metropolitan area. Most of the recreational resources within the study area are owned and managed by the City of Dallas, the Dallas Independent School District, and the Dallas County Open Space Board. A list of these resources and their approximate acreages is shown in table 2-6, and in Appendix I.

RECREATION ON THE TRINITY RIVER AND TRIBUTARIES

The most scenic wooded areas in Region 4 are often found in stream and river corridors. Scenic corridors along the Trinity, with natural meandering water courses bordered by riparian hardwoods or dense stands of trees and shrubs, are the most desirable segments of the river and the portions most intensely used by the recreating public. Use of these segments is the heaviest during higher stream flow periods, generally during the spring and fall seasons.

Recreation providers have expressed concern over stream bank erosion, in-stream flows and the quality of the water for contact recreation. In order to give citizens higher quality water resources, some users advocate tighter standards for the designation of stream segments as fishable and swimmable. Minimum in-stream flows are needed to preserve fish and wildlife habitat and historical and recreational resources.

Table 2-6
Recreational Resources Within the Study Area

Recreation Resource / Land Use Type	Number of Facilities	Approximate Acreage
Lakes	1	149
Landfills	1	2,009
Private Parks / Recreational Facilities	1	4
Golf Courses	4	627
Cemeteries	5	340
Public Parks	81	5,617
Natural Parks	2	243
City Open Space	4	765
Large Outdoor Stadiums	2	33
Proposed City Parks / Open Space	16	824
Proposed State Parks / Open Space	5	1,245

The Elm Fork of the Trinity River and its tributaries are currently being used for a variety of recreational activities, though access is limited or restricted. In spite of these limitations, avid canoeists, kayakers, fishermen, bicyclists, and bird watchers have located access points where park areas, roads, and bridges intersect with the river.

The Dallas Parks and Recreation Department conducted a recreational user survey in the communities surrounding the project area. Questionnaires were distributed to area residents through six neighborhood recreation centers. A copy of the questionnaire form and detailed findings are included in Appendix I. The activities most often selected from the list were picnicking, hiking/walking/jogging, bicycling, and fishing. While the survey is not statistically reliable due to the method of sampling, it does provide some insight into the types of activities residents of the area enjoy.

TRINITY RIVER STATE PARK

The Trinity River State Park is authorized by Chapter 22, Subchapter S, of the Parks and Wildlife Code. The Trinity River State Park would be established under the jurisdiction of the Texas Parks and Wildlife Department on property acquired under the 1983 Act of the 68th Legislature. A total of 5 parcels of land has been designated for this purpose, though no land has yet been acquired.

Parcels 1 and 2 consist of a 200-foot corridor extending about 11 miles along the east and west banks of the Trinity River. Parcel 3 includes about 90 acres and is located within the boundaries of Rochester Park. Parcels 4 and 5 designate 320 and 1,152 acres, respectively, for acquisition. In accordance with the 1983 Act, acquisition of the necessary park lands does not restrict the construction of flood control projects.

LAND USE

As is typical of investment in a floodplain, development is scattered. Existing land use within the study area consists of residential structures east of Lamar Street. Industrial properties are located along the west side of Lamar between Corinth Street and U.S. Highway 75 (Central Expressway), and along both sides of U.S. 75. Commercial properties are scattered throughout the study area.

MAJOR TRANSPORTATION ARTERIALS

The entire study area is served by transportation facilities, including public transit, highways, thoroughfares, and rail service. The Dallas Area Rapid Transit (DART) system provides public transportation between the communities within the study area and downtown Dallas. Highways serving the city and the study area are Interstate Highways 30, 35, 45, 67 and 20/635, U.S. Highways 75 (Central Expressway) and 175 (C. F. Hawn Freeway). The arterial street system consists of multiple four-lane roads, and Loop 12, which is a four-lane highway encircling the city. Utilization of the interstate highways have made the D\FW area a major trucking center for a five-state region.

Dallas is also a major hub for many rail routes. The Southern Pacific (SP) railroad has a major rail yard in the study area north of Loop 12 and east of U.S. 75. The Missouri, Kansas and Texas (MKT) railroad extends along IH-45 northward to the Central Business District. The St. Louis Southwestern railroad runs along the east bank of the Trinity River, west of Lamar Street, to its junction with the SP and Union Pacific line near the center of the study area. Burlington Northern railroad also serves the city.

LANDS IN PUBLIC OWNERSHIP

The city of Dallas has acquired a considerable amount of land in the study area. Over 300 acres of parkland have been acquired, including Moore, Rochester, Grover, and Roosevelt parks, and several miscellaneous parcels scattered throughout the project area. Major acquisitions at the Central Wastewater Treatment Plant, the McCommas Bluff Landfill, Floral Farms, Roosevelt Heights, and the Southeast Service Center have resulted in a total of over 3,000 acres being acquired by the City since 1980.

LANDFILLS

Four significant landfill areas are located within the floodplain in the vicinity of the study area. The McCommas Bluff Landfill, currently operated by the city, is located upstream of Highway 635 (IH-20), and is a primary site for solid waste disposal for the city. The South Loop Landfill is located immediately downstream of Loop 12 on the left overbank and was closed in 1983. The Elam Landfill is located immediately upstream of Loop 12 on the left overbank and was closed in 1980. The Linfield Landfill located on Linfield Road on the right bank of the Trinity River was closed in 1975. The Linfield Landfill has a significant influence on flood elevations due to its close proximity to the river channel, and due to fill placed above the 100-year water surface elevation. This landfill is located opposite the river channel from a natural narrowing of the left overbank, which combine to create a significant encroachment of the floodplain at this location.

INTERRELATIONSHIP TO OTHER PROPOSED ACTIONS

Several proposals within the Dallas area could be considered related to the proposed Dallas Floodway Extension area. The Corps of Engineers has begun studies to address the existing Dallas Floodway and the Stemmons North Industrial area. These studies were initiated to determine if further activities were justified to reduce flood damages within the area and to determine the needs and benefits of ecosystem restoration and other allied measures.

Dallas County has an active Open Space Program in place and, as a result of their activities, extensive acquisitions of key areas along the Trinity River floodplain have occurred. Recently, the citizens of Dallas approved a bond proposal that called for moving forward with actions that would accelerate acquisitions, and other actions that would promote acquisition and preservation of the "Great Trinity Forest".

The Trinity Parkway Corridor Major Transportation Investment Study (MTIS), conducted by the Texas Department of Transportation (TxDOT), was intended to develop a locally-preferred plan of action to solve transportation problems along the Trinity Corridor in Dallas, and to integrate with community plans and goals for the Trinity River Floodway, a major open space resource. The study started with identification of the transportation problem and ended with the selection of a locally-preferred alternative.

The study was focused on transportation needs in the IH-30/IH-35E interchange on the west edge of downtown Dallas, locally known as the "Mixmaster," and the depressed segment of IH-30 south of the downtown, locally known as the "Canyon." The study area was enlarged beyond downtown to cover a reasonable area of influence of the Canyon and Mixmaster on area transportation facilities.

The Recommended Plan of Action, as presented in the "Study Report, Trinity Parkway Corridor, Final Report, March 17, 1998", is comprised of seven elements in the corridor, including the Trinity Parkway, extension of Woodall Rodgers Freeway, and improvements to IH-30/IH-35E. Details of the study and recommended elements can be found in the referenced document.

Of the actions included within TxDOT's recommended plan, a proposed Trinity Parkway along the Trinity River would interface extensively with existing Corps of Engineers project features, including the Dallas Floodway levees. Furthermore, the initial alignment shown in the TxDOT document would run generally parallel to the Southern Pacific Railroad tracks near Lamar Street within the DFE study area.

The transportation planning will continue for several years before being finalized. TxDOT has recognized that additional environmental studies would be needed, and it is likely that an Environmental Impact Statement would be required to address the myriad of issues that the proposal would bring forward. In addition, should any aspect of the plan involve the discharge of dredged and fill material into the waters of the United States, including adjacent wetlands, prior approval from the U.S. Army Corps of Engineers would be required. Additionally, all proposed work within the limits of the existing Dallas Floodway or the Dallas Floodway Extension, if constructed as proposed, would be evaluated and approved by the U. S. Army Corps of Engineers. The evaluation of the proposed project would ensure there are no detrimental affects on the flood carrying capacity of ability to maintain the floodway. Furthermore, any development activity within the Trinity River Corridor must obtain a Corridor Development Certificate prior to construction.

CHAPTER 3

IDENTIFICATION OF PROBLEMS AND NEEDS

CHAPTER 3
IDENTIFICATION OF PROBLEMS AND NEEDS

This chapter identifies and investigates the problems and needs of the study area with regard to flood damage reduction, recreation, and environmental resources.

IDENTIFICATION OF FLOOD DAMAGE REDUCTION NEEDS

HISTORICAL FLOOD DATA

The Trinity River frequently exceeds its channel capacity and floods its banks. A number of major floods have been recorded in the study area prior to and since the turn of the century. The flood of record occurred in May 1908 and had an estimated peak discharge of 184,000 cubic feet per second at the Dallas gage. This flood caused the death of 11 persons and produced over $5 million in damage. Significant floods and the peak discharge recorded for each are listed in table 3-1.

Table 3-1
Significant Flood Events and
Peak Discharges Recorded at Dallas Gage

Time of Significant Flood Event	Dallas Gage Discharge (CFS)
May 1908	184,000
Apr 1922	69,600
Jun 1941	77,000
Apr 1942	111,000
Mar 1945	52,900
May 1949	82,500
May 1957	75,300
May 1966	42,100
May 1969	67,000
Nov 1981	37,400
May 1989	58,700
May 1990	82,300
Dec 1991	62,200

Continued urbanization throughout the watershed is a significant factor influencing both the current and future flood problems. Various Federal and non-Federal flood control projects have been constructed to alleviate the flooding problems. Federal projects which have significantly reduced the threat to life and property include the Fort Worth and Dallas Floodways and six reservoirs.

In 1989, Dallas recorded rainfall amounts of 9.6 inches in May and 8.8 inches in June. Several lives were lost along the Five Mile Creek tributary, and damages of over $1 million were incurred. The most destructive flood event in recent years, produced from the effects of Hurricane Norma, occurred in October 1989, causing at least $6 million in damages. Over 450 homes and businesses were damaged, and an additional 30 homes were completely destroyed. Dallas County was declared a disaster area by the President. Particular details of these storm events can also be found in National Weather Service Storm Data Reports. The December 1991 flood devastated residents in the Rochester Park neighborhood for the third consecutive year, and occurred in the midst of construction of a much needed levee in the neighborhood.

Channel capacities of the Trinity River within the study area are inadequate to confine events beyond the 2-year frequency. Increased urbanization in the upper watershed area and increased vegetation growth in the primary area of concern has intensified the flooding problem.

Flood prone areas within the 100-year floodplain of the watershed were identified by FEMA in March 1984. Dallas enrolled in the National Flood Insurance Program's Emergency Program since June 19, 1970 and the Regular Program since July 23, 1971, and currently holds 2,833 flood insurance policies valued at $146,577,700.

EXISTING CONDITIONS ANALYSES

General

In order to accurately assess the need for flood damage reduction measures, an analysis of annual damages under existing conditions was performed. Due to the complexity and length of this study, the existing conditions hydrology, hydraulic, and economics models used in the initial investigation phase (1991 - 1993) were modified to reflect more recent topographic data, and changes in design and economic parameters. The phases are referenced chronologically as "1991-1993", "1994-1996", and "1996-1997". The following sections discuss the basis for the existing conditions models for each phase of this study.

1991-1993

Hydrology. The hydrology model used during this initial phase of the study was developed from the Upper Trinity River Reconnaissance Study model and expected probability water surface elevations. The watershed area was divided into 110 subareas in order to be responsive to the timing of each major tributary's runoff contribution to the total flood hydrograph and also to obtain detailed flow information (flood hydrographs) at all major points of interest on the Clear, West, and Elm Forks, as well as the mainstem of the Trinity River. The United States Army Corps of Engineers (USACE) Hydrologic Engineering Center (HEC) program "HEC-1" was used to model the hydrology of this watershed. A one-hour computation time interval was used. All reservoirs with flood control storage were assumed to be at conservation pool level at the start of frequency related storms/floods and at a level corresponding to one-third of the full flood control pool (except at Lewisville Lake which was started at 89 percent full) at the start of the USACE Standard Project Flood (SPF). All reservoirs without flood control storage were assumed to be at normal (conservation pool) level at the start of all storm/flood events. Lake Bridgeport, Eagle Mountain Lake, Lake Worth, and Lake Arlington were assumed to reside at a level corresponding to 2, 3, 2, and 3 feet, respectively, above normal (conservation pool) level at the start of the SPF event. Comparisons were made between the frequency versus discharge relationships determined based on the statistical analysis of historical data at the major streamflow gages and those based on results of the HEC-1 modeling. Adjustments were made to the rainfall losses for some subareas in order to produce a better correlation.

Hydraulics. The hydraulic analysis for this study included that portion of the Trinity River from Interstate Highway 20/635 upstream to the confluence of the West Fork and the Elm Fork of the Trinity at the upstream end of the existing Dallas Floodway. The river, within the study area, is a perennial stream characterized by a main channel with an average depth of about 30 feet, a top width of about 200 feet, and overbanks which are generally very wide and flat. The historically stable river channel has an average bottom slope of about 0.05 percent. Channel migration and bank stability problems were not revealed by an analysis of historical topographic data and aerial photographs taken periodically over the past 47 years. The overbank areas in the floodplain are generally covered with heavy vegetation. Examination of historical aerial photographs revealed that a gradual increase in the density of the vegetative cover on the floodplain areas has occurred and has led to an increase in the hydraulic roughness of the floodplain. The areas that have the greatest density of vegetation are covered with mature trees of sufficient height to extend above the water surface of the highest flood flows considered in this analysis; therefore, a consistent roughness value was assumed for all depths of flows.

The HEC-2 Water Surface Profiles computer program was used to hydraulically model and compute water surface profiles. The hydraulic model utilized topographic maps, provided by the city of Dallas, which were compiled from aerial photography flown in March 1977. These maps were updated to reflect the contours of two city landfills completed after 1977. Channel geometry was input from surveyed cross sections used in previous Trinity River hydraulic models. The White Rock Creek confluence with the Trinity River and the low-lying residential areas north of the Rochester Park Levee store significant volumes of flood water during major flood events, and separate HEC-2 models were created to more accurately represent these storage volumes in the computation of peak discharges for the various flood events.

Economics. Detailed economic investigations and analyses were conducted in connection with this study. The principal purpose of these economic analyses was to identify the extent of the flood problem and, on a comparable basis, evaluate solutions to reduce flood losses. These analyses were conducted following procedures and guidelines as set forth in the Water Resources Council's Principles and Guidelines (March 10, 1983).

As part of these activities, field surveys were conducted to identify the numbers and types of property, as well as the market value of the investment, affected by flooding. Damageable property and costs associated with flooding are divided among five damage categories, as shown in table 3-2.

A full range of water surface profiles based on existing stream conditions were provided by the hydrology and hydraulics models, as described above. These profiles were used to delineate the floodplain limits and determine the relationship of damageable properties to both elevation and frequency of flood occurrence.

Table 3-2
Major Damage Categories

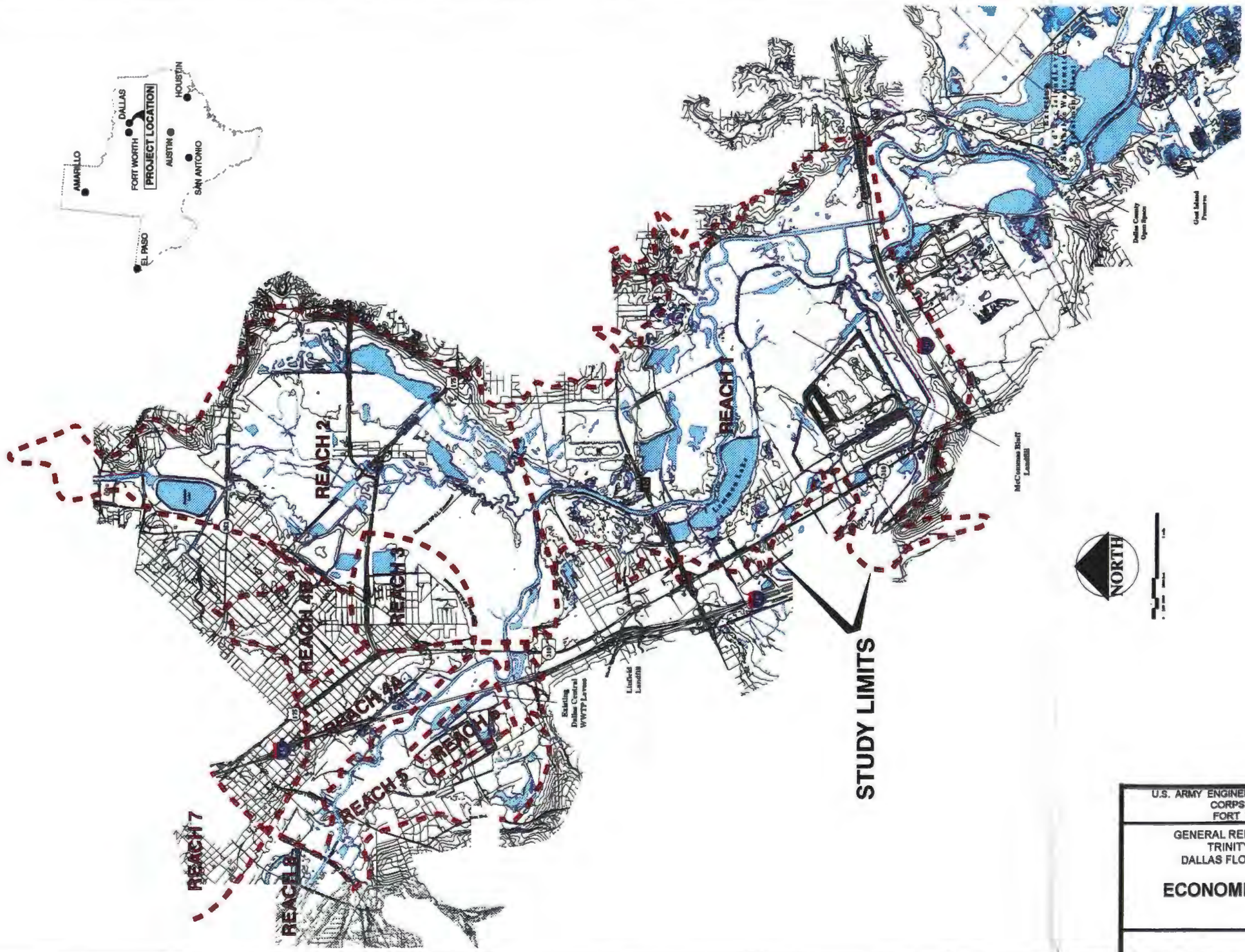
Damage Category	Activity Description
Residential	Single and multi-family dwellings
Commercial and Industrial	Retail and wholesale businesses
Public	Public and quasi-public buildings
Flood Insurance Administration	Costs to the public for flood insurance program administration
Other:	
Transportation	Streets, highways, and bridges
Communications and Utilities	Electrical, gas, telephone, sewerage, and water supply facilities and buildings
Public Health and Relief	Flood-fighting and related emergency management activities

Although the primary area of investigation is defined as that portion of the Trinity River between the confluence of Five Mile Creek near IH-20 downstream and the terminus of the existing Dallas Floodway Levees upstream, preliminary analysis revealed significant hydraulic correlations between the extension area and the leveed area upstream. Consequently, about eight miles of the existing Dallas Floodway was included in the study area. These primary and secondary study areas were further subdivided into reaches based on concentrations of damageable properties. The primary study area is defined as reaches 1 - 6, while the secondary study area includes reaches 7 and 8. These reaches are shown in figure 3-1 and defined as follows:

- **Reach 1 (Sleepy Hollow):** Extends from the confluence of White Rock Creek south eastward to the confluence of 5-Mile Creek. The reach is bounded by IH-20, the MKT Rail Road, and Linfield and Riverwood Roads. This reach includes the Sleepy Hollow Golf Course located near the river and Loop 12. The land use includes commercial, industrial, residential, and public facilities. The McCommas Bluff and Linfield landfill sites are located in this reach. The total investment value of this reach was estimated at $32 million.

- **Reach 2 (White Rock):** Includes a portion of the White Rock Creek Tributary from IH-30 upstream to its confluence with the Trinity River near Linfield Street. The reach is further bounded by Pemberton Road, IH-30, the Southern Pacific Railroad and the Rochester Park Levee. Land use includes single and multi-family residential, commercial and industrial properties. The total investment value of this reach was estimated at $7 million.

- **Reach 3 (Rochester Park):** This reach is located near the center of the study area and is predominately enclosed along its southern border by the Rochester Park Levee. The reach is further bounded by Hwy. 175 (Hawn Freeway), and Hwy. 310 (Central Expressway). The land use is predominately single and multi-family residential and a few commercial and public properties. The total investment value of this reach was estimated at $55 million.



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GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

ECONOMIC REACH MAP

FIGURE 3-1

- **Reach 4A (Lamar):** This reach (initially combined with reach 4B) is located within the SPF floodplain limits along the east bank of the Trinity River. Beginning near the intersection of Lamar Street and Hwy. 175 and continuing northerly upstream to the AT & SF railroad. The reach is bounded on the east by Hwy. 310 (Central Expressway). The major land use categories include residential, commercial and industrial facilities. The total investment value of this reach was estimated at $45 million.

- **Reach 4B (Oakland Channel):** This reach (initially combined with reach 4A) is located parallel and to the east of Reach 4A. It is bounded by Hwy. 310 and Second Avenue. The Oakland Channel, which flows into White Rock Creek is located within this reach. The primary land use categories are single and multifamily residential and some commercial facilities. The total investment value of this reach was estimated at $217 million.

- **Reach 5 (Cadillac Heights):** Located on the West Bank of the Trinity River, the SPF limits of this reach extends from IH-45 to the AT&SF Railroad at the end of the existing Dallas Floodway. This area includes single-family residential, commercial, industrial and public properties. The total investment value of this reach was estimated at $27 million.

- **Reach 6 (Treatment Plant):** This reach is located downstream of Reach 5 and consists solely of the Central Wastewater Treatment Plant facility. This public facility represents the greatest single investment in the study area. The total investment value of this reach was estimated at $459 million.

- **Reach 7 (East Levee):** This reach, located upstream of the primary study area, encompasses the SPF flood plain limits protected by the East Levee of the existing Dallas Floodway System. The area includes the Central Business District and a mixture of all land use categories. Commercial facilities dominate the reach (69 percent) with almost 1982 structures. A total of 2,885 structures were identified with an estimated value of over $4.8 billion.

- **Reach 8 (West Levee):** This reach, located upstream of the primary study area, encompasses the SPF flood plain limits protected by the West Levee of the existing Dallas Floodway. The area includes all land use categories - residential, commercial and industrial, and public facilities. Residential structures account for over 90 percent of the land use in this reach with over 6,900 identified. A total of 7,700 structures were identified with an estimated value of over $934 million.

Estimates of expected annual damages under existing conditions were calculated through integration of frequency-damage data. Generally, this involved multiplication of the mean damages between each pair of flood events by the difference in exceedance probabilities for that pair of events, repeated over the entire range of flood events through the SPF, for each category of damageable property. Incidental damages (comprising transportation, communications and utilities facilities, and public health and relief operations) were estimated on the basis of the historical information submitted by the local sponsor documenting Federal Emergency Management Agency (FEMA) claims.

Initial estimates of existing flood damages and benefits presented herein reflect June 1993 prices and level of development. The prevailing Federal interest rate of 8.0 percent was applied to convert first costs and undiscounted future damages and benefits to average annual equivalent values. A 50-year period of analysis was used, extending from 1997 to 2047. The STDMA Flood Damage Program was used to determine single event and expected annual damages (EAD). The total equivalent annual flood losses in the study area were estimated at over $20.8 million, based on June 1993 prices, and the prevailing Federal interest rate of 8.0 percent. This information is detailed by reach in table 3-3.

Table 3-3
Expected Average Annual Damages
(June 1993 prices and level of development, 8.0% interest, 50-year period of analysis)

Reach	Annual Damages			Description
	Direct	Incidental	Total	
1	$311,800	$32,427	$344,200	Below White Rock
2	$53,300	$5,543	$58,800	White Rock
3	$166,300	$17,295	$183,600	Rochester Park
4	$1,741,100	$181,074	$1,922,200	Lamar/Oakland Area
5	$1,086,900	$113,038	$1,199,900	Cadillac Heights
6	$1,930,800	$200,803	$2,131,600	Treatment Plant
Subtotal	$5,290,200	$550,181	$5,840,300	Study Area
7	$11,800,000	$1,227,200	$13,027,200	East Levee
8	$1,7968,000	$186,867	$1,983,700	West Levee
Subtotal	$13,596,800	$1,414,067	$15,010,900	Upstream Levees
Total	$18,887,000	$1,964,248	$20,851,200	

1994-1996

Hydrology and Hydraulics. The hydrology and hydraulic models were updated to incorporate the results of the Upper Trinity River Feasibility Study, which utilized more recent topographic maps developed from aerial photography flown in February 1991, estimated to have an accuracy of plus or minus 0.5 feet. Therefore, models for this study are a subset of the models used for the Upper Trinity Feasibility Study, thereby maintaining consistency between the two studies. A calibration of these models was accomplished by the methods described in Appendix A, to closely match the May 1990 Flood.

Baseline conditions were assumed to represent estimated watershed development for the year 2000, based on land use data obtained from the North Central Texas Council of Governments (NCTCOG), and "percent urbanization" and "percent imperviousness" for each subarea as derived from the Geographic Information System (GIS).

The development of the baseline model was based on the requirements of the Upper Trinity River Feasibility Study that certain projects which influence the hydraulic and hydrologic conditions within the floodplain would be incorporated into the HEC-2 model to form a basis for future hydraulic studies within the Trinity River corridor. The following projects are future permitted projects and/or projects constructed, or under construction, since the 1991 aerial photography and mapping was completed. All landfills have been represented as completed.

- Southside Sewage Treatment Plan Levee modification
- McCommas Bluff Landfill and Swale
- Rochester Park Levee
- Central Wastewater Treatment Plant Levee modification
- DART OC-2 Rail Line Bridge
- Dixie Metals Company Landfill
- Dallas Floodway channel and levee modifications (AT&SF Railroad bridge to Houston Street bridge)
- Various small permitted fill areas

A complete description of the hydrologic and hydraulic analysis for this baseline condition and corresponding water surface profiles are presented in Appendix A.

Economics. The expected annual damages for this baseline condition were revised based on the modifications to the hydrology and hydraulics models, as described above, and on supplemental data gathered from surveys and the Dallas County Appraisal District for the Upper Trinity Feasibility Study. In addition, a risk-based analysis was incorporated, in accordance with recent USACE guidelines. The NexGen Hydrologic Engineering Center-Flood Damage Assessment (HEC-FDA) program integrates hydrologic engineering and economic analysis through application of the Monte Carlo simulation, calculates stage-damage-uncertainty information at damage reach index locations, and computes equivalent annual damages. The revised expected annual damages for baseline conditions, based on October 1995 prices and a prevailing Federal interest rate of 7.63 percent, are shown in table 3-4.

Traditional expression of the frequency of flood events has been in terms of the recurrence interval in years, such as, the "100-Year Flood". The more appropriate expression of the probability of a particular flood magnitude is in terms of "percent chance exceedance", especially as it relates to a risk-based analysis. Therefore, the "100-Year Flood", which is defined as "the magnitude of flooding which has a 1 percent probability of being equaled or exceeded in any given year" would be expressed as the "1 percent chance flood". For comparison purposes, the nine flood events computed for this study, traditionally referred to as the 1-year, 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 500-year, and the Standard Project Flood (SPF), would be referred to, in probabilistic terms, as the 99 percent, 50 percent, 20 percent, 10 percent, 4 percent, 2 percent, 1 percent, 0.2 percent chance flood, and the SPF, respectively. Although the analyses contained herein were performed as risk-based analyses, results of these investigations are expressed in traditional terms for the benefit of the reader.

Table 3-4
Revised Expected Average Annual Damages
(October 1995 prices and level of development, 7.63% interest, 50-year period of analysis)

	Annual Damages			
Reach	Direct	Incidental	Total	Description
1	$338,200	$35,173	$373,400	Below White Rock
2	$58,400	$6,074	$64,500	White Rock
3	$168,000	$17,472	$185,500	Rochester Park
4	$1,853,800	$192,795	$2,046,600	Lamar/Oakland Area
5	$986,000	$102,544	$1,088,500	Cadillac Heights
6	$1,254,200	$130,437	$1,384,600	Treatment Plant
Subtotal	$4,658,600	$484,494	$5,143,100	Study Area
7	$12,131,000	$1,261,624	$13,392,600	East Levee
8	$1,102,400	$114,650	$1,217,000	West Levee
Subtotal	$13,233,400	$1,376,274	$14,609,600	Upstream Levees
Total	$17,892,000	$1,860,768	$19,752,700	

1996-1997

Hydrology and Hydraulics. The major change instigating the need for a revised hydraulic model during this phase of the study was the passage of the Water Resources Development Act (WRDA) of 1996, in October 1996. Section 351, contained therein, provided that the city of Dallas would be granted credit for the portions of two previously constructed non-Federal levees deemed compatible with the Federal plan. These levees included the Rochester Park Levee and the modifications to the Central Wastewater Treatment Plant (CWWTP) Levee, and were constructed by the city of Dallas in response to the floods of 1989-1991. Section 351 states the following:

> *(a) IN GENERAL -- The project for flood control, Dallas Floodway Extension, Dallas, Texas, authorized by section 301 of the River and Harbor Act of 1965 (79 Stat. 1091), is modified to provide that flood protection works constructed by the non-Federal interests along the Trinity River in Dallas, Texas, for Rochester Park and the Central Wastewater Treatment Plant shall be included as a part of the project and the cost of such works shall be credited against the non-Federal share of project costs.*
>
> *(b) DETERMINATION OF AMOUNT. -- The amount to be credited under subsection (a) shall be determined by the Secretary. In determining such amount, the Secretary may permit credit only for that portion of the work performed by the non-Federal interests that is compatible with the project referred to in subsection (a), including any modification thereof, and that is required for construction of such project.*
>
> *(c) CASH CONTRIBUTION.– Nothing in this section shall be construed to limit the applicability of the requirement contained in section 103(a)(1)(A) of the Water Resources Development Act of 1986 (33 U.S.C. 2213(a)(1)(A)) to the project referred to in subsection (a).*

In order to accurately assess the economic benefits associated with these levees, it was necessary to revise the existing conditions hydraulics model to reflect the characteristics of the study area prior to 1991 when the construction of these levees was initiated. Water surface profiles derived from this revised model are presented in Appendix A.

Economics. Table 3-5 displays the numbers and estimated total values of properties (structures and contents) located within the study area after applying the revised hydraulic model. A total of 2,550 structures were identified within the SPF limits. As shown, the total flood plain investment within the SPF limits of the primary study area is valued at over $641.0 million based on January 1997 prices.

Expected annual damages were tabulated for the final phase, utilizing the HEC-FDA program, based on the aforementioned revisions, and on the current prevailing Federal interest rate of 7.375 percent. Incidental damages, comprised of transportation, communications and utilities facilities, and public health and relief operations, were added to the results to obtain the total expected annual damages.

Table 3-6 shows the total expected annual damages for the SPF floodplain under these revised existing conditions. The primary study area could expect damages totaling over $6.5 million and the secondary study area over $13.1 million. The combined expected annual damage exceeds $19.6 million.

Table 3-5
Total Floodplain Investments by Reach
Under Existing Conditions
(January 1997 Prices and Level of Development)
(1,000's $)

Reach	Single-Family Residential		Multi-Family Residential		Commercial/ Industrial		Public		Total Structure Investment		Vehicles	Rail	Total Investment
	No.	*Value*	*No.*	*Value*	*No.*	*Value*	*No.*	*Value*	*No.*	*Value*	*Value*	*Value*	*Value*
Primary Study Area													
1	73	1,768.3	0	0.0	26	22,876.1	3	2,558.8	102	27,203.2	192.9	4,443.8	31,839.9
2	68	4,339.9	3	476.1	19	1,707.7	0	0.0	90	6,523.7	430.9	0.0	6,954.6
3	247	6,463.4	112	9,234.0	8	199.0	4	36,651.5	371	52,547.9	2,021.0	0.0	54,568.9
4A	107	2,715.3	6	382.0	68	34,194.2	0	0.0	181	37,291.5	345.3	7,063.1	44,699.9
4B	1,432	34,189.1	0	0.0	61	5,102.8	4	177,768.0	1497	217,059.9	0.0	0.0	217,059.9
5	228	6,630.1	0	0.0	66	18,006.2	0	0.0	294	24,636.3	742.8	1,623.0	27,002.1
6	0	0.0	0	0.0	0	0.0	15	458,878.6	15	458,878.6	0.0	0.0	458,878.6
	Area Total												
	2,155	$56,106.1	121	$10,092.1	248	$82,086.0	26	$675,856.9	2,550	$824,141.1	$3,732.9	$13,129.9	$841,003.9
%	84.5%	6.7%	4.7%	1.2%	9.7%	9.8%	1.0%	80.4%	100.0%		0.4%	1.6%	100.0%
Secondary Study Area													
7	869	75,871.6	3	1,691.3	1,982	4,553,940.5	31	$220,968.8	2,885	$4,852,472.2	$5,058.1	N/A	$4,857,530.3
8	6,493	$297,262.5	474	$110,933.0	642	$440,403.4	94	$58,497.6	7,703	$907,096.5	$27,221.7	N/A	$934,318.2
	Area Total												
	7,362	$373,134.1	477	$112,624.3	2,624	$4,994,343.9	125	$279,466.4	10,588	$5,759,568.7	$32,279.8	$0.0	$5,791,848.5
%	69.5%	6.4%	4.5%	1.9%	24.8%	86.2%	1.2%	4.8%	100.0%		0.6%	0.0%	100.0%
Total Investment													
	9,517	$429,240.2	598	$122,716.4	2,872	$5,076,429.9	151	$955,323.3	13,138	$6,583,709.8	$36,012.7	$13,129.9	$6,632,852.4

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Table 3-6
Expected Annual Damages
Under Existing Conditions (Pre-1991)
(January 1997 prices and level of development, 7.375% interest, 50-year period of analysis)

Reach	Annual Damages			Description
	Direct	Incidental	Total	
1	$294,200	$54,271	$348,900	Below White Rock
2	$50,800	$9,449	$60,200	White Rock
3	$431,500	$80,259	$511,800	Rochester Park
4A	$1,350,000	$251,100	$1,601,100	Lamar Area
4B	$741,100	$137,845	$878,900	Oakland Area
5	$1,085,700	$201,940	$1,287,600	Cadillac Heights
6	$1,696,300	$162,845	$1,859,100	Treatment Plant
Subtotal	$5,649,600	$898,159	$6,547,600	Study Area
7	$10,054,700	$1,870,174	$11,924,900	East Levee
8	$998,500	$185,721	$1,184,200	West Levee
Subtotal	$11,053,200	$2,055,895	$13,109,100	Upstream Levees
Total	$16,702,800	$2,954,054	$19,656,700	

IDENTIFICATION OF RECREATIONAL NEEDS

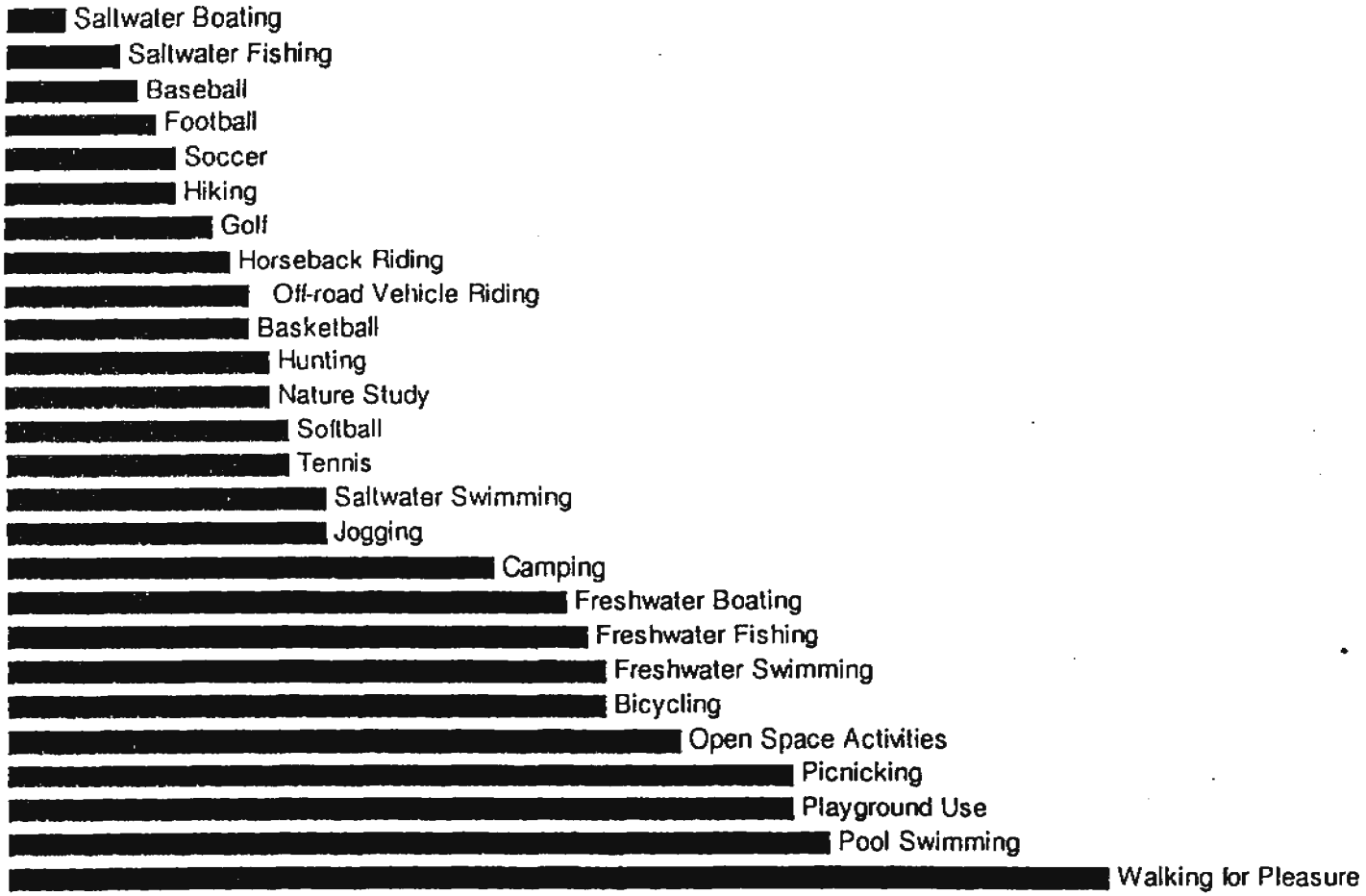
Open space and outdoor recreational facilities which currently exist within the study area are discussed in a preceding section of this report. While there are substantial amounts of open space and recreational facilities available to the residents of the area, projections show that the demand for these facilities is continuing to increase. Table 3-7 and figure 3-2 show the most popular outdoor recreational activities which were expected to occur in Region 4 in years 1995, and 2000, as projected in the 1990 Texas Outdoor Recreation Plan (TORP). Participation will increase for each projection year. Fresh water fishing, swimming, and picnicking will attract the most participation in the region for resource based activities. Participation in urban oriented activities projected for 1995 were over eight times as high as the participation in resource based activities in the region. This ratio is one of the highest in Texas. Texans from outside Region 4 will have little impact on the region's resources.

Table 3-8 shows regional facility needs for 13 of the 18 commonly used facilities/resources by 1995. Increases of more than 100 percent over existing supply are needed for five facilities (hiking, horseback, and multi-use trails, playgrounds, and freshwater swimming areas). Table 3-9 ranks the outdoor recreation needs within the region. Multi-use trails are the highest need followed by freshwater swimming, playgrounds, and hiking trails. Public recreation providers in the region have repeatedly expressed a need for more parks and passive open space. In recent years, park land and open space have become increasingly scarce as available sites have been reduced. Rapid development has replaced many natural areas with buildings and pavement. Needed lands shown in table 3-8 represent only the acres required to develop recreational facilities. Most park providers have identified undeveloped land as their highest priority need (park sites, open space, and greenbelt acquisition). The next greatest need expressed is for upgrading and renovating existing facilities.

Table 3-7
Projected Urban Outdoor Recreation Participation for Region 4

Activity/Facility Use	Project Participation (in 1000's Annual User Occasions)		
	1990	1995	2000
Baseball	4,852	4,882	5,183
Basketball	5,662	6,020	6,379
Bicycling	41,405	44,140	46,880
Bicycling on Trails	2,551	2,719	2,888
Football	2,673	2,870	3,068
Golf	5,268	5,781	6,295
Horseback Riding	3,054	3,255	3,456
Horseback Riding on Trails	784	835	887
Jogging/Running	19,073	20,055	21,039
Jogging/Running on Trails	5,875	6,177	6,480
Off-road Vehicle (ORV) Riding	5,374	5,723	6,074
ORV Riding on Trails	1,053	1,121	1,190
Open Space Activities	13,358	14,076	14,794
Playground Use	19,374	20,435	21,497
Soccer	5,748	6,073	6,398
Softball	6,607	6,911	7,217
Swimming, Pool	24,685	26,216	27,749
Tennis	5,732	6,132	6,533
Walking (Pleasure/Exercise)	57,876	63,100	68,330
Walking on Trails	13,549	14,772	15,996

Source: 1986 Participation Survey, Parks Division, TPWD, 1987.



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TRINITY RIVER, TEXAS
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MOST POPULAR OUTDOOR RECREATION ACTIVITIES

FIGURE 3-2

Table 3-8
Additional Urban Outdoor Recreation Facilities/Resources Needed in Region 4

Facility/Resource	1986 Facility Supply	Facilities Needed Above 1986 Supply		
		1990	1995	2000
Baseball Fields	310	24	46	68
Basketball Goals	469	214	258	301
Boat Ramp Lanes	423	*	*	*
Campsites	5,393	*	*	*
Fishing Structures, (yd.)	8,167	316	967	1,619
Golf Holes	666	*	28	89
Hiking Trail Miles	23	63	69	76
Horseback Riding Trail Miles	31	81	89	96
Lake Acres (BFS Suitable)	165,749	*	*	*
Off-Road Vehicle Riding Acres	2,899	*	*	*
Picnic Tables	8,947	*	*	*
Playground Acres, Equipped	915	930	1,031	1,133
Soccer/Football Fields	564	103	118	134
Softball Fields	478	*	16	37
Swimming, Freshwater (1000 yd^2)	390	1,029	1,100	1,170
Swimming, Pool (1000 yd^2)	90	67	77	87
Tennis Courts	877	621	726	830
Trail Miles, Multi-Use (Walk,Bike,Jog)	118	263	292	322
Developed Land, Acres		4,572	5,457	6,709

** Indicates no needs exist based on a regional analysis of supply and participation; however, needs may exist locally within the region due to inadequate distribution of existing facilities.*

Source: Parks Division, TPWD, 1988

Table 3-9
Ranking of Outdoor Recreation Facility/Resource Needs in Region 4 through 1995

Need by Rank	Facility/Resource
1	Trail Miles, Multi-Use (Walk, Bike, Jog)
2	Swimming, Freshwater (1000 yd^2)
3	Playground Area, Equipped
4	Hiking Trail Miles
5	Horseback Riding Trail Miles
6	Soccer/Football Fields
7	Swimming, Pool (1000 yd^2)
8	Tennis Courts
9	Basketball Goals
10	Baseball Fields
11	Golf Holes
12	Fishing Structures, Freshwater (yd.)
13	Softball Fields
14	Boat Ramp Lanes, Freshwater
15	Campsites
16	Picnic Tables
17	Off-Road Vehicle Riding Acres
18	Lake Acres (BFS Suitable)

Source: Parks Division, TPWD, 1988.

The City of Dallas and the Dallas County Open Space Board have specific plans to acquire additional lands to meet future public recreational demands. Proposed acquisitions are often dependent on the availability of public funds and are influenced by private development pressures and development permit approvals. Both the City and the County have bond funded open space acquisition programs. The recent slump in the Texas economy has temporarily suppressed rising land costs, making the present a very good time to pursue needed acquisitions.

As would be expected, river and creek segments which have had trees and shrubs removed, have been channelized, lined with levees, or heavily developed are less desirable and the least utilized by area canoeists, bicyclists, hikers, and bird watchers. Many of these channelized and leveed river segments offer recreation potential but will need to be enhanced with river access points, trails, play areas, sports fields, tree and shrub plantings and wildlife habitat improvements in order to attract recreational users to the floodway.

Without exception, the recreational master plans and sector plans of the cities and counties with jurisdiction along the Trinity River call for utilization of the flood plain for open space, linear parks, access areas, active and passive use areas, interpretive areas, natural areas, "urban wilderness" areas, and a system of linked hiking, biking and equestrian trails. A regional goal is to tie public lands and open space within the Trinity Corridor and its tributaries from Lewisville Lake, Lewisville, Coppell, Carrollton, Irving, White Rock Lake, Dallas, Grand Prairie, Mountain Creek Lake, Joe Pool Lake, Arlington, Fort Worth, Lake Worth, Benbrook Lake and other publicly owned areas. The cities have expressed interest in exploring Federal cost sharing options for acquiring riparian forests, open fields and wetlands which border the Trinity River and its tributaries, and have encouraged the Corps to consider the full potential for cost sharing in the acquisition of natural areas and open space, and in the construction of recreational facilities in conjunction with structural and nonstructural flood protection alternatives.

Working toward a system of parks, recreational areas, and linear trails along the Trinity is an integral portion of the North Central Texas Council of Government's ***Common Vision*** work program. NCTCOG has identified the Trinity River Corridor as a "unique regional resource." The value of this resource is increased because of its location within the heart of a growing Metroplex. The 100-mile long corridor encompasses the SPF flood plain of the West Fork above Eagle Mountain Lake and the Clear Fork from Benbrook to the Elm Fork, and along the Elm Fork from Lewisville Lake through the mainstem of the river, with its major tributaries, downstream to south Dallas.

While there are obviously conflicts between desires to reclaim the flood plain or preserve it, there is room within the 70,000 acres of the Corridor for both of these desires to be met. "The Trinity River Corridor is valuable to all 4 million residents of the Region and the millions to come." (NCTCOG, 1989)

The North Central Texas Council of Governments (NCTCOG) is pursuing a Trinity Greenbelt of major parks linked by a regional trail system. According to NCTCOG, "Tens of thousands of acres of open space are being preserved within the river corridor with outstanding potential for active and passive recreation. Using the Trinity River Information Network, local park departments and recreational professionals will prepare a realistic Trinity Greenbelt strategy of major parks linked by a regional trails system." It is the intent of NCTCOG to implement a "world class" Trinity Greenbelt strategy.

Local bicycle, equestrian, and conservation groups have shown a keen interest in the development of trails as part of a recreation plan for the study area, and have offered many recommendations for consideration. These recommendations are presented in appendix f.

IDENTIFICATION OF ENVIRONMENTAL NEEDS

The Dallas-Fort Worth Metroplex has experienced extensive urban development, and expansion continues into surrounding counties. The need to provide protection against ravaging floods in these areas has escalated along with the new development, as continually increasing areas of impervious surfaces associated with rooftops, parking lots, and highways yields greater volumes of storm water runoff. In addition, local drainage programs tend to increase the speed of runoff, thereby necessitating on-going improvement of flood control features. Within the Metroplex, the Corps of Engineers has constructed Benbrook, Joe Pool, Grapevine, Lewisville, and Ray Roberts Lakes, all of which are multi-purpose projects providing flood damage reduction benefits to the area. In addition, the Corps has constructed the Fort Worth and Dallas Floodways, which are composed of levees and channels, that provide needed protection for the downtown business districts of the respective cities.

With the exception of Joe Pool Lake and Lake Ray Roberts, these projects were constructed prior to the enactment of legislation requiring environmental review. Joe Pool Lake and Lake Ray Roberts were authorized prior to Corps authorities to mitigate environmental losses. Review of available information 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 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 for 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 floodplain, and only 745 acres within the Standard Project Flood zone. Even without a definitive historic record of emergent wetlands losses within the area prior to the major Corps construction activities, it is clear that significant losses have occurred. These losses to wetlands adjacent to the riparian woodlands in the form of scars, seeps and cutoffs have also impacted many species of migratory shore birds, wading birds, reptiles, and amphibians. From a resource protection standpoint, it could be easily argued that priorities should be established for efforts to maintain and improve the integrity of bottomland hardwood forests because of their ecological significance, their visibility and appeal to observers, and the length of time required to re-establish a mature forest. Emergent wetlands also have ecological significance and can be established comparatively quicker than forests; therefore, annualized benefits can be quite high. Furthermore, emergent wetlands can be established in conjunction with other project features without inducing flood damages or compromising flood reduction benefits.

In summary, natural habitat in the area has given way to increased urbanization, making the remaining natural habitat more important. Accordingly, future actions should focus on protecting and enhancing the remaining natural environment of the area. Any fish, wildlife and environmental mitigation plan to be proposed for impacts that would accrue to bottomland hardwood forests will be based upon recognition of the importance of offsetting unavoidable losses to this significant habitat.

CHAPTER 4

PLAN FORMULATION

CHAPTER 4
PLAN FORMULATION

This chapter details the steps that were taken to formulate a plan which best meets or exceeds the planning objectives as set forth below. The formulation of a plan to resolve the flood related problems and needs necessitated the exploration of possible alternative measures, including structural and non-structural solutions. Beneficial and adverse contributions of each alternative were evaluated against existing conditions.

As stated previously in this report, the plan formulation process was performed in three phases, each predicated by changes deemed significant enough to necessitate reevaluation and revision of existing conditions hydrology, hydraulic and/or economic models. These changes included, but were not limited to, the availability of more recent technical data, the addition of risk-based analysis requirements, and the passage of legislation providing for inclusion of previous non-Federal construction in the Federal plan. Two of these phases were completed during the development of the NED Plan, while the third was initiated during selection of the Locally Preferred Plan (LPP).

PLANNING OBJECTIVES

Planning objectives are an expression of public and professional concerns about the use of water and related land resources resulting from the analysis of existing and future conditions in the study area. These planning objectives were used in guiding the development of alternative plans and their evaluation for the 1997 to 2047 period of analyses.

Legislation requires that Federal water and related land resources planning be directed at contributing to National Economic Development (NED), consistent with protecting the Nation's environment. Contribution to NED is achieved by increasing the net value of the nation's output of goods and services, expressed in monetary units. NED contributions must also consider the environmental effects of proposed changes on ecological, cultural, and aesthetic attributes of natural and cultural resources.

Plans formulated as part of this study were evaluated based on their contribution to the National Economic Development, and they are consistent with protection of the Nation's environment. In addition to these National objectives, additional planning objectives evolved from meetings with area residents, from contact with the local sponsor, State and Federal agencies, and from observations made in the area. Specific needs, desires, and goals of the community were identified. The planning objectives for the Dallas Floodway Extension General Reevaluation study are as follows:

- Reduce flood damages, provide better health and safety measures, reduce emergency services, reduce potential for loss of life due to high velocity flows, reduce isolations caused by flood waters, reduce overtopping of bridges and roads along the Trinity River, and reduce the loss of jobs and/or wages caused by flooding from the Trinity River within the city of Dallas.

- Preserve and protect existing environmental and aesthetically pleasing areas and maintain, as much as possible, the existing vegetation and wildlife habitat along the Trinity. The channel portion of the Trinity River is possibly the largest remaining natural channel within Dallas.

- Preserve and/or protect historically and culturally significant areas.

PLANNING CONSTRAINTS

In order to provide direction for the plan formulation efforts, maximize good impacts, minimize bad impacts, and reflect restrictions of the General Investigation Program, the following constraints were taken into account:

- Flood control projects which solve problems in one area but compound them in others should be avoided, unless overriding public interest favors implementation of such a plan.

- Total benefits must exceed total costs for a plan to be implemented with the Corps of Engineers as a participant, unless a specific exception is granted to allow such participation.

FORMULATION AND EVALUATION CRITERIA

Consideration was given to economic, social, and environmental impacts for each alternative during the development of long term solutions to the flood problems within the Trinity River watershed. Appropriate Corps of Engineers engineering and design manuals, criteria, and regulations relating to flood control channels, outlet works, embankment, streamflow routing, backwater computation, cost estimates, environmental mitigation, environmental restoration, recreation features, etc., were used in developing alternative plans.

TECHNICAL CRITERIA

Alternative plans must be feasible, practicable, and soundly engineered to provide a project life of at least 50 years. Existing facilities should be utilized to the maximum extent possible. The plan should be complete within itself and not require additional future improvements other than normal operation and maintenance.

ECONOMIC CRITERIA

The NED objective is the maximization of the economic worth of alternative plans as set forth in *Principles and Guidelines for Planning Water and Related Land Resources Implementation Studies*. The NED objective is to increase the nation's output of goods and services and improve national economic efficiency. For flood control projects, this objective relates to a plan's capability to prevent flood damages by comparing the plan's economic benefits with the project cost. The amount that a project's economic benefits exceed the project cost is defined as net benefits. In the plan formulation process, the plan that yields the greatest net benefits best meets the NED objective.

The plan selected as the recommended plan should seek to provide a maximum of net benefits, unless certain provisions can be applied to supercede this criteria. One such provision, stated in Planning Guidance Letter 97-10, allows a locally preferred plan to be selected as the recommended plan if the plan yields greater net benefits than any smaller scale alternative. In such instances, larger scale plans need not be investigated in an effort to identify the NED Plan. The other provision allowing recommendation of a plan other than the NED Plan involves the granting of an exception by the Assistant Secretary of the Army (Civil Works). Such an exception may be granted for an economically justified plan when overriding and compelling reasons favor the selection of such a plan. Recommended plans which are less costly than the NED Plan would be cost shared on the same basis as the NED Plan. Federal participation in a recommended plan which is more costly than the NED Plan would be limited to the Federal share of the NED Plan, unless the increased development is deemed worthy of warranting Federal participation, and is specified as such in the exception. Cost sharing would then be calculated on the same basis as the NED Plan.

To meet the Federal guidelines for planning water resource projects, the following economic criteria were followed:

- The recommended plan must be economically feasible, i.e. the plan's benefits must exceed the cost of the plan.
- Alternative plans must be evaluated using the current Federal interest rate and price levels, and a 50-year period of analysis.
- Annualized costs must include the cost of operation and maintenance.

Economic feasibility of a plan is displayed as a relationship of benefits to costs, expressed in terms of a benefit-cost ratio (BCR). Identified as benefits are the monetary savings or benefits due to damages prevented, reduction in the cost of emergency services, and reduction of economic disruption. These project benefits are subsequently annualized to represent an annual benefit applicable for the life of the project. The project cost, which includes the construction or first cost, the interest on the first cost during construction, the operation and maintenance costs, and the interest to amortize the project cost over the life of the project are also annualized to represent an annual project cost applicable for the analysis period of the project. The annual benefits and the annual costs are then related in a ratio of benefits to costs. To be economically feasible, a plan must have greater benefits than costs or, more specifically, a BCR greater than 1.0.

ENVIRONMENTAL AND SOCIAL CRITERIA

Plans formulated under Federal directives should be consistent with protecting and enhancing the existing environment by the management, conservation, preservation, creation, or improvement of the quality of certain natural and cultural resources and ecological systems in the proposed project area. Structural and non-structural measures must be evaluated in accordance with guidelines established by the National Environmental Policy Act of 1969 (Public Law 91-190), as amended, and the *Principles and Guidelines for Water and Related Land Resources Implementation Studies*, as developed by the U.S. Water Resources Council, dated July 1983. The following environmental and social criteria were considered:

- Promote the protection and enhancement of areas of natural beauty and human enjoyment.
- Protect areas of valuable natural resources.
- Protect quality aspects of water, land, and air resources in the watershed.
- Protect against possible loss of life and hazards to health.
- Promote safety
- Preserve and enhance social, cultural, educational, and historical values within the project area.
- Minimize and, if possible, avoid the displacement of people and destruction or disruption of community cohesion.

IDENTIFICATION OF THE NED PLAN

The following sections provide a chronological review of the plan formulation process for the development of the NED plan for this study. This process included a preliminary analysis of alternatives, an In-Progress Review (IPR) meeting, and a final analysis of NED alternatives.

INITIAL SCREENING OF ALTERNATIVES

An extensive number of non-structural and structural flood damage reduction alternatives were investigated from the study initiation in January 1991 through July 1993. During this time frame, environmental restoration was not a desired project feature of either the local sponsor or special interest groups. During this period, the focus of all environmental concerns was directed primarily toward minimization of impacts to bottomland hardwoods.

Investigated Non-Structural Alternatives

The objectives of non-structural measures are to avoid flood damages by removal of damageable properties from the flood prone areas, and to manage the development of the floodplain in a manner that will minimize flood damage. The full range of non-structural alternatives includes no action, floodplain management, flood warning, flood proofing, structure relocation, and permanent evacuation.

No Action Plan. The fundamental alternative to any flood control plan is the no action plan. Adoption of this alternative implies acceptance of the costs and adverse effects of continued flooding. For the city of Dallas, these estimated costs equate to over $6,500,000 annually. In addition, the residents would continue to suffer from the social and economic stresses associated with repetitive flooding and the potential for loss of life. Although citizens with flood insurance would be partially compensated for future damages, these damages would nonetheless continue to occur and Federal funds would continue to be expended in the flood insurance program and in federal emergency flood assistance and relief. The no action plan is recommended only when no other solutions are feasible or when environmental damage would be irreparable.

Floodplain Management. Effective floodplain management is dependent on the development of enforceable regulations which insure that uses of floodplain lands are compatible with the level of flood hazard. Several means of regulation are available to control future development, including zoning ordinances, subdivision regulations, and building codes.

Zoning ordinances promote prudent use and development of the floodplain to prevent excessive property damage, expenditure of public funds, inconvenience, and loss of life due to flooding. Subdivision regulations guide the division of large land parcels into smaller lots and requires proof of compliance with other regulations and ordinances. A subdivision ordinance with special reference to flood hazards would require installation of adequate drainage facilities, prohibit encroachment in floodway areas, require the placement of critical streets and utilities above a selected flood elevation, and require that building lots be filled or structures be elevated above a selected flood elevation.

Building codes specify the design and construction materials of both new construction and repair of flood damaged structures. The specifications can require proper anchorage of buildings, restrict materials which tend to deteriorate when exposed to water, require water-tightness of exterior walls, placement of valves on sewer lines, and placement of utilities such as heaters and air conditioners at high elevations to reduce flood damages.

Floodplain management is the most effective means to control future development of the floodplain, and insure that existing flood problems do not worsen. This alternative did not require further consideration because the city of Dallas presently participates in the regular phase of the National Flood Insurance Program, and has adopted the Trinity River Corridor Development Certificate (CDC) process.

Flood Warning. Flood forecasting and temporary evacuation involves the determination of imminent flooding, implementation of a plan to warn the public, and organization of assistance in the evacuation of persons and some personal property. Notification of impending flooding can be accomplished by radio, siren, individual notification or by elaborate remote sensor devices. Some type of flood warning and emergency evacuation effort should be a part of any flood control plan. These measures normally serve to reduce the hazards to life and damage to portable personal property. It was not necessary to evaluate this alternative since the city of Dallas currently has a flood warning system in place.

Flood Proofing. Damage to existing structures can be reduced or eliminated through various flood proofing measures. These methods protect damageable property by preventing flood waters from entering the building and/or reaching the contents inside. Flood proofing is most easily applied to new construction, and most applicable where flooding is of short duration, low velocity, infrequent occurrence and of shallow depths. Flood proofing is usually employed in locations where structural flood protection is not feasible or where collective action is not possible. Typically, flood proofing techniques include water-tight door and window seals, raising of structures, installation of check valves on gravity-flow water and sewer lines, incorporation of seepage controls, and sandbagging of door openings during emergency situations.

Flood proofing of single-family residences within the floodplain would be impractical in frequently flooded zones where flooding depths can easily exceed the window sill heights and the structural integrity is poor. This alternative could be beneficial to commercial and industrial structures. For structures located within less-frequent flood event zones, such measures as sandbagging or altered landscaping adjacent to entryways could be helpful, since flooding depths would be shallow. However, any method requiring personal attendance, such as sandbagging, has a low reliability due to occupant absence and the occurrence of late night floods. The hydrologic characteristics of the Trinity River and the poor structural characteristics of the residential structures makes it impractical to implement the outlined flood proofing techniques.

Raising Structures In-Place. One method of flood proofing evaluated in detail was that of raising the structures at their existing site. This plan is most applicable where a limited number of structures are receiving a large portion of the total flood damages along a given stream reach. However, there is still the potential for loss of life with this alternative, since flooding could easily exceed the level of protection provided and residents are apt to ignore or respond slowly to warnings.

The city of Dallas participates in the Federal Emergency Management Agency (FEMA) floodplain management program. Requirements of the program specify that certain regulations be incorporated into the code of any community participating in the National Flood Insurance Program. One of these regulations stipulates that any substantial improvement made to an existing structure located within the 100-year floodplain should also elevate the structure at least 1 foot above the 100-year flood elevation. Substantial improvement is expressed as the cost of structural repairs equivalent to at least 50 percent of the structure's fair market value. Therefore, structures within the 10-year floodplain would have to be elevated at least 1 foot above the 100-year flood plain, or an average of about 4 feet above their existing finished floor elevations.

Many of the structures in the study area's 10-year floodplain were built in the 1940's or 1950's. Frequent flooding over the structure life has contributed to the dilapidation of these structures. Many of the residential structures do not have the structural integrity required to undergo raising. Furthermore, for those structures which might survive raising in place, the number of feet they would have to be raised is cost prohibitive, could induce damages on adjacent property, and would not be aesthetically pleasing. The majority of the commercial and industrial properties are already elevated 5 feet above ground level and the nature of these businesses makes it impractical to be raised above the 100-year floodplain. Based on the above findings, a raise-in-place plan was determined to be infeasible for this study area.

Relocation. Plans for structure relocation would move the existing frequently flooded structures from the floodplain to a non flood-prone site. The practicality of this measure depends on the frequency of

flooding, the value of the property, its importance to the community, and the need for land use areas that are more compatible with floodplain constraints.

Each of the structures within the study area was analyzed on an individual basis, with benefits being limited to the average annual losses covered by subsidized flood insurance plus the public damages prevented. All structures within the 10 year-flood zone were evaluated based on this economic criteria. As in the case of raising the structures in-place, either the structural integrity or the type of business made it impractical to consider this alternative further.

Permanent Evacuation. Flood plain evacuation involves the acquisition and removal or demolition of frequently flooded structures from the floodplain. This alternative was evaluated for the evacuation of individual structures within the 10-year flood frequency zone in accordance with the non-structural economic criteria previously outlined. Benefits were also derived for the evacuation of all structures within individual flood zones, including the 2-, 5-, 10-, and 100-year zones. Eligibility under the evacuation alternative rests primarily with the economic criteria and the frequency of flooding. The structural integrity of the structure was not a factor in determining feasibility as is the case in other non-structural plans.

Benefit Methodology. Benefits for removing individual structures from the floodplain are limited to the sum of:

annualized residual value of the vacated land, *or* average annual recreation benefits for the land

plus:

reduction in annual flood insurance subsidy:

agency cost:

average annual damages to the structure and its contents,

plus:

agent fee (at 15 percent of the estimated premium), and other administrative costs (at $131 per policy)

minus:

policy holder's cost:

estimated annual insurance premium (at $0.55 per $100 of structure value for the first $45,000 and $0.17 per $100 thereafter, plus $0.65 per $100 of contents value for the first $15,000 and $0.30 per $100 thereafter),

annual deductible ($500 each for structure and contents per flood occurrence, times the probability of a flood in a typical year), and

annual uninsured losses (5 percent of the structure value per flood occurrence, times the probability of a flood in a typical year)

plus:

average annual public damages prevented (that is, damages to communications and public utilities facilities, and costs for flood fighting and public relief) based on actual FEMA claims.

Analysis Results - Individual Structure Evacuation. Reaches 2 and 5 contain commercial and industrial structures within the 2- to 5-year flood frequency zone which meet this non-structural economic criteria. Table 4-1 presents a summary of the economic analysis for the evacuation of eligible structures in reaches 2 and 5. The investigated alternative yielding the greatest net benefits is shown shaded in the table. The cost estimates include land acquisition, demolition and disposal, and the remediation of asbestos, lead based paint, and other hazardous non-CERCLA contaminants.

In reach 2, about $154,300 in annual damages would be eliminated with the permanent evacuation of 5 commercial structures. The first cost for this plan is estimated at about $874,800. The annual costs and claimable annual benefits are $75,800 and $145,600, respectively, with a resultant benefit-to-cost ratio of 1.9 and excess benefits of $69,800.

In reach 5, an estimated $419,000 in annual damages could be eliminated with the evacuation of only 2 commercial structures. The first cost for this plan is estimated at about $580,300. The annual costs and claimable annual benefits are $50,800 and $410,800, respectively with a resultant benefit-to-cost ratio (BCR) of 8.1 and excess benefits of $360,000. The benefits derived in this reach signal the need for additional investigation to obtain empirical flooding evidence associated with the contents in these structures.

In summary, the permanent evacuation plans were found to be economically feasible for 7 commercial structures. Total damages would be reduced by 12 percent in the immediate study area. The combined plans would have an estimated project first cost of $1,455,100. The total annual costs and benefits would be $126,600 and $556,400, respectively. The resultant BCR would be 4.2, with excess benefits of $429,800.

The Uniform Relocation Assistance Program requires that displaced property owners be compensated for losses attributable to evacuation. A maximum of $22,000 is allowed for residential structures to cover moving expenses, temporary lodging, and the cost to obtain housing in accordance with Federal guidelines. Maximum relocation expenses have not been set for commercial/industrial structures. These costs would be 100 percent non-Federal.

The local sponsor desires recreational facilities; however, a specific recreation design was not considered at this point since the BCR is greater than 1.0, and the structures are randomly located throughout the flood plain. It is recognized that individual structures may be selected for evacuation in conjunction with other flood control measures.

Table 4-1
Economic Analysis of Individual Structure Evacuation Plan
(June 1993 prices, 8.0% interest, 50-year period of analysis)
(Thousands of Dollars)

Reach	Number of Structures	First Costs	Annual Costs	Annual Benefits	Benefit/Cost Ratio	Net Benefits
2	5	$874.8	$75.8	$145.6	1.9	$69.8
5	2	$580.3	$50.8	$410.8	8.1	$360.0
Combined	7	$1,455.1	$126.6	$556.4	4.2	$429.8

Investigated Structural Alternatives

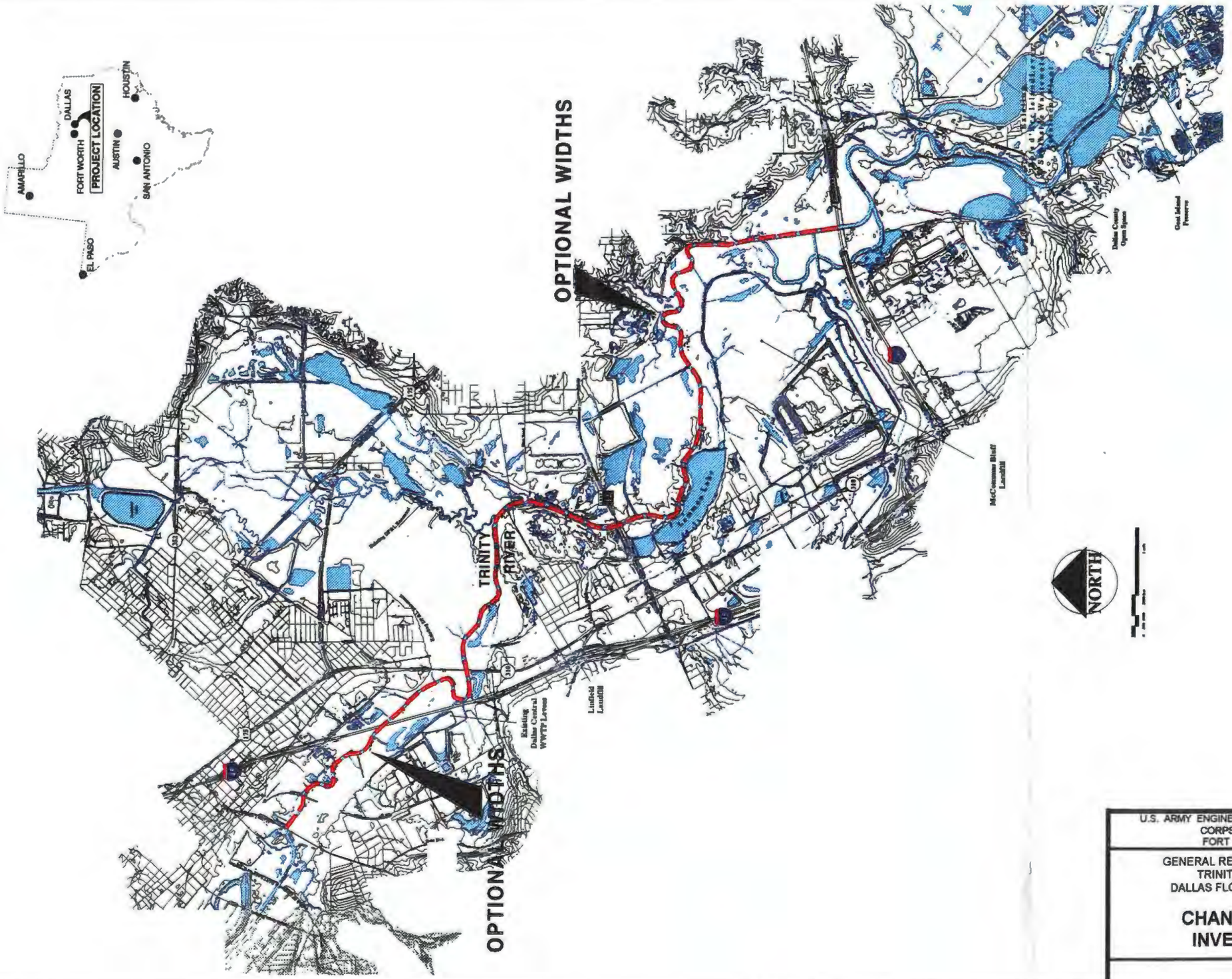
Various structural alternatives were investigated in this study, including construction of channels, levees, swales, and combinations thereof, as well as vegetation management plans. The following paragraphs describe the individual plans investigated.

Channel Plans Investigated. The preliminary design featured a 5-mile channel extending from the downstream end of the existing Dallas Floodway downstream to Loop 12, as shown in figure 4-1. The channel would be a grass-lined trapezoid with 3-foot horizontal to 1-foot vertical side slopes. Between the existing Floodway upstream and continuing to just below IH-45, the channel alignment would be along the west bank of the Trinity River. At IH-45, the channel would veer to the east and cross the river to the east bank, rejoining the natural channel at the center of the large oxbow and continuing along the east bank to IH-20. The channel would be aligned to preserve at least one side of the river bank. Channel sizes investigated for this alignment included 100-, 150-, 200-, and 250-foot bottom widths. Figure 4-2 shows a typical channel section. The results of the analysis are shown in table 4-2.

Project first costs ranged from about $38.9 million to $78.3 million. Each plan was deemed feasible, with benefit-cost ratios ranging from 1.7 to 2.8. The optimum bottom width would be 150 feet. All four designs would increase the level of protection in the primary and secondary study portions of the study area and reduce damages in the unprotected primary study area by 50 to 75 percent. However, due to intense public concern regarding environmental impacts of this plan, other plans with fewer environmental impacts were evaluated.

Table 4-2
Summary of Channel Alternatives
(June 1993 prices, 8.0% interest, 50-year period of analysis)
(Millions of Dollars)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
100' BW	$38.9	$3.6	$11.1	2.8	$6.5
150' BW	$52.1	$5.0	$11.9	2.4	$6.9
200' BW	$74.2	$6.3	$12.5	2.0	$6.2
250' BW	$78.3	$7.6	$13.2	1.7	$5.6



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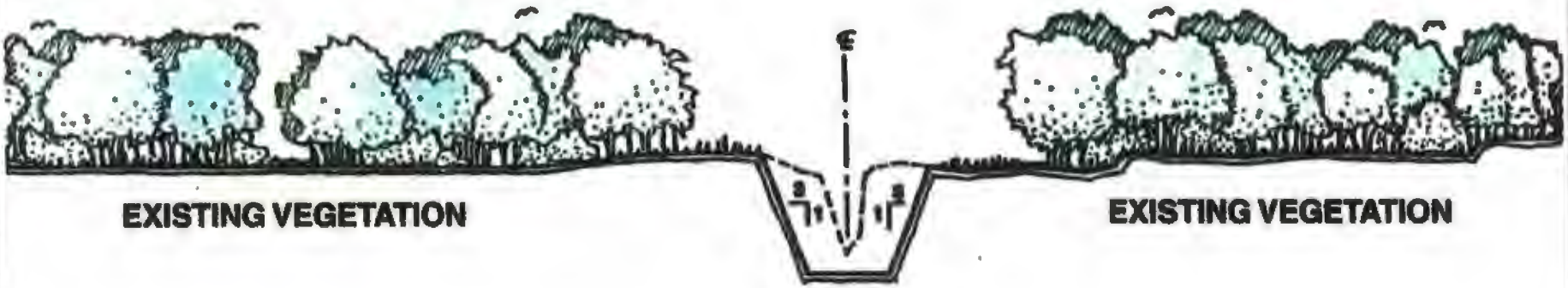
CHANNEL PLANS INVESTIGATED

FIGURE 4-1



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TYPICAL CHANNEL SECTION

FIGURE 4-2

Levee Plans Investigated. Levee designs providing 100-year and SPF levels of protection were investigated for the east and west banks of the Trinity River between the existing Dallas Floodway Levee System and U.S. Hwy. 75 (Central Expressway). Figure 4-3 shows the general layout of these levees.

Lamar Street Levee: This levee would be constructed along the east bank with an average SPF height of about 27 feet, with 1v:3.5h side slopes, and a length of about 2.5 miles. The 100-year levee would consist of a series of small levees with a typical height of about 15 feet including freeboard, and an aggregate length of about 13,200 feet.

Cadillac Heights/Treatment Plant Levees: Constructed along the west bank of the Trinity River between the Cedar Creek confluence and Hwy. 75, these investigated levees are referred to as the Cadillac Heights Levee (Reach 5) and Central Wastewater Treatment Plant (CWWTP) Levee (Reach 6). The average height would be about 25 feet for the SPF levee and 15 feet for the 100-year levee, including freeboard. The total length would be about 1.3 miles.

As shown in table 4-3, individual annual levee costs would be supported by the annual benefits. It was not considered practical to construct single levees along the east or west bank of the Trinity due to induced damages which would occur along the opposite bank. However, as a combined levee system, induced damages to the existing Dallas Floodway produced negative net benefits. Levees providing 100-year levels of protection to the Lamar and Cadillac Heights areas would raise water surface elevations at the downstream end of the existing Floodway by 0.3 feet. Comparatively, SPF levees would raise water surface elevations 0.6 to 2.0 feet, assuming the event occurred within the Floodway. Therefore, the conclusion was reached that construction of levees would require a relief channel or swale to offset the effects to the existing Floodway.

Table 4-3
Summary of Levee Alternatives
(June 1993 prices, 8.0% interest, 50-year period of analysis)
(Millions of Dollars)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
100-Year Lamar	$9.0	$.8	$1.5	1.9	$0.7
100-Year Cadillac	$9.1	$.8	$1.2	1.5	$0.4
SPF Lamar	$14.6	$1.3	$2.2	1.7	$0.9
SPF Cadillac/ CWWTP	$29.3	$2.6	$2.8	1.1	$0.2
All 100-Year	$18.2	$1.6	$2.6	1.6	($1.1)
All SPF	$43.9	$3.9	$1.8	0.5	($2.1)

Vegetation Management Plan Investigated. This plan would clear non-endangered species underbrush from the downstream end of the existing Dallas Floodway to Loop 12. The width of the clearing would extend approximately 1,000 feet from the centerline of the river to both the east and west banks, leaving an overstory of tree cover above 20 foot. Although some selective clearing and pruning would be required, there would be an attempt to leave a 100-foot wide buffer zone for riparian habitat along both sides of the river channel. Small parcels of the understory (shrubs and other vegetation of approximately 3-5 acres in size) would be left in their existing state throughout the 2,000-foot area. All remaining understory vegetation would be removed. Hydraulic performance of this alternative demonstrated the significant impact of vegetation on the water surface elevations. The alternative was removed from consideration due to the requirement for expensive, intense maintenance, and the significant impact to environmental resources

which this plan would cause. However, hydraulic findings regarding the impact of vegetation removal initiated development of the swale alternative.

Swale Plans Investigated. An economic analysis was conducted to ascertain the performance of overbank swales. These grass-lined swales would be divided into lower and upper swales, with the dividing line at the IH-45 river crossing. Various swale sizes were investigated, including average bottom widths (BW) ranging from 300 - 1,500 feet. The swale plan would also include clearing the site of all non-endangered species vegetation. These swales are shown in figure 4-4, and described below. Figure 4-5 shows a typical swale section.

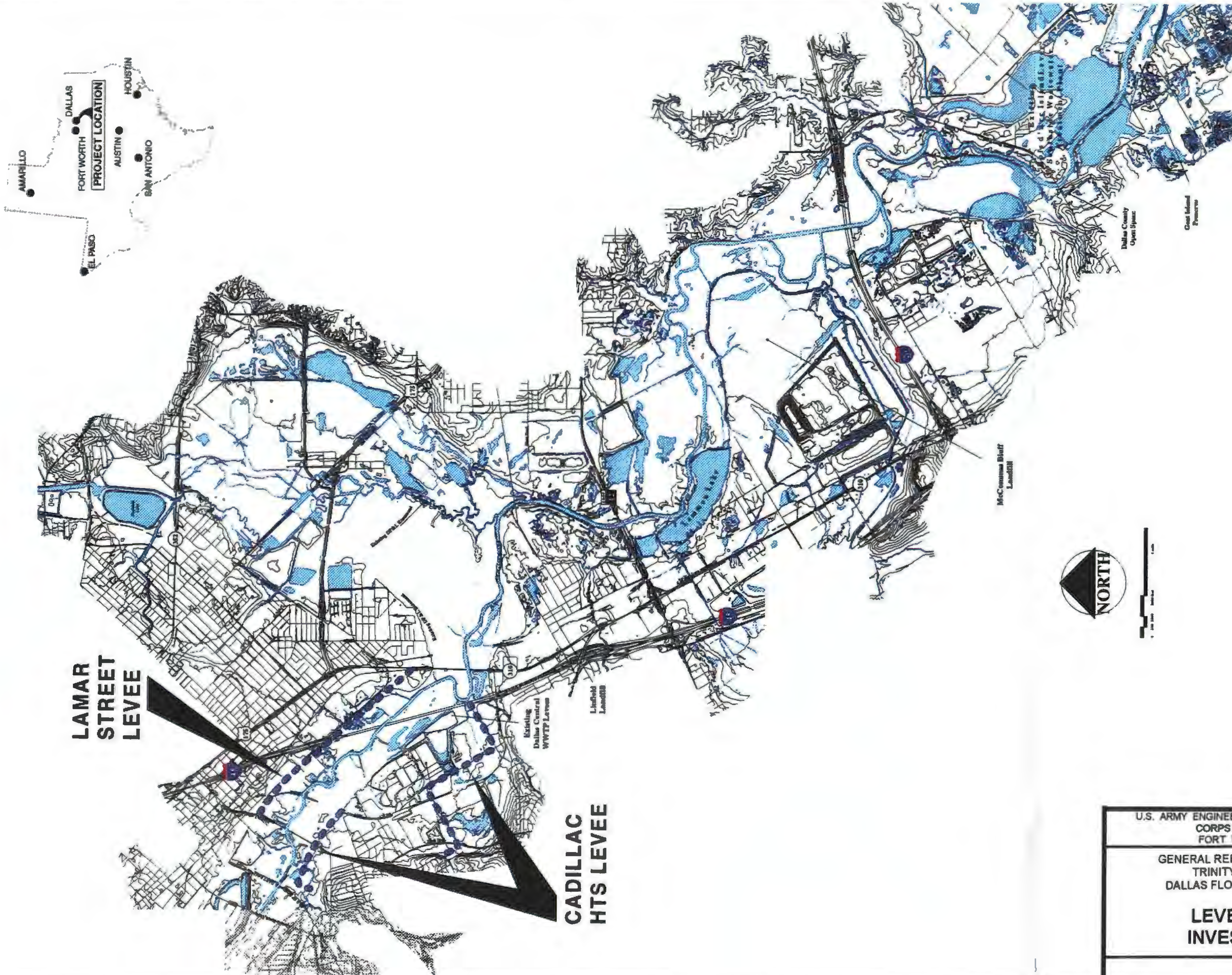
Lower Overbank Swale: This swale would extend from Hwy. 310, beginning at least 100' from the edge of the east bank, downstream to about 2,000 feet below Loop 12, for a total length of 17,300 feet, or 3.3 miles. The lower swale would be designed with a slope of .0005 ft/ft.

Upper Overbank Swale: This swale would be designed to work in conjunction with the lower overbank swale to maximize channel relief. The length of the upper swale would be about 7,800 feet, or 1.5 miles, and would extend from the confluence of Cedar Creek, at the upstream end, to the river crossing of IH-45.

The Multiple Object Management (MOM) approach was incorporated into the design of the swales to avoid and minimize environmental impacts. The wider swales would impact the higher quality habitat to a greater extent than the 300- to 500-foot swales. Fragmentation of habitat would be unavoidable and would require significant mitigation. Approximately 3,200 acres of land would be required to offset the environmental impacts. All swale sizes were economically feasible, with benefits ranging from about $7.8 million to $11.0 million. The results of the analysis of the swale alternatives are shown in table 4-4. As shown, the 1,200-foot BW swale would produce the greatest net benefits among all the swale plans, and among all the alternatives evaluated in the 1991 to 1993 time period.

Table 4-4
Summary of Swale Alternatives
(June 1993 prices, 8.0% interest, 50-year period of analysis)
(Millions of Dollars)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
300' BW	$15.2	$1.4	$ 9.3	6.6	$7.8
500' BW	$21.6	$1.9	$11.5	6.0	$9.5
600' BW	$23.7	$2.3	$11.8	5.2	$9.5
900' BW	$31.9	$3.1	$12.7	4.1	$9.6
1,200' BW	$43.8	$4.4	$15.3	3.5	$10.9
1,500' BW	$54.8	$5.4	$15.7	2.9	$10.2



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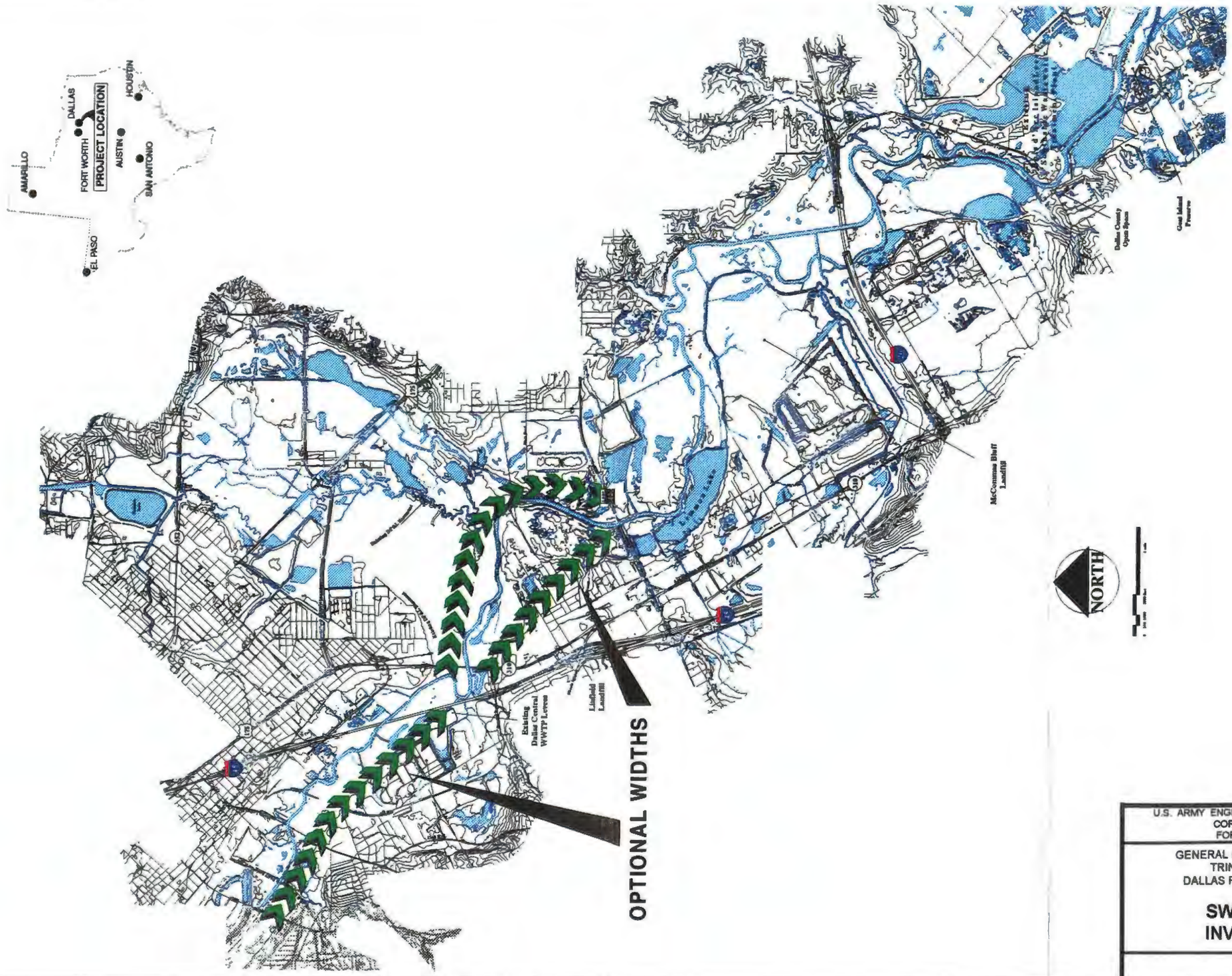
LEVEE PLANS INVESTIGATED

FIGURE 4-3



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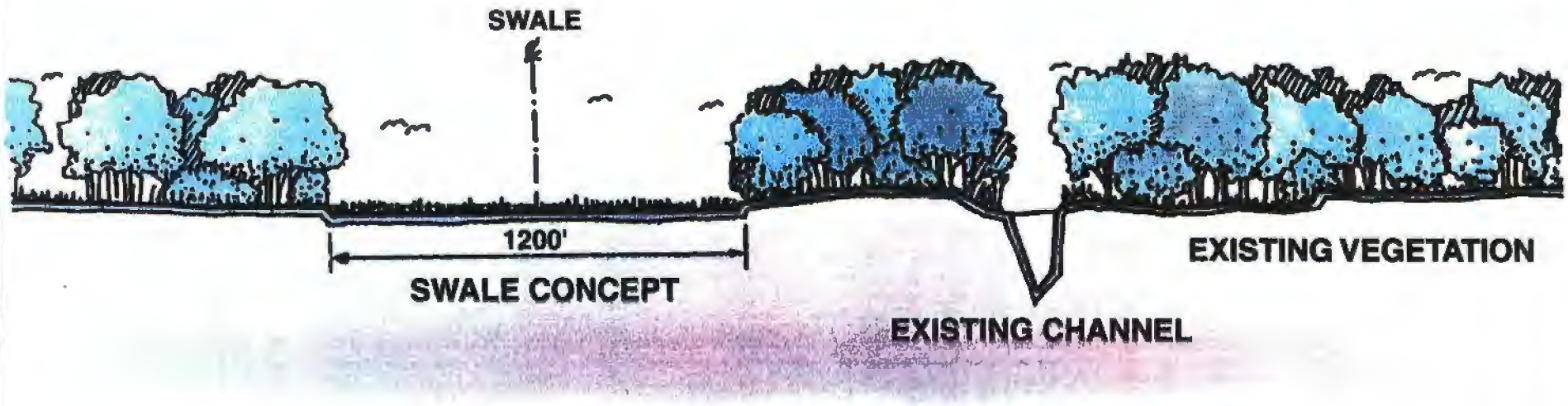
SWALE PLANS INVESTIGATED

FIGURE 4-4



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TYPICAL SWALE SECTION

FIGURE 4-5

Recreation Plan Investigated. Benefits for the initial recreation plan were derived based on Region 4 facility needs and carrying capacity factors extracted from the Texas Outdoor Recreational Plan (TORP). Since the TORP does not identify a net need for picnic facilities, benefits were calculated only for the trail system. This project would generate at least $1.0 million in annual recreation benefits. The total estimated project first cost for the recreation plan would be about $8.9 million, with a resulting BCR of 1.2. These recreation features could be adapted to any of the proposed swale alternatives.

Summary of Initial Alternatives

The costs and benefits associated with the most feasible plans investigated from 1991-1993 are summarized in table 4-5, not including recreation. The results of these analyses served as the basis for identifying the preliminary NED Plan and as an aid to the local sponsor in the selection of a locally preferred plan.

As shown in the table, the 1,200-foot bottom width upper and lower swale alternative was identified as the plan producing the greatest net benefits. The general layout of this plan is shown in figure 4-6. An optimization curve is presented in figure 4-7. The net benefits were calculated at $11.0 million based on a first cost of $43.8 million. Accordingly, this plan was designated as the NED Plan and carried forward in the formulation process.

Table 4-5
Summary of Economic Analyses of Investigated Plans
1991-1993 (Flood Control Only)
(June 1993 prices, 8.0% interest, 50-year period of analysis)
(Millions of Dollars)

Investigated Alternatives	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
Non-Structural: 7 Individual Structures	$1.46	$0.13	$0.56	4.2	$0.4
Channels: 150' BW	$52.1	$5.0	$11.9	2.4	$6.9
Swales: 1,200' BW	$43.8	$4.4	$15.3	3.5	$11.0

IN-PROGRESS REVIEW MEETING

Subsequent to the preceding analyses and designation of the preliminary NED Plan, an in-progress review (IPR) was held on July 19, 1993, with representatives from Headquarters, U.S. Army Corps of Engineers (HQUSACE), Southwestern Division (SWD), and the Fort Worth District (SWF) in attendance. The major pertinent discussions, concerns, issues, and concurrences included the following:

- Proposed Section 215/104 agreements regarding credit to the local sponsor for non-Federal construction of the Rochester Park Levee and modifications to the CWWTP Levee were deemed invalid due to the timing of the requests and/or lack of prior approval from the Assistant Secretary of the Army (Civil Works). To receive credit, the local sponsor must seek Legislative approval.

- Initial guidance received August 21, 1992, specified a risk-based analysis would be required only for levees. Subsequent guidance, however, directed risk-based analysis be accomplished and integrated into the analysis regardless of the alternatives.

FINAL ANALYSIS OF NED PLAN

Key Revisions and Assumptions.

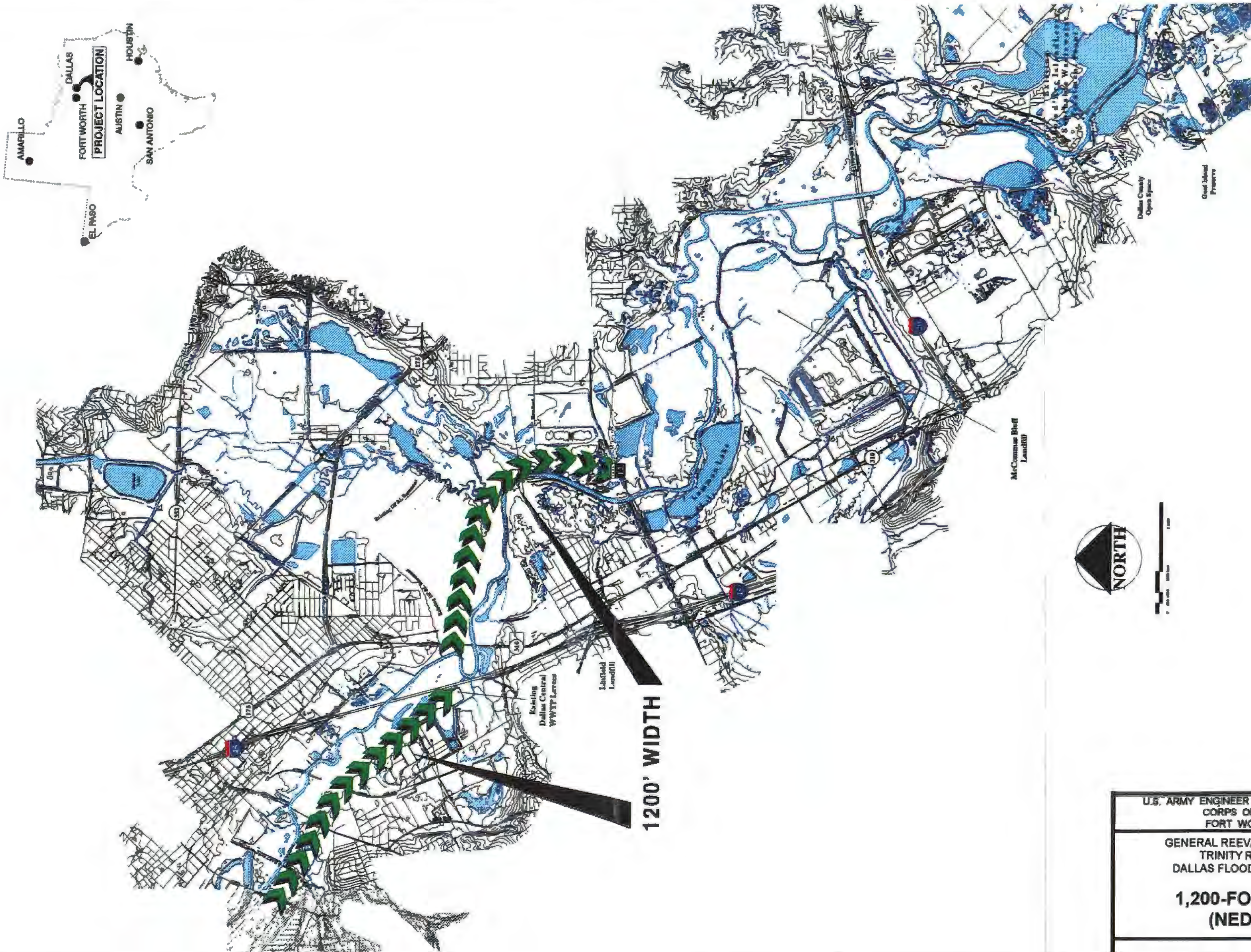
During this phase of the plan formulation process, the following revisions were made regarding engineering and economic parameters:

- The hydrology model developed for the Upper Trinity River Feasibility Study was approved for use in this study, thereby ensuring compatability of the results of this analysis with future Upper Trinity River studies. The revised hydraulic model included computed probability water surface elevations, incorporated the effects of extending the 100-foot benched channel within the existing Floodway, and assumed design grade for the levees in the existing Floodway. In addition, updated aerial photography was used to establish digital topography.

- Current floodplain investment data was gathered through field surveys and from the Dallas County Appraisal District.

- A risk-based analysis was incorporated into all assumptions and benefit calculations. Traditional expression of the frequency of flood events has been in terms of the recurrence interval in years, such as, the "100-Year Flood". The more appropriate expression of the probability of a particular flood magnitude is in terms of "percent chance exceedance", especially as it relates to a risk-based analysis. Therefore, the "100-Year Flood", which is defined as "the magnitude of flooding which has a 1 percent probability of being equaled or exceeded in any given year" would be expressed as the "1 percent chance flood". For comparison purposes, the nine flood events computed for this study, traditionally referred to as the 1-year, 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 500-year, and the Standard Project Flood (SPF), would be referred to, in probabilistic terms, as the 99 percent, 50 percent, 20 percent, 10 percent, 4 percent, 2 percent, 1 percent, 0.2 percent chance flood, and the SPF, respectively. Although the analyses contained herein were performed as risk-based analyses, results of these investigations are expressed in traditional terms for the benefit of the reader.

- Cost data was updated to reflect October 1995 prices and level of development, and the prevailing Federal interest rate of 7.63 percent was applied to the economic analyses.



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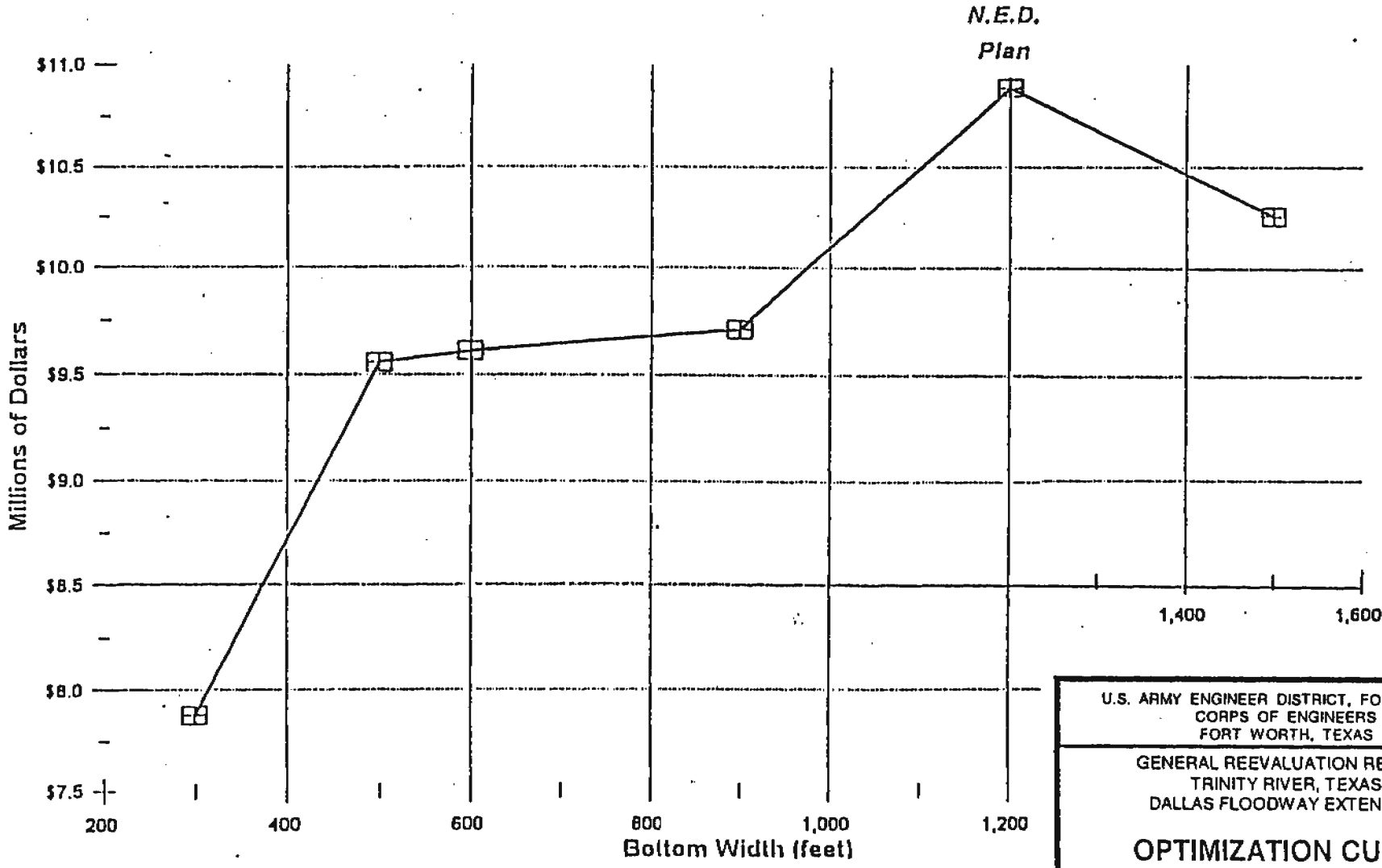
1,200-FOOT SWALE (NED) PLAN

FIGURE 4-6

Dallas Floodway Extension
Swale Alternatives: Net Benefits



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OPTIMIZATION CURVE

FIGURE 4-7

Investigated Structural Alternatives

Revised Swale Plans Investigated. Examination of the results of the preliminary investigations indicated that the majority of benefits for the 1,200-foot swale would be realized in the existing Floodway. Smaller swales, while not providing as many upstream benefits, would yield benefits in the immediate study area at significantly reduced costs, and would cause fewer adverse impacts to environmental resources. Also, in accordance with the request of the local sponsor, a west bank alignment for the lower swale was considered.

The upper swale alignments developed in this phase of the study would be designed to work in conjunction with a lower swale to maximize channel relief and minimize environmental damage. The investigated upper swale would have an approximate 300-foot bottom width and would extend from the Cedar Creek confluence to the oxbow near IH-45. The complementary lower swale would consist of an approximate 500-foot bottom width swale, aligned between Loop 12 and IH-45, and traversing either the Linfield Landfill or the historic Joppa neighborhood, as shown in figure 4-8 and described below:

> **Linfield Swale:** In conjunction with the upper 300-foot swale, this alignment would consist of a 500-foot bottom width channel beginning at Loop 12, at the Sleepy Hollow Golf Course, and extending through the Linfield Landfill. The maximum depth would be about 30 feet, with a minimum depth of about nine feet. Preliminary HTRW investigations indicate manageable levels of contaminants within the landfill. This alignment would reduce damages in the study area and raise the level of protection in the existing Floodway to the 500-year frequency.
>
> **Joppa Swale:** This plan would consist of a 500-foot bottom width channel beginning at Loop 12, at the golf course, and would pass through the Joppa neighborhood, thereby avoiding the Linfield Landfill. This alignment would displace approximately 17 residents and impact about 68 structures. This alignment would also traverse a large pond previously used as a gravel pit, and a parcel of the Southern Pacific railroad property which has been cited as an illegal dumping area. This alignment would reduce damages in the study area and raise the level of protection in the existing Floodway to the 500-year frequency. This neighborhood, however, is located outside the floodplain.

Adverse environmental impacts would be significantly reduced with either of these west bank alignments when compared to the east bank alignment as proposed in the 1,200-foot swale plan. Flood damage reduction benefits would be similar with either of these west bank alignments, each reducing damages in the study area by more than 30 percent and in the existing Floodway by more than 20 percent. While the preliminary cost estimates for going through the landfill would be comparable with costs associated with relocating and abating contaminated areas within the Joppa neighborhood, the Linfield swale, in conjunction with the 300-foot upper swale, would produce greater net benefits than the Joppa swale. Opposition to disrupting the Joppa neighborhood and the historic, cultural nature of the area prompted the city to request further refinement of the Linfield swale to optimize benefits and to incorporate wetlands and vegetation within the swale. This request was used by the design team to incorporate the chain of wetlands concept into both the upper swale and lower (Linfield) swale.

The Chain of Wetlands alternative would utilize the best identified swale plan (300-foot upper swale and 500-foot Linfield swale), but would also include connected wetlands and pockets of sparsely planted trees within the open grassy areas. The average depth of the swale would be about 2 feet, with the wetland areas approximately 2 - 4 feet deep. The vegetated areas would contain about 10 trees per acre. This plan is shown in figure 4-9.

Comparative costs and benefits for the above mentioned alternatives are presented in table 4-6. As shown, the Chain of Wetlands alternative would provide the greatest amount of net benefits, and was, therefore, carried forward in the formulation process.

Table 4-6
Summary of Revised Swale Alternatives
(October 1995 prices, 7.63% interest, 50-year period of analysis)
(Millions of Dollars)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
300' / 500' Linfield Swale	$34.5	$2.9	$7.2	2.5	$4.4
300' / 500' Joppa Swale	$33.4	$2.8	$6.3	2.3	$3.5
Chain of Wetlands	$50.6	$4.2	$9.4	2.2	$5.2

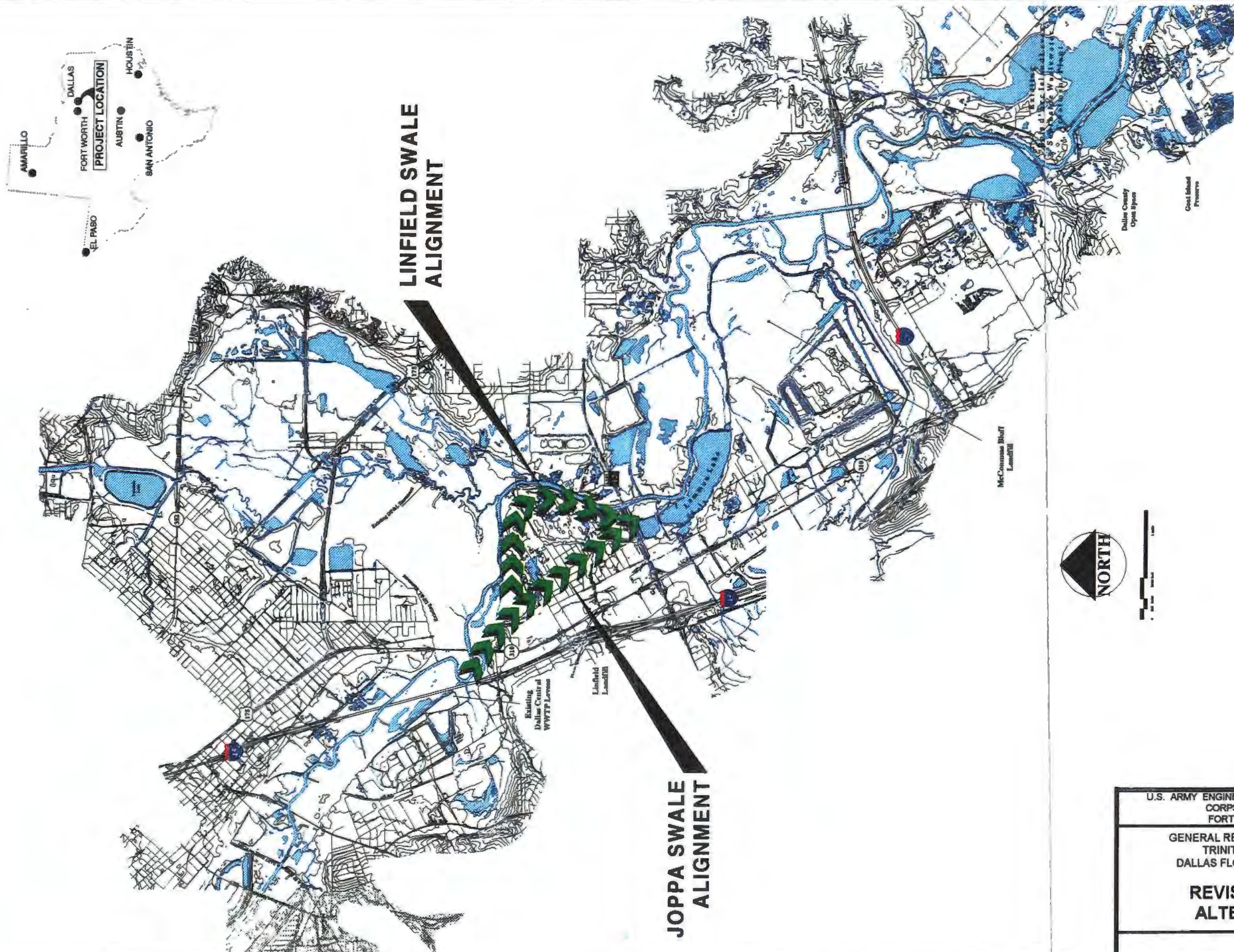
NED Plan Determination

Due to the revisions to hydrology and economic models in this phase of plan formulation, and due to the similarity of benefits between the 900-foot swale and the 1,200-foot swale in the preliminary formulation phase, both of these alternatives were carried forward for further analysis. The 1,200-foot swale was designated as the preliminary NED plan in 1993. The Chain of Wetlands was carried forward from the more recent studies due to the sponsor's interest in including wetland features. Also included in this array of alternatives was the Chain of Wetlands Plus SPF Levees alternative, due to indications that this plan would be the most likely candidate for being selected as the LPP. This alternative would include the addition of SPF levees on both sides of the river, at Lamar Street and at Cadillac Heights, as shown in figure 4-10. Table 4-7 presents the array of alternatives investigated in the final determination of the NED plan.

Based on applicable criteria, the 1,200-foot swale would produce the greatest net benefits and was designated as the NED plan. As shown, the NED plan would have net benefits of $8.6 million and a first cost of $47.5 million, without recreation.

Table 4-7
Final Array of Alternatives - NED Plan
(October 1995 prices, 7.63% interest, 50-year period of analysis)
(Millions of Dollars)

Investigated Alternative	First Cost	Annual Cost	Annual Benefit	Benefit/Cost Ratio	Net Benefits
1,200' BW Swale	$47.5	$4.3	$12.8	3.0	$8.6
900' BW Swale	$40.7	$3.7	$11.6	3.2	$7.9
Chain of Wetlands	$50.6	$4.2	$9.4	2.2	$5.2
Chain of Wetlands with SPF Levees	$82.6	$7.2	$11.5	1.6	$4.3



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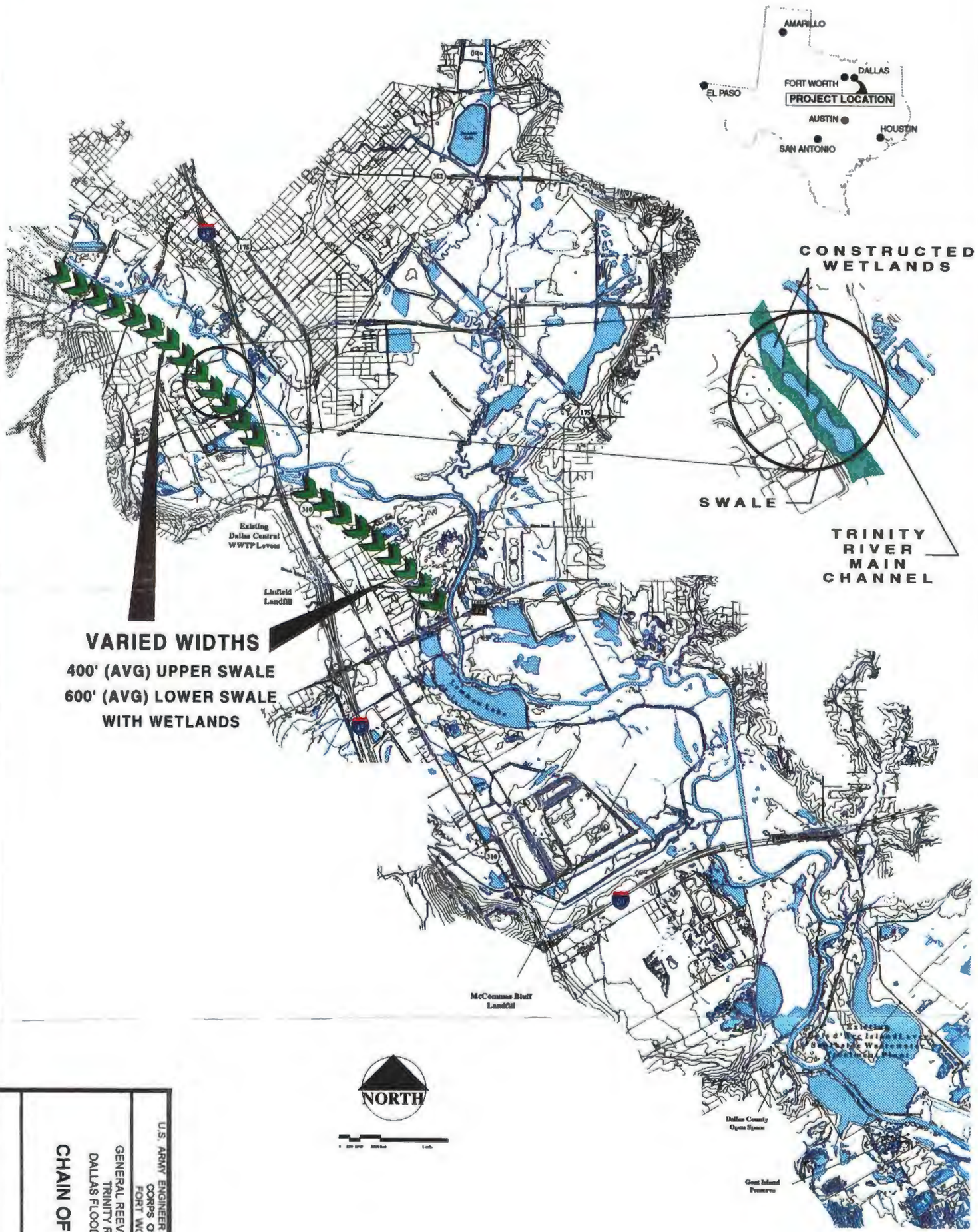
REVISED SWALE ALTERNATIVES

FIGURE 4-8



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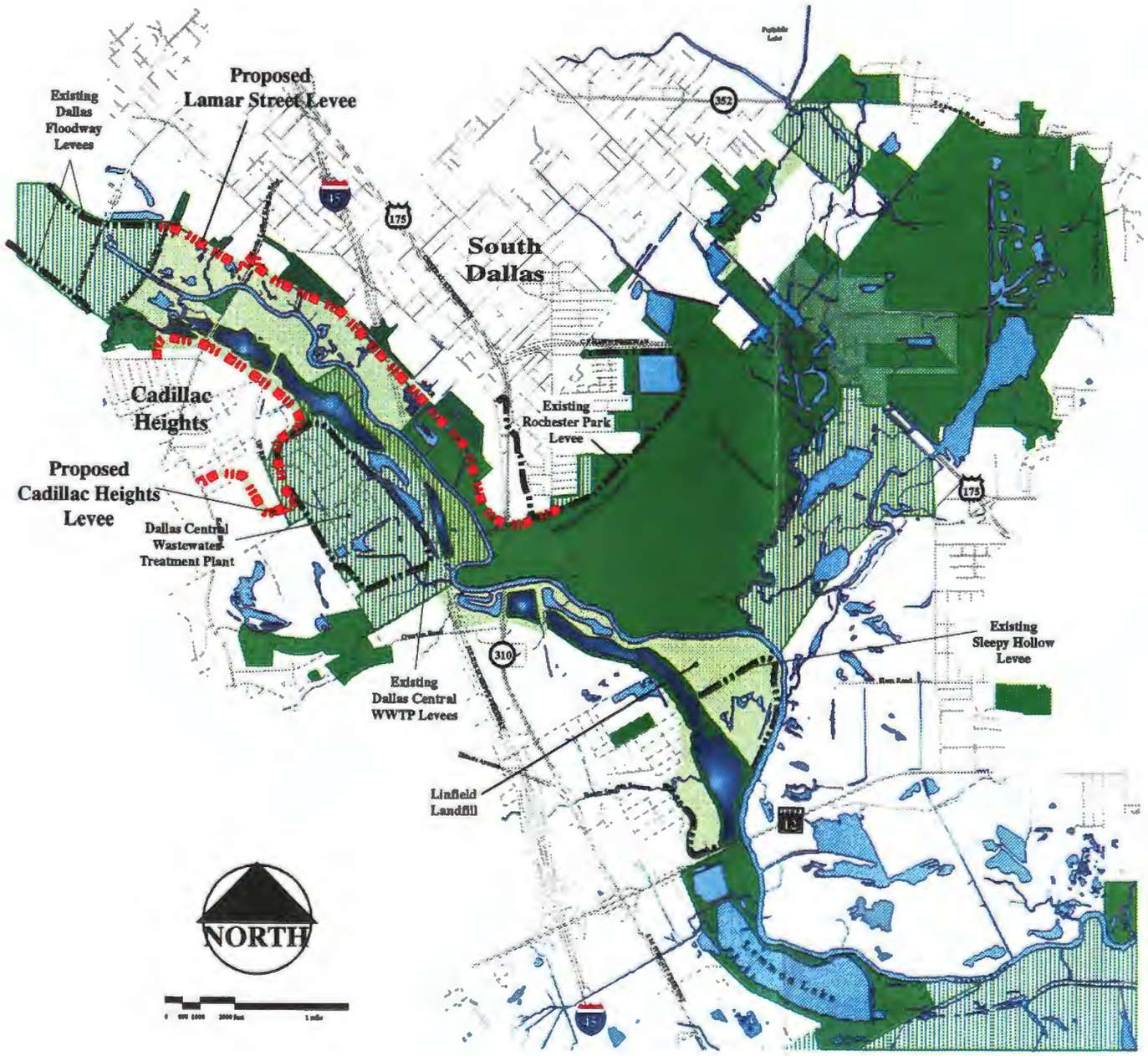
CHAIN OF WETLANDS

FIGURE 4-9



Legend

- Public Park Lands
- Other Public Lands
- Proposed Project Lands
- Proposed Sumps
- Proposed Swale
- Proposed Wetlands
- Existing Levees
- Proposed Levees

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CHAIN OF WETLANDS AND SPF LEVEES

FIGURE 4-10

SELECTION OF THE LOCALLY PREFERRED PLAN

The selection of the Locally Preferred Plan (LPP) began during the development of the NED plan. Many of the alternatives developed by the Corps were deemed worthy of further investigation as potential candidates for the LPP. Following HQUSACE and SWD approval of the preliminary plan formulation process, a series of informal discussions and meetings were held with the city and local interest groups to seek public input for various alternatives. The following issues were deemed worthy of further consideration and resolution:

- Due to the presence of pristine bottomland hardwoods on the east bank in the lower swale area, and the subsequent public input regarding the adverse impacts a 1,200-foot swale would have in this area, further studies were requested by the city.
- The city requested an evaluation of a west bank alignment for the lower swale.
- The city requested that the plans incorporate environmental restoration and recreation features into the flood control options.
- The city sought maximum flood protection for the area residents by construction of SPF levees along Lamar Street and the Cadillac Heights and wastewater treatment plant areas.

NON-STRUCTURAL ALTERNATIVE

The non-structural analysis performed in the preliminary phase of the study investigated the feasibility of evacuation of individual structures within the study area. These investigations revealed only seven structures scattered throughout the floodplain could be economically justified for acquisition. Such a plan was not adopted because it did not adequately address the area's flood problems and did not offer a comprehensive solution. Given these findings, an evaluation of non-structural buyout options from an entire flood zone perspective was performed. Table 4-8 presents a summary of the economic analysis for the evacuation of all structures within various flood zones.

Table 4-8
Economic Analysis of Flood Zone Evacuation Plans
(October 1996 prices, 7.63% interest, 50-year period of analysis)
(Millions of Dollars)

Zone	Number of Structures	First Costs	Annual Costs	Annual Benefits	Benefit/Cost Ratio	Net Benefits
0-2 Year	0	$0.0	$0.0	$0.0	0	$0.0
0-5 Year	13	$13.0	$1.1	$0.9	0.8	($0.2)
0-10 Year	37	$24.0	$2.0	$1.2	0.6	($0.8)
0-100 Year	508	$60.0	$5.8	$1.3	0.2	($4.5)

In the 0 - 5-year flood zone, one residential, five commercial, and seven industrial structures would be removed. The first cost of this plan was estimated at $13,000,000, with a BCR of 0.8.

In the 0 - 10-year flood zone, three residential, 20 commercial, and 14 industrial structures would be removed. The first cost of this plan was estimated at about $24,000,000, with a BCR of 0.6.

In the 0 - 100-year flood zone, 378 residential, 88 commercial, 39 industrial, and three public structures would be removed. The first cost of this plan was estimated at about $60,000,000, with a BCR of 0.2.

These plans would provide unacceptably small impacts on flood damages and were, therefore, screened from further consideration.

The local sponsor decided to focus efforts on the Chain of Wetlands concept, with the possible addition of levees on both sides of the river. The following sections present the development of the LPP, including descriptions of the various features considered, and rationale behind the selections of preferred solutions.

CHAIN OF WETLANDS

The Chain of Wetlands concept was formulated through the iterative process of addressing several issues raised by the city, and from further analysis regarding the hydraulic improvements which could be attained through various vegetation management plans within the area. First, intense concern voiced by citizens and special interest groups over the adverse impacts a 1,200-foot swale would have on important environmental resources in the Trinity River corridor prompted the city to look at smaller swale alternatives, which would provide a reasonable degree of protection in the immediate study area, though providing less benefits to the existing upstream Floodway. Second, the city's desire to add project features which would restore some of the corridor's fish and wildlife habitat qualities shifted the investigations to the examination of a series of connected wetland pools within the open, grass-lined swales.

Swale

Initial Alignment. The original Chain of Wetlands plan would consist of an off-channel swale designed to allow the natural river to retain its meanders, natural banks and bottom, and to preserve the tree canopy along the most ecologically significant vegetation adjacent to the river. The swales would resemble a broad meadow, with side slopes less than the crown of a football field. The centerline of the swales would follow the alignment of the 1,200-foot swale plan. The upper swale would have an average bottom width of approximately 300 feet, and would extend from the upstream end near the Cedar Creek confluence with the Trinity River to the oxbow near IH-45. The complementary lower swale would extend from the State Highway (S.H.) 310 bridge to Loop 12. This swale would have an approximate 500-foot bottom width from S.H. 310 through the Linfield Landfill, but would widen out to a 1,300-foot width through the Sleepy Hollow Golf Course. The maximum depth of the lower swale would be 30 feet through the Linfield Landfill, while the minimum depth would be seven feet.

Revised Alignment. Extensive public involvement revealed continued concerns regarding disturbance of existing environmental resources. Further investigations determined that the higher quality forested zones existed in the areas closest to the river; consequently, it was decided the original alignment of the upper portion of the swale would be shifted to the west to avoid these areas to the extent possible. Downstream of the upstream end of the CWWTP levee, no alignment changes would be necessary. Upstream of this point, the swale would be relocated to the west a distance varying from 200 feet to 500 feet, with an average of approximately 400 feet. Further movement to the west would be prohibited by existing underground utility lines, including three 60-inch diameter and one newly constructed 120-inch diameter pipes. The possibility of locating the swale west of these lines was evaluated, but was considered cost prohibitive. The higher ground elevation west of the utility lines would have required vastly greater excavation quantities, resulting in an estimated $11 million increase in construction costs alone, not

including expected higher costs for real estate and for removal of hazardous, toxic and radiological wastes (HTRW).

When comparing these alignments, it is noted that the initial (eastern) alignment would require acquisition of 940 acres of additional land, at an estimated cost of approximately $4.6 million, to mitigate for impacts to 280 acres of high quality forested areas. The revised (western) alignment would impact 287 acres of lower quality trees, but would require only 635 acres of mitigation, at an estimated cost of approximately $3.1 million. The lower quality forested areas impacted by the western alignment would require significantly less mitigation.

Environmental Restoration (Wetlands)

The proposal to modify the flood swale for 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 of using 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 the 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, 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 4-9 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 would thus be a good estimator for frequency of flooding without the 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 a flooding event would occur only 5 % of the time during August to irrigate and promote optimum seed production of wetland plants. Flooding would occur approximately 40% of the time during the October to January period, when food and cover produced by the wetlands vegetation would be 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. Considering suitability values only, there would remain an increase in average annual habitat units in this alternative; however, 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 would be almost totally lost because of the low frequency of flooding that occurs naturally during the summer months.

The wetland complex, as proposed with dependable water supply available (Table 4-10), would provide 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 would provide for development of 123 acres of emergent wetland, which would yield over 117 average annual

habitat units, and would more than triple the 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. This analysis shows an increase of 48% in acres and a 516% 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 justifiable 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 which project alternatives would be supportable when environmental output levels continue to increase with increased expenditure of economic resources.

<u>Cost Effectiveness of Emergent Wetland Restoration.</u> 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 were derived from tables 4-9 and table 4-10. An operation and maintenance cost of $50,000 was estimated for the alternative with a dependable water source, and $35,000 for those without dependable water.

Pertinent information related to the cost effectiveness for the two action alternatives and the no action alternative are displayed in table 9 of Appendix F. 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.

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 adding a 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. Furthermore, evaluation of the data indicates that the best buy would 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.

Table 4-9
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 4-10
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.

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 conduced to determine if the entire chain of wetlands was justifiable or if only a portion of the complex should be constructed and managed. The chain of wetlands, as proposed and evaluated, could contain from one to seven cells (See Figure 2 of Appendix F, and Plates C-21 through C-29 of Appendix C) that would be connected to the water source. A series of water distribution and control structures would be used to manage the emergent wetlands for optimum habitat output. For this analysis, the cells were named in alphabetical order, with the uppermost or northern wetland cell named Cell A, with the most southerly located cell named Cell G. The detailed incremental analyses for each cell is presented in Appendix F, the results of which are shown in table 4-11.

Table 4-11
Incremental Analysis of Environmental Restoration Plan

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

Summary - Environmental Restoration Plan. The planning goal for environmental restoration for the proposed project area was to develop a wetland complex providing 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 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 analyses was conducted to assist in the determination of whether 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 was 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 4-11). All seven of the final alternatives were considered viable alternatives that must be carefully evaluated under the question, "Is this level of output worth the cost?" 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 chain of wetlands would achieve the goal of maximizing emergent wetland habitat within this area without violating other developed criteria. 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 was 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 the additional expense in adding Cell G to provide an additional 56 AAHUs, at an incremental average cost of $2943, is worthwhile. 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.

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 was examined in the same manner as if a NED plan were being sought. 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 chain of wetlands, particularly when considering the other non-habitat benefits such as water quality, aesthetics, 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. Therefore, the entire wetland complex, with Cells A through G, is included in the environmental restoration plan.

Summary

The Chain of Wetlands Plan is, therefore, defined as the westernmost aligned swale, as described above, into which a connected series of wetlands would be developed and managed utilizing treated effluent from the CWWTP as a source of water, when needed, to supplement overbank flows from the Trinity River. The Dallas City Council, in response to the public opposition voiced against the NED Plan, and in support of the multi-objective outputs of the Chain of Wetlands Plan, voted to adopt the Chain of Wetlands Plan as the initial LPP on August 28, 1996. The total first cost of this plan was estimated at approximately $68.2 million, of which $48.9 million would be for flood control, $10.1 million would be for environmental restoration, and $9.3 million would be for recreation. This plan would yield average annual flood control

benefits of $10.9 million, with a flood control benefit-cost ratio of 1.75. Total net annual flood control benefits for the Chain of Wetlands Plan would be $4.7 million.

However, intense social and public pressure to provide added flood protection in the immediate study area comparable to that provided to the Central Business District by the existing Dallas Floodway levees prompted the city to request additional levee solutions aimed at removing more residents and businesses from flood risk.

CHAIN OF WETLANDS PLUS LEVEES

Public desires to provide greater flood protection to the neighborhoods downstream of the existing Dallas Floodway prompted further, more detailed investigation of plans involving a combination of levees and channels. In order to provide equitable protection to these areas, the city requested that SPF levees be designed on both sides of the river in the Lamar Street and Cadillac Heights areas.

Lamar Levee

Initial Alignment. The initial alignment of the Lamar Levee, located on the east side of the river, would parallel and abut the Southern Pacific Railroad line from Interstate Highway 45 (IH-45) on the upstream end to a point just upstream of S.H. 310 on the downstream side. Upstream of IH-45, the levee alignment would move away from the railroad and connect to the east levee of the existing Dallas Floodway. On the downstream end, from the point upstream of S.H. 310, the levee alignment would shift toward the river, follow a high embankment around and under S.H. 310, and connect to the existing Rochester Park Levee at the east embankment of the Southern Pacific Railroad. This levee alignment, as shown in figure 4-11, would be designed to protect all structures on the east side of the Trinity River.

Secondary (Couplet) Alignment. Concurrent studies conducted by the Texas Department of Transportation (TxDOT) regarding major transportation projects within the downtown Dallas area, including the current study area and the existing Dallas Floodway, yielded preliminary designs which indicated conflicts between roadway alignments and levee alignments within the study area might be minimized by shifting the entire levee closer to the Southern Pacific Railroad. The upstream end of the levee would tie into the east levee of the existing Dallas Floodway, as in the initial alignment, but would shift adjacent to the railroad much further upstream, near Martin Luther King, Jr. (MLK) Boulevard, thereby eliminating flood protection for all businesses in the area. The downstream end of this proposed levee would remain adjacent to the railroad downstream of S.H. 310, and would then roughly parallel the railroad and connect to the Rochester Park Levee at approximately the same location as proposed in the initial alignment. This alignment is also shown in figure 4-11.

The investigation of this proposed alignment revealed several obstacles to feasibility. First, the alignment would eliminate protection to all businesses between the river and the railroad, thereby reducing economic benefits derived from the levee. Second, the placement of the levee adjacent to the railroad would require acquisition of structures along the more densely populated east side of the tracks for construction of sump areas, thereby further reducing economic benefits while increasing project costs. Third, the proposed alignment underneath S.H. 310, on the downstream end, would yield no hydraulic benefit due to the high, existing embankments at this highway, which would restrict conveyance of flood waters to a greater degree than the levee. Vast amounts of excavation and bridge construction would be required to produce hydraulic benefits within this area. For these reasons, the couplet alignment was eliminated from further investigation.

Final Alignment. The next alignment investigated, shown in figure 4-11, would be very similar to the initial alignment, with the exception that the upstream end of the levee would be aligned through the large warehouse structure previously owned and occupied by Proctor & Gamble, but which had essentially been abandoned since the previous analysis. The acquisition of this structure was deemed advantageous for the hydraulic benefits derived from moving the levee further from the river, and for the potential use of this property as a sump area behind the levee.

Summary. As a result of these analyses, the Lamar Street Levee, included in the Chain of Wetlands Plus Levees Plan is defined as a SPF plus 2 foot earthen levee connecting the downstream end of the east levee in the existing Dallas Floodway, at the east abutment of the old Atchison, Topeka and Santa Fe (AT&SF) Railroad bridge, with the existing Rochester Park Levee, at the east abutment of the Southern Pacific Railroad bridge. The levee would have an average height of 21 feet and would be about 3 miles long. This extension would not require raising any portion of the existing Floodway levee, and only about 1,000 feet of the Rochester Park Levee would have to be raised less than one foot. About 4,500 feet of the existing Rochester Park Levee would be made unnecessary by the Lamar Levee. Although the alignment of this levee would be adjacent to several commercial businesses, the majority of these businesses would not require relocation. The Proctor and Gamble storage facility and some smaller commercial structures at the downstream end of the Lamar Levee, near S.H. 310, would require relocation, however.

Cadillac Heights Levee

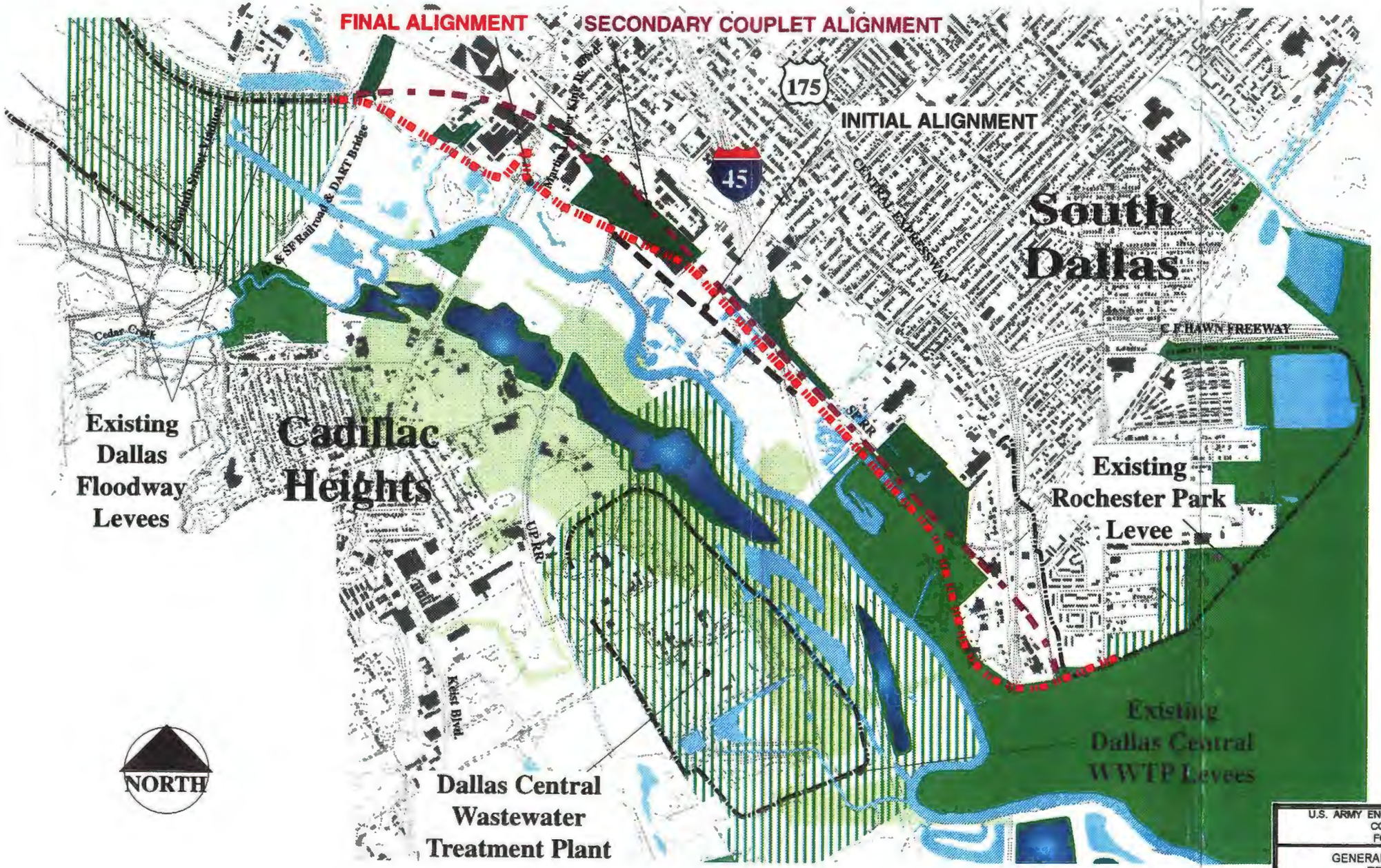
The Cadillac Heights Levee, on the west side of the river, would be composed of new construction and modification of previous construction. Several design iterations were required prior to a final alignment. A proposed new levee would be constructed between Cedar Creek and the CWWTP, a modification to the existing CWWTP Levee would be required, and an extension of the proposed levee behind the CWWTP would be necessary. Two major areas of concern regarding the location of this levee were the possible adverse environmental impacts which this levee might create, and the possible disruption of businesses within the area. Additional obstacles with which the design of this levee had to contend were the presence of large underground sewer lines running parallel with the general flow of the river, and the presence of a utility easement on which large Texas Utilities (TU) towers were located. The underground sewer lines, alluded to previously, included three active 60-inch diameter lines and one 120-inch diameter line, in addition to two abandoned 36-inch diameter lines. The alternatives investigated for this levee are described in the following sections, and are shown in figure 4-12.

New Levee - Eastern Alignment. The initial alignment of the proposed earthen levee would begin upstream near the confluence of Cedar Creek with the Trinity River. Downstream of the MLK Boulevard bridge, the levee would cross over to the east side of the underground sewer lines and TU easement, and then proceed downstream and connect to the CWWTP Levee. Although this alignment would protect a meat packing plant, several potentially insurmountable issues were identified. Foremost, placement of a levee at this location in the floodplain would create significant adverse hydraulic impacts to upstream water surface elevations. In addition, the swale and chain of wetlands would have to be moved closer to the river to accommodate the levee, thereby eliminating the environmental benefits which instigated the realignment of the chain of wetlands as far west as possible. Furthermore, serious concerns were voiced about crossing over major sewer lines with a levee, due to the need for access to the lines and due to potential hazards to the levee in the event of a sewer line break. For these reasons, this "eastern" alignment was eliminated from further consideration.

New Levee - Western Alignment. Several options were investigated for placement of a levee west of the sewer lines, with varying degrees of impact to existing businesses. The upstream end of each levee would match the initial, eastern alignment from Cedar Creek to MLK Boulevard. Downstream of MLK Boulevard, however, each of these "western" alignments would be located on the west side of the sewer lines. These options are described as follows:

<u>Western - Earthen Option.</u> This option would include an entirely earthen levee constructed through the existing meat packing plant, thus requiring acquisition and relocation of the plant. This alignment would cause no impacts to the sewer lines.

<u>Western - Floodwall Option.</u> The alignment of this levee would be the same as the western-earthen option, with the exception that a floodwall would be constructed around the packing plant's main facility, and would require relocation of a barn structure. The floodwall would be required to cross the sewer lines at two locations.



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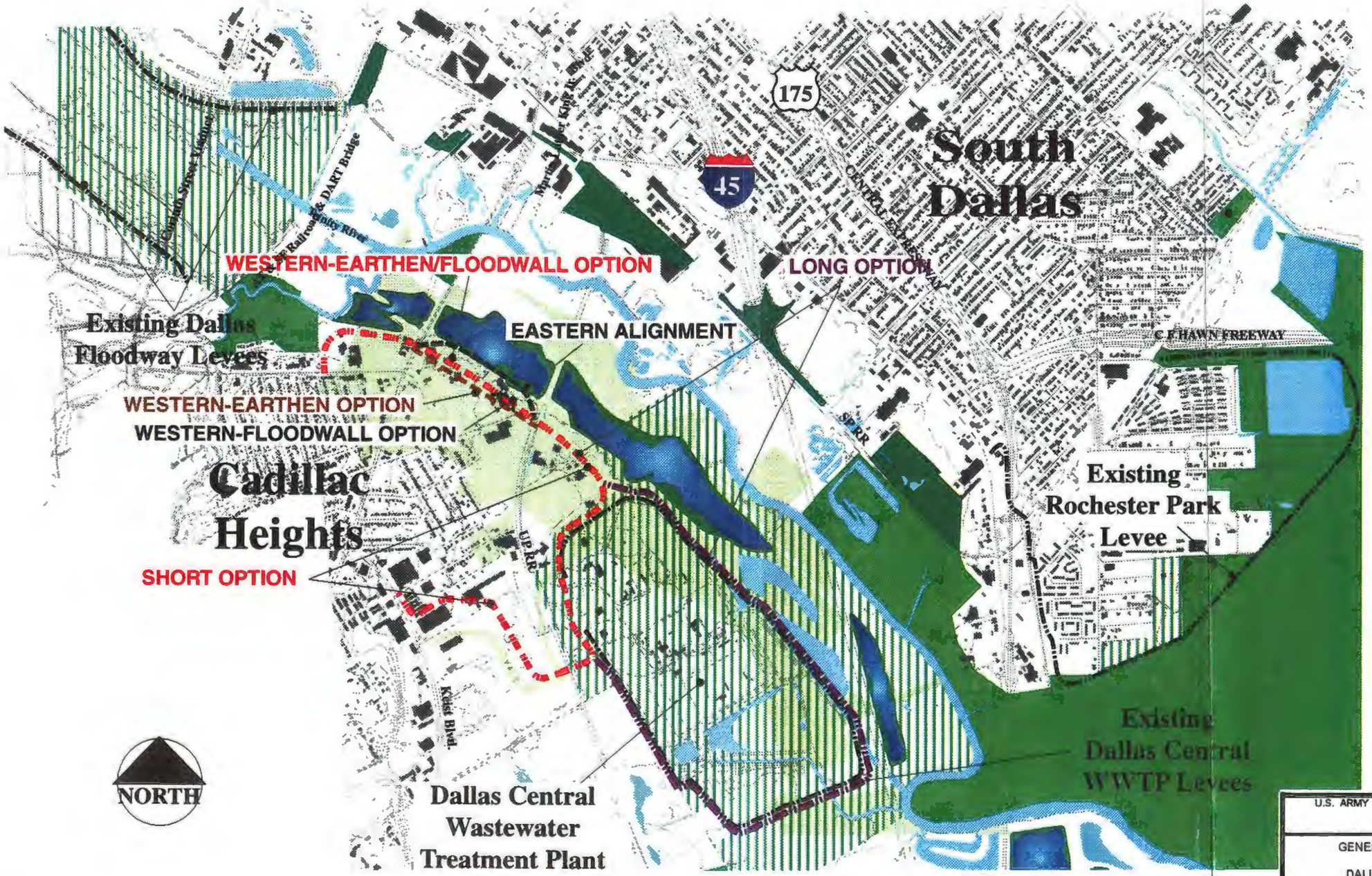
GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

LAMAR LEVEE ALTERNATIVES

FIGURE 4-11



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FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

CADILLAC HEIGHTS LEVEE ALTERNATIVES

FIGURE 4-12

Western - Earthen/Floodwall Option. The intent of this option would be to minimize the levee footprint to accommodate placement between the westernmost 60-inch sewer line and the 120-inch line, from MLK Boulevard to the Missouri-Kansas-Texas (MKT) Railroad upstream of the CWWTP. Within this area, the earthen levee would require 3:1 side slopes, a 15-foot crest width and a 6-foot high concrete floodwall on top. There would be some overburden placed on the sewer lines within this area. The remaining portions of the Cadillac Heights Levee would consist entirely of earthen embankments with side slopes of 4:1 and crest widths of approximately 20 feet. This alignment would also require relocation of the Dallas City Packing barn facility.

A comparison of direct construction costs, preliminary real estate acquisition and relocation costs, and environmental impacts revealed that these options would be economically and environmentally comparable. However, from an engineering and operation and maintenance standpoint, the risks associated with constructing a floodwall and/or earthen levee on top of sewer lines would make such options much less desirable; therefore, subsequent engineering recommendations endorsed the western-earthen option.

Based on the preceding discussions, decisions were made that further analysis of the Cadillac Heights Levee would be based on an earthen levee located west of the underground sewer lines between Cedar Creek and the CWWTP, thereby requiring acquisition and relocation of several businesses, including the meat packing plant.

CWWTP Levee Tie-In. The proposed new levee, as described above, would be designed to tie into and utilize the existing CWWTP Levee. Two options were investigated for the CWWTP Levee, as shown in figure 4-12, and as described below.

Short Option. In this option, the proposed new levee would tie into the CWWTP Levee, utilize and raise the northwest corner of this levee at the plant entrance to SPF levels, and then extend from the west side of the CWWTP Levee to high ground near the intersection of Kiest Boulevard and McGowan Avenue. This short option, in combination with the Chain of Wetlands and the Lamar Levee, would provide approximately 500-year flood protection to the CWWTP, as opposed to the current 140-year protection. The upstream impacts to the SPF flood elevation at the downstream end of the existing Dallas Floodway for the short option (including the Chain of Wetlands and Lamar Levee) would be an overall reduction of 1.1 feet.

Long Option. The long option would encompass and provide SPF protection to the entire CWWTP. This option would raise the entire CWWTP Levee about 4 feet, except for the northwest corner at the entrance, and would utilize the alignment of the existing levee system. The long option would tie into high ground in the same manner as the short option. The upstream impacts to the SPF flood elevation at the downstream end of the existing Dallas Floodway for the long option (including the Chain of Wetlands and Lamar Levee) would be an overall reduction of 0.45 feet.

The long option was estimated to cost $3.5 million more than the short option, and would yield a loss of benefits in the existing Dallas Floodway of approximately $0.9 million compared to the short option. Due to the increased cost and decreased benefits of the long option, the local sponsor would be responsible for 100% of the increased cost. Based on these findings, the city opted to support the short option.

Summary. The Cadillac Heights Levee to be included in the Chain of Wetlands Plus Levees Plan is defined as a SPF plus 2 foot earthen levee beginning upstream near the confluence of Cedar Creek and the Trinity River and extending on the west side of the underground sewer lines to the CWWTP Levee. The short option, as described above, would be utilized around the CWWTP. The average height of the Cadillac Heights Levee would be about 20 feet, with a length of approximately 2.3 miles.

Interior Drainage

While providing a substantial degree of riverine flood damage reduction to existing properties in the Dallas Floodway Extension study area, the proposed Lamar Street and Cadillac Heights levees would trap a major portion of the surface runoff from about 1,264 and 337 acres of localized subbasin area, respectively. Current Corps policies require that the interior drainage facilities (sumps and sluice outlets)

be designed so as to ensure that this runoff does not contribute to any induced flood damage, and that the interior drainage system be designed to operate in such a way that it does not impair the effective operation of the proposed levee. In addition, current Corps engineering manuals indicate that the minimum facilities from which to begin sump optimization planning procedures should at least meet any minimum design standards established by the local sponsor's drainage ordinance.

The facilities along the proposed levees were initially sized to accommodate collection and/or passage of the 100-year frequency (.01 probability of exceedance) localized runoff event, in accordance with drainage system standards of the local sponsor, the City of Dallas. Along the Lamar Street Levee, this design entailed the proposed implementation of a series of five sumps with related outlet sluice facilities. Areas exhibiting the more low-lying terrain adjacent to the landward side of the proposed levee alignment were chosen for use as sumps. Three of these sites would require extensive excavation, while the existing terrain at the other two sites was found to be adequate in providing the necessary sump storage. Along the Cadillac Heights Levee, this design entailed the proposed implementation of a series of four outlet sluice facilities. Due to the higher terrain along the proposed Cadillac Heights Levee, in contrast with that along the Lamar Street Levee, it is possible to adequately pass the interior runoff design hydrograph without having to temporarily store significant floodwaters. As a result, no specific sump excavations are currently proposed along the Cadillac Heights Levee.

In all instances, any known existing storm sewer lines capable of draining portions of the localized runoff into the Trinity River were assumed to remain in place, and be supplemented with a flap gate, to ensure that the occasionally high river stages do not cause a reversal of flow into the landward side of the proposed levees. Flows capable of being diverted to the river, using the existing storm sewer lines, were subtracted from the total localized runoff in order to develop effective inflow hydrographs at each facility for the design event. The actual sizing of any required sump excavation and the outlet sluice facilities was accomplished by first taking advantage of the mostly vacant real estate pockets along the landward side of the proposed levees, by next varying the size and number of outlet conduits (up to reasonable limits), and by lastly incorporating a degree of surface excavation, to the point that it could be ensured that the 100-year frequency (initial design level) event could be passed without creating a pooling effective on adjacent, non-sump properties.

Summary. The sumps along the proposed Lamar Street Levee would be situated from upstream to downstream as follows, and as shown in figure 4-11. The first would be located immediately southeast of the Dallas Area Rapid Transit (DART) rail line. It would require no excavation, but would inundate 1.68 acres under the design condition. The second would be located at the southwest "dead" end of Forest Avenue. It would require some limited excavation (on the southwest side of an existing commercial activity) and would inundate 1.80 acres under the design condition. The third would straddle the Missouri-Kansas-Texas (MKT) Railway and occupy the long triangular area bounded by that railway, the Southern-Pacific (SP) Railway, and the proposed Lamar Street Levee. It would require extensive excavation and would inundate 17.10 acres under the design condition. The fourth would be located beneath the north end of the Interstate Highway 45 (Julius Schepps Freeway) bridge over the Trinity River valley. It would require no excavation, but would inundate 8.08 acres under the design condition. The fifth would be located along the northeast side of the SP Railway, behind the active commercial entities along the more southeastern end of Lamar Street. It would require substantial excavation and would inundate 12.20 acres under the design condition.

The interior drainage facilities (sluice structures) along the proposed Cadillac Heights Levee, none of which would require significant excavation or would be expected to create a significant area of inundation, would be situated from upstream to downstream as follows. The first would be located west of Martin Luther King Jr. (Cedar Crest) Boulevard. The second would be located adjacent to the west side of the MKT Railway, at the point where it crosses the northeastern leg of the proposed levee alignment. The third would be located several hundred feet east of the MKT Railway. The fourth would be located adjacent to the MKT Railway, at the point where it crosses the southern leg of the proposed levee alignment.

Those sump areas which would be excavated would have three-on-one side slopes, and generally flat bottoms (sloped very slightly to the outlet). The outlet sluice facilities are proposed as simple rectangular

conduits with both a flapgate (at the outlet end) and a manually operated sluice gate. Pertinent data on the sumps and outlet sluice structures, including hydrologic effects, are presented in table A-9 of Appendix A.

Summary

The Chain of Wetlands Plus Levees Plan is defined as the Chain of Wetlands Plan, described previously, in combination with SPF plus 2 foot levees protecting the Lamar and Cadillac Heights areas. Preliminary analyses indicated this plan would impact about 600 acres of environmental resources, including approximately 193 acres of bottomland hardwoods, and would require approximately 1,400 acres of mitigation at an estimated cost of about $6.0 million.

FINAL ANALYSIS OF THE LOCALLY PREFERRED PLAN

As stated previously, the formulation process for this study was comprised of three distinct phases, two of which were completed during identification of the NED Plan. The revisions in the third phase of this process entailed the use of January 1997 price levels and application of the prevailing Federal interest rate of 7.375 percent in all economic analyses, incorporation of Congressional legislation, specifically the Water Resources Development Act (WRDA) of 1996, and inclusion of final revisions to the hydrologic model from the Upper Trinity River Feasibility Study. The following sections reflect the impact these revisions had on overall project cost and benefit analyses.

Impacts of WRDA 1996

On October 12, 1996, during the alternative formulation process and prior to final selection of the LPP, Congress passed WRDA 1996 (Public Law 104-303), which necessitated several revisions in the analysis of alternatives for this project. As stated previously, the local sponsor's request for a Section 215 or Section 104 agreement regarding credit for the non-Federal construction of the Rochester Park Levee and modifications to the CWWTP Levee was denied due to the timing of the request and/or lack of prior approval from the Assistant Secretary of the Army (Civil Works). The sponsor subsequently sought legislation approving the credit. Section 351 of WRDA 1996, quoted in Chapter 3 of this document, is the culmination of that effort.

In summary, Section 351 recognized and acknowledged that the Rochester Park and CWWTP Levees, previously constructed by the non-Federal sponsor (City of Dallas), should be treated as the first element of the project. The actual cost of these levees was $26,958,000 ($14,220,000 for CWWTP, and $12,738,000 for Rochester Park). The legislation stated that costs for the portions of the previously constructed levees compatible with the authorized project, as modified, would be credited toward the non-Federal share of the Federal project. Finally, it specified that the requirement for a 5% cash contribution during construction, stated in WRDA 1986, would remain applicable.

The inclusion of costs for the Rochester Park and CWWTP Levees as part of the overall project costs necessitated revision of the "existing conditions" hydraulic and economic models to reflect pre-1991 conditions in order to capture the benefits derived from these levees. Revised existing conditions damages are presented in table 3-6, in Chapter 3, of this report.

Further guidance received from HQUSACE provided instructions on the implementation of Section 351 in regard to economic justification requirements for the non-Federal levees, and the extent of inclusion of their respective costs and benefits into the various alternatives investigated. This guidance indicated that the portions of the non-Federal levees that are compatible with the authorized project shall be included in the Federal plan, and that if the levees are incrementally economically justified, they shall be included in the NED Plan as well. This guidance, therefore, required incremental analyses of the non-Federal levees, as described in the following paragraphs.

Central Wastewater Treatment Plant Levee

The Central Wastewater Treatment Plant (CWWTP) was previously protected by a levee providing adequate protection from storms with an exceedance probability of 0.02 or greater (50-year). After the flood event in 1990, when access to the plant was curtailed and a near failure occurred, some difficult decisions were made. Dallas Water Utilities estimated $90 million of flood damages would be incurred for any overtopping of its levees, not including costs for clean-up, downstream environmental problems associated with uncontained raw sewage, fines levied by the Environmental Protection Agency, and loss of customer service to the city for the time the CWWTP is down. Due to the amount at risk, both monetary and non-monetary, the city could ill afford to wait for the Federal process. Thus, in 1992-1994, coordination with Corps officials took place to ensure that the levee placement would be physically compatible with the alignment of the Authorized Plan, and the levee protecting the CWWTP was upgraded to its current height. The upgraded levee now provides protection from storms with an exceedance probability of 0.01 (100-year), with a level of confidence of 66%, which indicates an approximate 140-year level of protection.

Table 4-12 contains the benefits and actual costs of the CWWTP levee upgrade. Total investment cost is $14.2 million, with net benefits of $22,000, yielding a BCR of 1.02.

Table 4-12
Benefit Cost Analysis for the CWWTP Levee Upgrade
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Project Alternatives Include Land/Mitigation & HTRW Costs	CWWTP Levee
ESTIMATED FIRST COST	
Non-Federal Levee Cost	$14,220,000
ANNUAL CHARGES	
Interest	$1,048,725
Amortization	$30,765
Operation/Maintenance ($/year)	$75,000
Replacements	$0
TOTAL ANNUAL CHARGES	$1,154,490
ANNUAL BENEFITS	
Inundation Reduction	$1,085,300
Existing Dallas Floodway	$91,208
TOTAL BENEFITS	$1,176,508
NET BENEFITS	$22,018
BENEFIT COST RATIO	1.02

** The estimated first costs reflect actual expenditures for the CWWTP Levee upgrade in 1993.*

Rochester Park Levee

The Rochester Park Levee was constructed from 1991-1993, following a series of floods that devastated the area. Public outcry resulted in the city taking immediate action to extend protection to the citizens most vulnerable to flooding. Sufficient funds were not available to construct the entire eastern levee (referred to in this text as the Lamar Levee), so the city built only a portion of the system following the

alignment proposed in the Authorized Plan, to the extent possible. In order to provide the maximum protection possible with the funds available, the upstream portion (tail) deviated from the alignment and tied back to high ground in as short a distance as possible. As a stand alone project, the Rochester Park Levee is not economically justified, yielding a BCR of about 0.5.

Construction of the remainder of the Lamar Levee, as proposed in the Chain of Wetlands Plus Levees Plan, would mean that about 4,500 feet of the upstream portion of the Rochester Park Levee would be abandoned, i.e., it would be physically incompatible with the Lamar Levee. The downstream portion of the levee, however, would be fully utilized as part of the system.

Since only a portion of the Rochester Park Levee would qualify for credit under the criteria of physical utilization, economic viability of this piece was tested as part of the Lamar Levee system. An evaluation of the benefits and costs for the Lamar Levee system, with the compatible portion of Rochester Park included, shows the system to be justified as a second added element to the Chain of Wetlands swale. These benefits and costs are provided in table 4-13. Note that the creditable portion of Rochester Park was estimated at approximately $8.9 million, and is shown in the line item entitled "Non-Federal Levee Cost".

Table 4-13
Benefit Cost Analysis for the Lamar Levee System
(Including the Compatible Portion of Rochester Park Levee)
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Project Alternatives Include Land/Mitigation & HTRW Costs	Lamar Levee Incremental
ESTIMATED FIRST COST	$15,631,200
Annual Interest Rate	0.073750
Project Life (years)	50
Construction Period (months)	24
Compound Interest Factor	25.77523
Capital Recovery Factor	0.0759135
Interest During Construction	$1,166,944
Non-Federal Levee Cost	$8,900,000
Investment Cost	$25,698,144
ANNUAL CHARGES	
Interest	$1,895,238
Amortization	$55,598
Operation/Maintenance ($/year)	$181,000
Replacements	$0
TOTAL ANNUAL CHARGES	$2,131,836
ANNUAL BENEFITS	
Inundation Reduction	$1,061,700
Existing Dallas Floodway	$1,450,200
TOTAL BENEFITS	$2,511,900
NET BENEFITS	$380,100
BENEFIT-COST RATIO	1.18

** The estimated first costs reflect actual expenditures for construction of the Rochester Park Levee from 1991 - 1993.*

In accordance with the policy guidance received, and based on Section 351 of WRDA 1996, the total project costs and benefits for all the plans investigated for the LPP were increased to account for the portions of the non-Federal levees deemed compatible for each alternative, as summarized below.

- **NED Plan:** The economic infeasibility of the Rochester Park Levee as a stand alone project preclude the inclusion of the costs and benefits of this levee in the NED Plan. Therefore, only the costs and benefits of the CWWTP Levee upgrade would be added. The cost of this levee upgrade was $14,220,000. Included in this amount was $190,000 in lands, easements, relocations, rights-of-way, and disposal area (LERRD) costs.

- **Chain of Wetlands Plan:** Should the Chain of Wetlands Plan be identified as the final Recommended Plan, the requirements of Section 351 of WRDA 1996 to include the non-Federal levees in the authorized project would allow the costs and benefits of both levees to be included in this alternative. The total cost of both levees was $26,958,000, of which $1,272,000 was defined as LERRD costs.

- **Chain of Wetlands Plus Levees Plan:** The compatible portions of non-Federal levees for this plan would include the entire CWWTP Levee and the portion of the Rochester Park Levee physically utilized in the Lamar Levee system. The estimated cost of the "compatible" portion of Rochester Park was $8,900,000, including $756,000 in LERRD costs. Total non-Federal levee costs added to this alternative would amount to $23,120,000, including $946,000 in LERRD costs.

Table 4-14 presents costs for each of these plans, at January 1997 price levels and level of development. The total cost of the NED Plan, as shown in the table, would be increased to $73.5 million. Should the Chain of Wetlands Plan be designated as the Recommended Plan, it would have an estimated cost of $95.2 million. The Chain of Wetlands Plus Levees Plan would have an estimated cost of $119.2 million. Flood control only costs are presented in the bottom portion of this table.

The residual average annual damages and benefits of each of these alternatives were calculated by reach, and are shown in table 4-15. Table 4-16 presents an economic analysis for each of these plans. It is noted that the estimated first costs shown in this table do not include environmental restoration costs. Outputs for these features are non-monetary and are not included in the benefit-cost ratio. Also, costs for the compatible non-Federal levees are shown separately from estimated first costs of currently proposed components of each plan.

Table 4-14
Costs of Locally Preferred Plan Alternatives
(January 1997 prices, 7.375% interest, 50-year period of analysis)

	PROJECT COSTS		
	NED Plan With CWMT Levee	Chain of Wetlands With CWMT Flood Rochester Park Levees	Chain of Wetlands Plus Levees With CWMT Flood and Compatible Rochester Park Levees
LERRD (NON-FEDERAL LEVEES)	$190,000	$1,272,000	$946,000
RELOC/UTIL. - FLOOD CONTROL	$5,321,426	$1,525,247	$3,260,902
- ENVIRONMENTAL RESTORATION		$169,472	$169,472
- RECREATION			
EXCAV./DISP. - FLOOD CONTROL	$18,303,092	$16,366,595	$23,949,640
- ENVIRONMENTAL RESTORATION		$8,812,782	$8,812,782
- RECREATION			
FILL - FLOOD CONTROL	$97,854	$72,825	$1,808,192
- ENVIRONMENTAL RESTORATION			
- RECREATION			
HTRW - FLOOD CONTROL	$0	$4,041,908	$4,041,908
- ENVIRONMENTAL RESTORATION			
- RECREATION			
OTHER CONST. - NON-FEDERAL LEVEES	$14,030,000	$25,686,000	$22,174,000
- FLOOD CONTROL	$3,897,441	$16,294,824	$19,759,933
- ENVIRONMENTAL RESTORATION			
- RECREATION	$8,272,400	$8,272,400	$8,272,400
MITIGATION (W/O LAND) - FLOOD CONT.	$2,940,163	$377,800	$626,487
- ENVIRONMENTAL RESTORATION			
- RECREATION			
REAL ESTATE - FLOOD CONTROL	$4,687,800	$2,464,384	$11,779,560
- ENVIRONMENTAL RESTORATION			
- MITIGATION (FLOOD CONT.)	$11,107,200	$3,104,200	$5,140,513
ENG'RING. & DESIGN - FLOOD CONTROL	$1,833,599	$2,320,752	$3,206,824
- ENVIRONMENTAL RESTORATION	$0	$538,935	$538,935
- RECREATION	$496,344	$496,344	$496,344
CONST. MGMT. - FLOOD CONTROL	$1,833,599	$2,320,752	$3,206,824
- ENVIRONMENTAL RESTORATION	$0	$538,935	$538,935
- RECREATION	$496,344	$496,344	$496,344
TOTAL PROJECT COSTS	**$73,507,261**	**$95,172,499**	**$119,225,995**
FLOOD CONTROL COSTS ONLY (WITHOUT LOCAL LEVEES)	$50,022,173	$48,889,287	$76,780,782
LOCAL LEVEE COSTS DEEMED "COMPATIBLE"	$14,220,000	$26,958,000	$23,120,000
TOTAL FLOOD CONTROL COSTS	$64,242,173	$75,847,287	$99,900,782

Table 4-15
Annual Residual Damages and Benefits of LPP Alternatives
(January 1997 prices, 7.375% interest, 50-year period of analysis)

NED PLAN

Reach	Annual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$209,600	$38,986	$248,600	$100,300
2	$20,500	$3,813	$24,300	$35,900
3	$32,300	$6,008	$38,300	$89,200
4A	$524,500	$97,557	$622,100	$979,000
4B	$306,600	$57,028	$363,600	$515,300
5	$384,400	$71,498	$455,900	$831,700
6	$361,100	$34,666	$395,800	$1,463,300
Subtotal	$1,839,000	$309,555	$2,148,600	$4,014,700
7	$2,544,900	$473,351	$3,018,300	$8,906,600
8	$433,300	$80,594	$513,900	$670,300
Subtotal	$2,978,200	$553,945	$3,532,200	$9,576,900
Total	$4,817,200	$863,500	$5,680,800	$13,591,600

CHAIN OF WETLANDS PLAN

Reach	Annual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$269,700	$50,164	$319,900	$29,900
2	$29,800	$5,543	$35,300	$24,900
3	$47,400	$8,816	$56,200	$455,600
4A	$631,200	$117,403	$748,600	$852,500
4B	$420,300	$78,176	$498,500	$380,400
5	$459,200	$85,411	$544,600	$743,000
6	$538,400	$51,686	$590,100	$1,269,000
Subtotal	$2,396,000	$397,200	$2,793,200	$3,754,400
7	$4,449,800	$827,663	$5,277,500	$6,647,400
8	$602,700	$112,102	$714,800	$469,400
Subtotal	$5,052,500	$939,765	$5,992,300	$7,116,800
Total	$7,448,500	$1,336,965	$8,785,500	$10,871,200

CHAIN OF WETLANDS PLUS LEVEES PLAN

Reach	Annual Damages			Annual Benefits
	Direct	Incidental	Total	
1	$269,700	$50,164	$319,900	$29,000
2	$29,800	$5,543	$35,300	$24,900
3	$16,600	$3,088	$19,700	$492,100
4A	$18,400	$3,422	$21,800	$1,579,300
4B	$132,200	$24,589	$156,800	$722,100
5	$13,800	$2,567	$16,400	$1,271,200
6	$688,900	$66,134	$755,000	$1,104,100
Subtotal	$1,169,400	$155,507	$1,324,900	$5,222,700
7	$4,737,000	$881,082	$5,618,082	$6,306,818
8	$873,900	$162,545	$1,036,445	$147,755
Subtotal	$5,610,900	$1,043,627	$6,654,527	$6,454,573
Total	$6,780,300	$1,199,135	$7,979,427	$11,677,273

Table 4-16
Economic Analysis of LPP Alternatives
(January 1997 prices, 7.375% interest, 50-year period of analysis)

	NED Plan		Chain of Wetlands Plan		Chain of Wetlands Plus Levees Plan	
	Flood Control Only	With Recreation	Flood Control Only	With Recreation	Flood Control Only	With Recreation
INVESTMENT						
Estimated First Cost	$50,022,173	$59,287,261	$48,889,287	$58,154,374	$76,780,782	$86,045,870
Annual Interest Rate	0.0738	0.0738	0.0738	0.0738	0.0738	0.0738
Project Life (years)	50	50	50	50	50	50
Construction Period (months)	24	24	24	24	36	36
Compound Interest Factor	25.77523	25.77523	25.77523	25.77523	40.15579	40.15579
Capital Recovery Factor	0.0759	0.0759	0.0759	0.0759	0.0759	0.0759
Interest During Construction	$3,734,394	$4,426,078	$3,649,819	$4,341,502	$8,810,783	$9,873,974
Cost of non-Federal Levees	$14,220,000	$14,220,000	$26,958,000	$26,958,000	$23,120,000	$23,120,000
Investment Cost	$67,976,567	$77,933,339	$79,497,106	$89,453,876	$108,711,565	$119,039,844
ANNUAL CHARGES						
Interest	$5,013,272	$5,747,584	$5,862,912	$6,597,223	$8,017,478	$8,779,189
Amortization	$147,067	$168,609	$171,992	$193,533	$235,197	$257,543
Operation/Maintenance ($/year)	$375,000	$375,000	$175,000	$175,000	$495,000	$495,000
Replacements	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	$5,535,339	$6,291,193	$6,209,904	$6,965,757	$8,747,675	$9,531,731
ANNUAL BENEFITS						
Inundation Reduction	$4,014,700	$4,014,700	$3,754,400	$3,754,400	$5,222,700	$5,222,700
Existing Dallas Floodway	$9,576,900	$9,576,900	$7,116,800	$7,116,800	$6,454,573	$6,454,573
Recreation	$0	$1,000,000	$0	$1,000,000	$0	$1,000,000
TOTAL ANNUAL BENEFITS	$13,591,600	$14,591,600	$10,871,200	$11,871,200	$11,677,273	$12,677,273
NET ANNUAL BENEFITS	$8,056,261	$8,300,407	$4,661,296	$4,905,443	$2,929,598	$3,145,542
BENEFIT-COST RATIO	2.46	2.32	1.75	1.70	1.33	1.33
ENVIRONMENTAL RESTORATION	$0	$0	$0	$10,060,125	$0	$10,060,125
TOTAL PROJECT COSTS	$64,242,173	$73,507,261	$75,847,287	$95,172,499	$99,900,782	$119,225,995
No. of Structures No Longer at Risk from 100-yr Flood Event	403		511		719	
No. of Structures No Longer at Risk from SPF Event	580		241		688	

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To further aid the local sponsor in the LPP selection process, estimated cost apportionment calculations were performed showing approximate Federal/non-Federal cost sharing responsibilities for each plan. These calculations were performed assuming that the cost sharing provisions of WRDA 1986 would be applicable to flood control and recreation costs, while WRDA 1996 cost sharing requirements would be appropriate for environmental restoration features, due to the need for a Congressionally authorized amendment to the original 1965 authorization adding environmental restoration as a project purpose. The non-Federal share of project costs for each of these purposes would be as follows:

- Flood Control: 25 - 50%
- Environmental Restoration: 35%
- Recreation: 50%

Furthermore, Federal cost sharing for recreation features would be limited to 10% of the Federal share of flood control costs.

In order to calculate cost apportionments, the methodology for determining the appropriate amount of credit for "compatible" non-Federal construction was established. The amount of credit applied toward the non-Federal share of project costs for the advanced construction of the Rochester Park and CWWTP Levees would vary for different plans and would not necessarily be equal to the cost added to the plan for these levees. This credit was calculated in the following manner:

- The costs for the compatible portions of these levees applicable to each plan, as previously identified, were added as a flood control project cost.
- Federal and non-Federal project costs were then calculated *as if these levees were being constructed during implementation of the currently proposed project.*
- The required 5% cash contribution was calculated and Federal/non-Federal costs were revised accordingly.
- The non-Federal share was assessed in regard to compliance with the applicable cost sharing percentages, as described above, and Federal/non-Federal apportionments were again revised, as necessary.
- The amount of credit applied toward the non-Federal share of project costs for each plan was calculated as the non-Federal share (as derived above) minus the required 5% cash contribution, with a maximum credit equal to the total cost of the "compatible" non-Federal levees added to that particular plan.

A summary of these calculations is presented in table 4-17.

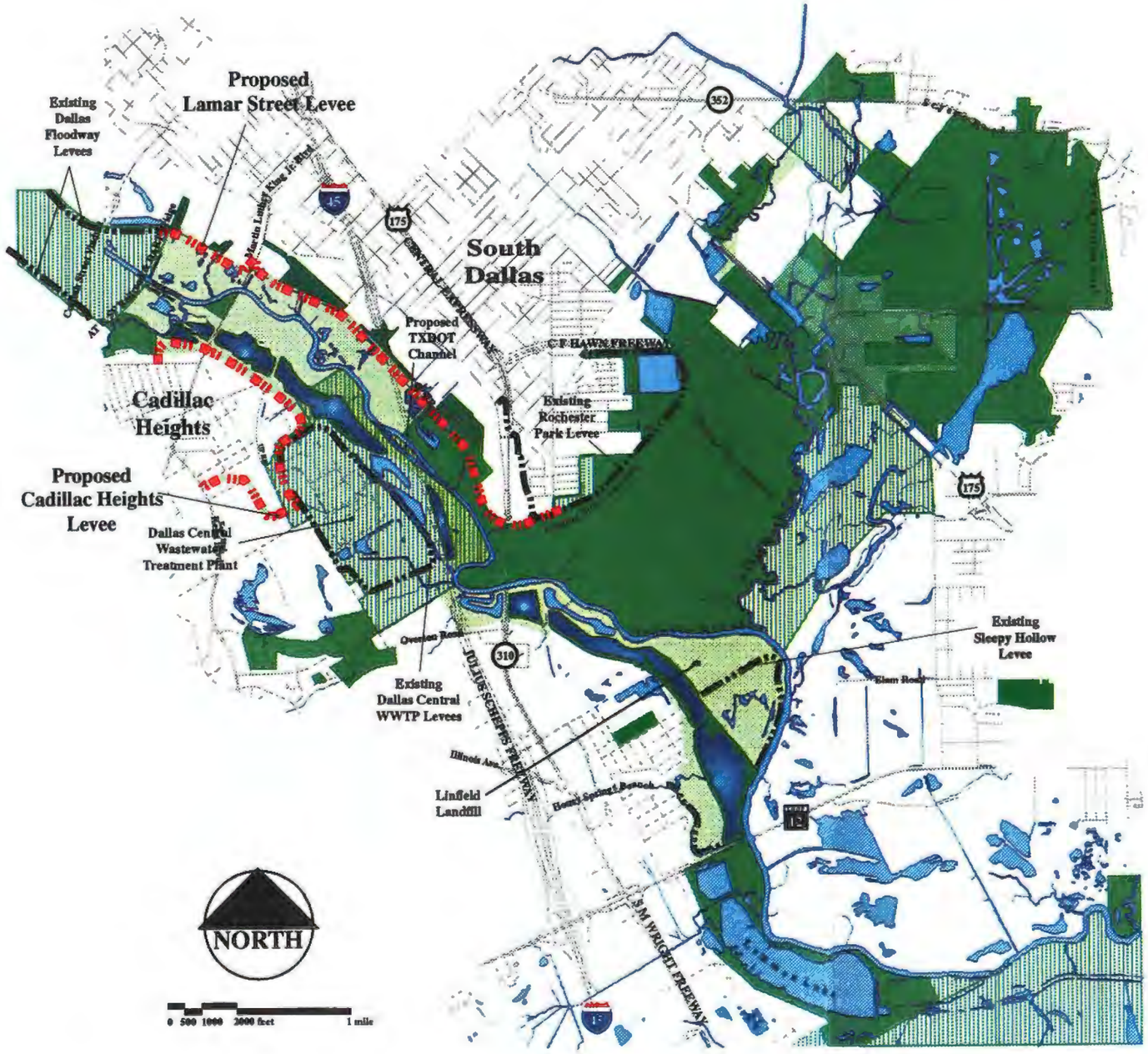
Summary

Based on these analyses, and because the Chain of Wetlands Plus Levees Plan satisfactorily met the city's desire for a multiple objective project providing flood protection to the study area comparable to that provided upstream by the existing Dallas Floodway, this plan was formally adopted by the Dallas City Council as the final LPP on March 26, 1997. Figure 4-13 presents a general layout of the features of this plan.

Table 4-17
Cost Apportionment Data For LPP Alternatives
(January 1997 prices)

Investigated Alternative	Federal Share	Non-Federal Share
NED Plan		
Total Project Cost	$73,507,261	
Share Prior to Levee Credit	$44,356,182	$29,151,079
Percent of Total Project Cost	60.3%	39.7%
Amount of Levee Credit	$14,030,000	($14,030,000)
Remaining Share of Project Cost	$58,386,182	$14,741,079
Uncredited Compatible * Non-Federal Construction	$0	
Chain of Wetlands Plan		
Total Project Cost	$95,172,499	
Share Prior to Levee Credit	$68,057,090	$27,115,410
Percent of Total Project Cost	71.5%	28.5%
Amount of Levee Credit	$15,169,457	($15,169,457)
Remaining Share of Project Cost	$83,226,547	$11,945,952
Uncredited Compatible * Non-Federal Construction	$11,788,543	
Chain of Wetlands Plus Levees Plan		
Total Project Cost	$119,225,995	
Share Prior to Levee Credit	$84,950,393	$34,275,602
Percent of Total Project Cost	71.3%	28.7%
Amount of Levee Credit	$21,126,975	($21,126,975)
Remaining Share of Project Cost	$106,077,368	$13,148,627
Uncredited Compatible * Non-Federal Construction	$1,993,025	

** "Compatible" costs of non-Federal Levees vary with each plan, as defined on pages 4-51 and 4-52 of this document.*



Legend

- Public Park Lands
- Other Public Lands
- Proposed Project Lands
- Proposed Sumps
- Proposed Swale
- Proposed Wetlands
- Existing Levees
- Proposed Levees

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

LOCALLY PREFERRED PLAN

FIGURE 4-13

FORMULATION OF THE RECOMMENDED PLAN

This section presents the identification of the Tentative Federally Supportable Plan (TFSP), and the final array of alternatives investigated for designation of the Recommended Plan.

Also presented herein are details of a proposal by the Texas Department of Transportation (TxDOT) to include a realignment of a section of the river channel at the IH-45 bridge.

IDENTIFICATION OF THE TENTATIVE FEDERALLY SUPPORTABLE PLAN

The Federally Supportable Plan (FSP) can be defined as the plan which sets the maximum limit for Federal participation in the implementation of a project. Due to maximization of net benefits, the NED Plan is normally denoted as the FSP. However, designation of a plan (larger or smaller) other than the NED Plan is permitted if there are overriding or compelling reasons favoring selection of such a plan. A recommended project which is smaller (less costly) than the NED Plan would, with appropriate approval, be designated as the FSP, thereby establishing lower Federal participation constraints. Should the local sponsor prefer a plan which is more costly than the NED Plan, an exception to the NED requirements may be granted by the Assistant Secretary of the Army for Civil Works (ASA(CW)), should the increased development warrant full Federal participation. Such an exception would be cost shared the same as the NED Plan and would become the Federally Supportable Plan. This section provides comparative data between the final array of alternatives investigated, prior to any decisions by the ASA(CW) regarding an exception, and presents rationale for designation of a plan other than the NED as the Tentative Federally Supportable Plan (TFSP). The final Federally Supportable Plan (FSP) will be designated following the decision of the ASA(CW).

Due to the significant adverse environmental impacts associated with implementation of the NED Plan, an incremental analysis of the separable flood control elements of the LPP was performed to determine whether a Tentative Federally Supportable Plan could be established which would complement the LPP. These separable elements include the swale (with incorporated chain of wetlands), the SPF Lamar Levee, and the SPF Cadillac Heights Levee. In accordance with Section 351 of WRDA 1996, the costs and benefits of the CWWTP Levee and the "compatible" portion of the Rochester Park Levee are included in this analysis, shown in table 4-18. Note that the benefits for the chain of wetlands *increment* of the LPP are different than the benefits for the Chain of Wetlands Plan presented in table 4-16. The reason for this difference is that the Chain of Wetlands Plan would include the costs and benefits of the CWWTP Levee upgrade and the *entire* costs and benefits for the Rochester Park Levee. However, the LPP would only include the costs and benefits for the CWWTP Levee upgrade and the *portion* of the Rochester Park Levee which would be compatible with the LPP. Since the Rochester Park Levee would be an integral part of the Lamar Levee system, the costs and benefits of its "compatible" portion were included in the Lamar Levee increment, while the CWWTP Levee was included in the chain of wetlands increment.

Given the three separable flood control features, it was assumed that the chain of wetlands swale must be the first added element. It would achieve benefits from all reaches, the net benefits would be far greater than the other elements, and it is the only feature which would not adversely impact adjoining areas due to increased water surfaces for given storms. The chain of wetlands swale and CWWTP Levee, when analyzed as an increment of the LPP, would have a flood control first cost of $63.1 million ($48.9 million for the chain of wetlands and $14.2 million for the CWWTP Levee), a BCR of 2.05, and net annual flood control benefits of $5.4 million. Comparatively, the NED Plan would have estimated flood control costs of $64.2 million ($50.0 million for the 1,200-foot swale and $14.2 million for the CWWTP Levee), net annual flood control benefits of approximately $8.1 million, and a BCR of 2.46. From an environmental standpoint, the NED Plan was estimated to directly impact over 725 acres of environmental resources, including 504 acres of mature bottomland hardwoods, and would require the purchase of 3,200 acres of mitigation land. The chain of wetlands portion of the LPP was preliminarily estimated to directly impact only 287 acres of lower quality terrestrial, including 114 acres of bottomland hardwoods, requiring only 635 acres of mitigation.

As shown, the Chain of Wetlands Plan would yield fewer net benefits than the NED Plan, but would have a lower estimated first cost. Based on these findings, and on the expected difficulty in implementing the NED Plan from a public acceptability standpoint, general consent, by ASA(CW) and HQUSACE representatives, for designation of the chain of wetlands as the first increment of the Tentative Federally

Supportable Plan, in lieu of the NED Plan, was given during the Alternative Formulation Briefing, held June 19, 1997. Furthermore, policy guidance allows for the addition of incrementally justified elements of the LPP to the Tentative Federally Supportable Plan, with full cost sharing provisions. The levees were analyzed as separate increments for possible inclusion in the Tentative Federally Supportable Plan.

The SPF Cadillac Heights Levee was analyzed as the second added element by combining it with the swale. Results showed this increment would have a negative contribution, with a BCR of 0.81.

The SPF Lamar Levee system, however, fared much better as a second added element, with an incremental BCR of 1.36. Combined with the swale, net annual benefits of $6.1 million would be achieved. This levee was, therefore, incorporated into the Tentative Federally Supportable Plan.

Finally, both levees were evaluated as a system to determine overall economic efficiency. As a total system, the LPP would have net annual flood control benefits of $2.9 million, with a BCR of 1.33.

Due to the incremental infeasibility of the SPF Cadillac Heights levee, further analysis was performed to determine whether or not a 100-year levee could be economically justified. This analysis, shown in table 4-19, revealed that a 100-year levee would be incrementally justified, and can be added to the Tentative Federally Supportable Plan.

Summary

The identified Tentative Federally Supportable Plan, as shown in figure 4-14, would consist of the following elements:

- **Chain of Wetlands:** The chain of wetlands increment would consist of upper and lower swales, separated at Interstate Highway (IH) 45. The upper swale would have an average 400-foot bottom width and would extend from Cedar Creek to the oxbow lake at IH-45, a distance of about 1.5 miles. The lower swale would have an average 600-foot bottom width, would extend between IH-45 and Loop 12, a distance of about 2.2 miles, and would be aligned through the Linfield Landfill and Sleepy Hollow Golf Course to minimize impacts to forested areas and nearby residential areas. Excavated wetlands and vegetative plantings would be added as environmental restoration features within the footprint of the swales to form a "chain of wetlands."

- **SPF Lamar Levee:** This increment would include construction of an earthen levee providing SPF protection (.00125 probability of exceedance) for the Lamar Street area and. This levee would extend from the existing Dallas Floodway East levee to the previously constructed Rochester Park Levee, a distance of 2.9 miles.

- **100-Year Cadillac Heights Levee:** This increment would include a levee / floodwall system providing 100-year protection (.01 probability of exceedance) for the Cadillac Heights area. This levee would extend from near Cedar Creek to the Central Wastewater Treatment Plant (CWWTP), a distance of 1.1 miles.

- **Non-Federal Levees:** In addition to the levees described above, the Tentative Federally Supportable Plan would also include the costs and benefits of the portions of the previously constructed non-Federal levees. The total cost for the compatible portions of these levees was estimated at $23.1 million ($14.2 million for the CWWTP Levee upgrade and $8.9 million for the compatible portion of the Rochester Park Levee).

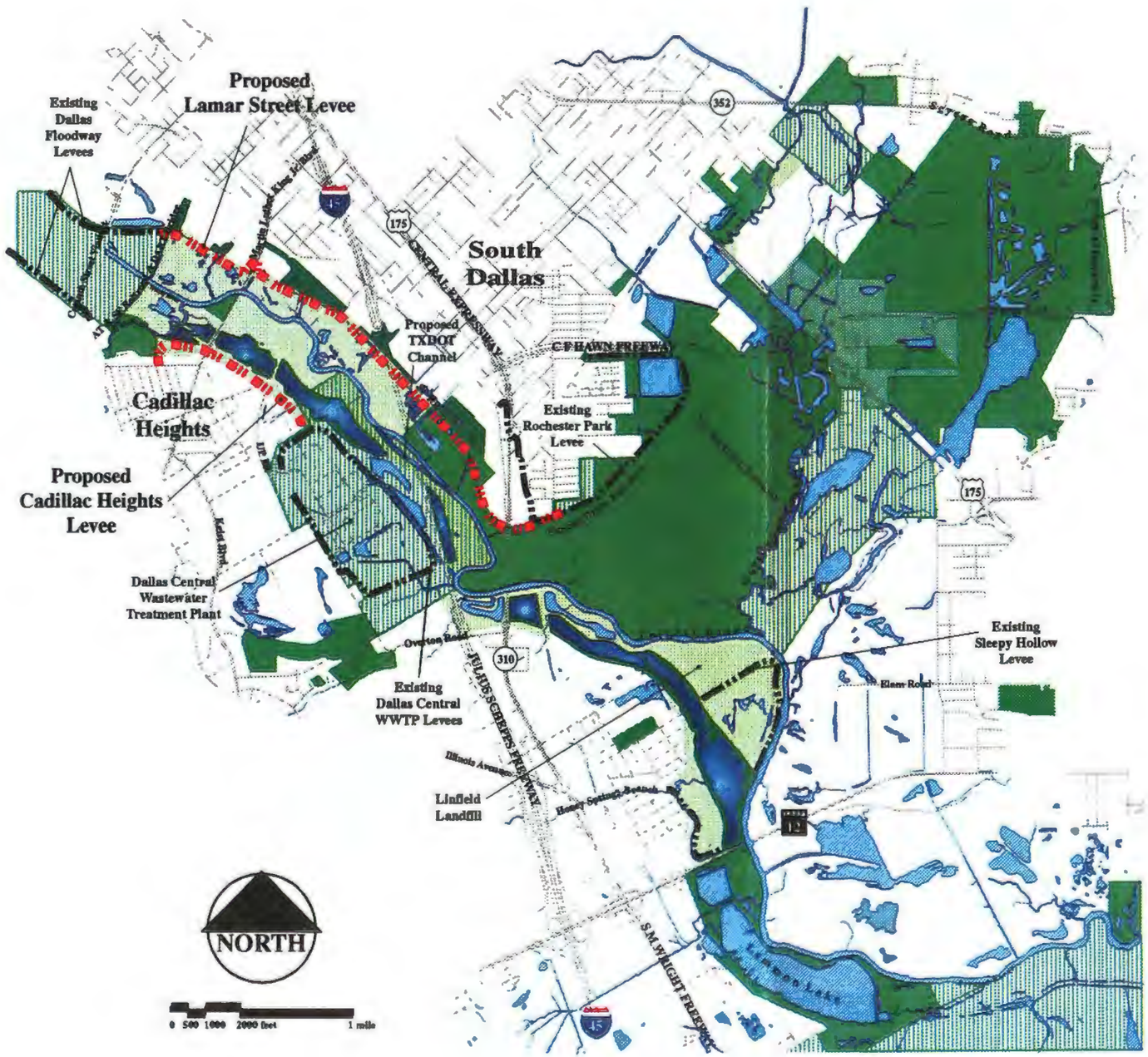
- **Recreation Features:** The Tentative Federally Supportable Plan would include recreation amenities compatible with the regional recreation master plan, including hike/bike trails, equestrian trails, canoe launches and pavilions.

Table 4-18
Incremental Analysis of the LPP - Flood Control Only
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Description	Chain of Wetlands	Chain of Wetlands Plus SPF Cadillac Heights	SPF Cadillac Heights Incremental	Chain of Wetlands Plus SPF Lamar	SPF Lamar Incremental	Chain of Wetlands Both SPF Levees
INVESTMENT						
Estimated First Cost	$48,889,287	$61,149,587	$12,260,300	$64,520,487	$15,631,200	$76,780,782
Annual Interest Rate	0.073750	0.07375	0.07375	0.073750	0.073750	0.073750
Project Life (years)	50	50	50	50	50	50
Construction Period (months)	24	24	24	24	24	36
Compound Interest Factor	25.77523	25.77523	25.77523	25.77523	25.77523	40.15579
Capital Recovery Factor	0.0759135	0.0759135	0.0759135	0.0759135	0.0759135	0.0759135
Interest During Construction	$3,649,819	$4,565,109	$915,290	$4,816,763	$1,166,944	$8,810,783
Cost of Non-Federal Levees	$14,220,000	$14,220,000	$0	$23,120,000	$8,900,000	$23,120,000
Investment Cost	$66,759,106	$79,934,696	$13,175,583	$92,457,250	$25,698,144	$108,711,565
ANNUAL CHARGES						
Interest	$4,923,484	$5,895,184	$971,700	$6,818,722	$1,895,238	$8,017,478
Amortization	$144,433	$172,939	$28,505	$200,031	$55,598	$235,197
O&M ($/year)	$50,000	$189,000	$139,000	$231,000	$181,000	$495,000
Replacements	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	$5,117,917	$6,257,123	$1,139,204	$7,249,753	$2,131,836	$8,747,676
ANNUAL BENEFITS						
Inundation Reduction	$3,370,100	$4,289,800	$919,700	$4,816,100	$1,443,000	$5,222,700
Existing Dallas Floodway	$7,116,800	$7,116,800	$0	$8,567,000	$1,450,200	$6,454,578
TOTAL ANNUAL BENEFITS	$10,486,900	$11,406,600	$919,700	$13,383,100	$2,893,200	$11,677,278
NET ANNUAL BENEFITS	$5,368,983	$5,149,477	($219,504)	$6,133,347	$761,364	$2,929,598
BENEFIT - COST RATIO	2.05	1.82	0.81	1.85	0.36	1.33

Table 4-19
Incremental Analysis of the
100-Year Cadillac Heights Levee - Flood Control Only
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Description	Chain of Wetlands Plus SPF Lamar	Chain of Wetlands, SPF Lamar and 100-Year Cadillac Heights Levee	100-Year Cadillac Heights Incremental
INVESTMENT			
Estimated First Cost	$64,520,487	$67,224,987	$2,704,500
Annual Interest Rate	0.073750	0.073750	0.073750
Project Life (years)	50	50	50
Construction Period (months)	24	24	24
Compound Interest Factor	25.77523	25.77523	25.77523
Capital Recovery Factor	0.0759135	0.0759135	0.0759135
Interest During Construction	$4,816,763	$5,018,668	$201,904
Cost of Current Levees	$23,120,000	$23,120,000	$0
Investment Cost	$92,457,250	$95,363,654	$2,906,404
ANNUAL CHARGES			
Interest	$6,818,722	$7,033,069	$214,347
Amortization	$200,031	$206,319	$6,288
O&M ($/year)	$231,000	$370,000	$139,000
Replacements	$0	$0	$0
TOTAL ANNUAL CHARGES	$7,249,753	$7,609,389	$359,635
ANNUAL BENEFITS			
Inundation Reduction	$4,816,100	$5,272,300	$456,200
Existing Dallas Floodway	$8,567,000	$8,567,000	$0
TOTAL BENEFITS	$13,383,100	$13,839,300	$456,200
NET ANNUAL BENEFITS	$6,133,347	$6,229,911	$96,565
BENEFIT - COST RATIO	1.85	1.82	1.27



Legend

- Public Park Lands
- Other Public Lands
- Proposed Project Lands
- Proposed Sumps
- Proposed Swale
- Proposed Wetlands
- Existing Levees
- Proposed Levees

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

TENTATIVE FEDERALLY SUPPORTABLE PLAN

FIGURE 4-14

The flood control first cost of the Tentative Federally Supportable Plan would be $67.2 million, plus $23.1 million for the non-Federal levees, for a total of $90.3 million. Total annual flood control benefits would equal $13.8 million, net annual flood control benefits would be $6.2 million, and the BCR would be 1.82.

CHANNEL REALIGNMENT PROPOSAL AT IH-45 BRIDGE

During the Environmental Impact Statement (EIS) scoping process, the Texas Department of Transportation (TxDOT) submitted a proposal to realign the Trinity River at IH-45 as a part of the Dallas Floodway Extension project. TxDOT provided documentation that the bridge at IH-45 was constructed in 1972 to complement the authorized navigation channel of the Dallas Floodway Extension portion of the Trinity River Project. The bridge, which consists of 23 spans, varying in length from 78 feet to 480 feet, was constructed such that the longer spans would be located over the proposed navigation channel. The navigation channel, however, was never built. Currently, three of the shorter 78-foot spans span the existing Trinity River. In the years following construction, the constricted flows through the existing 78-foot spans have resulted in blockage and subsequent damage to the existing piers, due to debris accumulations. This proposal cited a 1984 flood event in which massive accumulations of driftwood precipitated a fracture in one of the bridge columns supporting the section spanning the river. The narrow bridge span at this crossing was deemed the cause of the debris blockage.

IH-45 has been designated as a major transportation corridor for national defense, and TxDOT has considered replacement of the bridge spans over the existing channel as a solution to the on-going maintenance costs and to provide long-term integrity of the structure. Alternatively, TxDOT has proposed a plan to relocate the existing river channel to pass normal river flow beneath the existing 320-foot bridge span that is located nearest the river channel. A plan to relocate a portion of the existing river channel has been designed to accomplish these goals at a significantly lower cost than replacement of the short bridge spans. The plan calls for realignment of about 3,300 feet of existing river channel. The proposed channel would have a trapezoidal cross section with a 30-foot bottom width, 3H:1V side slopes, and a top width of approximately 180 feet. The existing river channel in the reach where the realignment is proposed has an average bottom slope that is nearly zero. Therefore, the proposed channel realignment section has been designed with a zero bottom slope from beginning to end. The proposed channel has an average depth of 15 feet and has been designed to closely approximate the channel flow capacity and the flow velocities of the existing river channel. The proposed channel alignment would be centered between the nearest 320-foot span of the IH-45 bridge which has a face-to-face clearance distance between the piers of about 200 feet normal to the flow. Excavation around the piers would not be required. The proposed realignment will result in the channel being moved laterally a maximum distance of about 350 feet. The existing channel would be filled to the existing top of bank elevation 396.0 to prevent further collection of debris. Relocation of the channel would result in modifications to the existing Central Mitigation Swale, which would be reduced in size by filling of the portion of the swale near the proposed channel realignment. A minimum of 150 feet from the top of bank of the proposed river channel realignment to the top of the bank of the Central Mitigation Swale would be required.

Several alternatives regarding filling of the old river channel have been investigated. The investigated alternatives accomplish the primary goals of the IH-45 bridge channel realignment project to some degree, but the proposed plan for the channel realignment accomplishes these goals with a minimal risk to the bridge structure and a minimal filling of the old channel. The primary objective of the project is to reduce the risk of damage to the bridge piers from floating debris and reduce or eliminate the cost of continual maintenance to remove the debris and periodically repair the structure. The proposed plan to fill the old channel is to fill from the upstream diversion of the river channel to the downstream side of the bridge. The fill will be placed up to the level of the existing overbank areas at the approximate elevation of 396.0 and will be placed around the existing bridge piers located within the old channel. This is the only partial channel fill plan that will ensure complete diversion of channel confined flows and minimize the risk to the existing bridge piers. The channel fill will terminate at the downstream end with a very gradual slope of the fill to the streambed of the old channel just downstream of the bridge piers. A portion of the old channel downstream of the IH-45 bridge is to remain unfilled as existing. This unfilled portion of the old channel will provide a slack water area for use as a possible river access point and may provide some

habitat diversity near the river. However, slack water areas such as this have a tendency to collect trash and debris both from flood events and from the ease of public access. Therefore, additional maintenance to remove trash may be required for the unfilled portion of the old river channel. The filled portion of the old river channel will maximize the diversion of channel confined river flows to the new channel alignment, stabilize the bridge piers in the old channel, and minimize the risk of floating debris collecting on the bridge piers. The Texas Department of Transportation (TXDOT) maintains an access road directly beneath the IH-45 bridge which provides access to the river channel from either side of the river. Filling of the old river channel beneath the bridge as proposed will provide continued access to the river channel within the TXDOT right-of-way for inspection and maintenance. A plan view of the proposed relocation of the Trinity River channel at IH-45 may be found in Appendix C.

TxDOT's proposal included relocation of a section of the existing Trinity River to an adjacent span, beneath a 1,120-foot plate girder unit structure that was originally designed and constructed to span the river. This continuous plate girder unit, which consists of two 320-foot end spans and a 480-foot center span, has considerably stronger columns and drill shafts designed specifically for lateral forces, in anticipation of possible boat or debris impacts.

Alternatives for IH-45 Proposal

Three alternatives were investigated to determine the economic feasibility of a solution to the problem. The alternatives included the following:

- No Action
- Column/Pier Armoring
- River Realignment

In the absence of a project to reroute the Trinity River, the "No Action" alternative, TxDOT indicated that the 78-foot bridge spans spanning the river, in its existing location, would be replaced by a single 320-foot span, which would span the existing river in its entirety. This work effort would be accomplished at a future data, either in a planned replacement scenario, or as a reaction to a catastrophic or partial failure of the bridge during a flood event. This larger span would reduce the risk of loss of life due to bridge failure, prevent extensive and expensive repairs due to partial failure of the bridge in a flood event, reduce routine maintenance costs associated with removal of accumulated debris around the bridge columns, and reduce the possibility of significant costs associated with rerouting of traffic and loss of potential wages due to delays should this major thoroughfare between Dallas and Houston catastrophically fail. The first cost of this reconstruction was estimated to be $12.5 million, with an annualized cost of $1.1 million.

The second alternative would involve armoring the six sets of columns in the existing Trinity River with concrete to protect them against impacts similar to those which caused the 1984 column failure. The first cost of this alternative was estimated to be $4.9 million, with an annualized cost of $0.5 million. However, an element of risk exists with this alternative. It would still be possible to have a large flood event carrying sufficient debris to cause the bridge to fail.

The third alternative investigated would involve rerouting a portion of the existing Trinity River to a new site beneath the adjacent 1,120-foot plate girder structure. This location would follow the original authorized navigation channel project location and would provide the needed cross-sectional area under the bridge to avert potential damage from high debris flows. This alternative was estimated to have a first cost of $1.9 million, and an annualized cost of $0.2 million.

Economic Analysis of IH-45 Proposal

An economic analysis of this proposal was performed, using the "No Action Plan" as the basis for project benefits. This analysis assumes that in time, with no changes in annual maintenance of the existing bridge, the bridge would fail or be damaged to such an extent as to require complete replacement. The

results of this analysis are presented in table 4-20. As shown, the alternative which involved armored protection of the existing columns was economically feasible, with net benefits of $0.6 million, and a BCR of 2.30. The alternative providing maximum net benefits, however, was determined to be the rerouting of the river to an adjacent span. This alternative yielded $0.9 million in net benefits, with a BCR of 6.69. The general layout of this plan is shown in Appendix C.

Table 4-20
Economic Analysis of IH-45 Proposal
(January 1997 prices, 7.375%, 50-year period of analysis)

Project Alternatives Include	No-Action Plan	Column/Pier Armoring	River Realignment
INVESTMENT			
Estimated First Cost	$12,449,000	$4,874,000	$1,935,000
Annual Interest Rate	0.0738	0.0738	0.0738
Project Life (years)	30	30	50
Construction Period (months)	6	6	6
Compound Interest Factor	6.09295	6.09295	6.09295
Capital Recovery Factor	0.0836	0.0836	0.0759
Interest During Construction	$224,093	$87,738	$34,831
Investment Cost	$12,673,225	$4,961,870	$1,969,831
ANNUAL COSTS			
Interest	$934,650	$365,938	$145,275
Amortization	$125,379	$49,089	$4,262
Operation/Maintenance	$10,000	$50,000	$10,000
Replacements	$0	$0	$0
Total Annual Costs	$1,070,000	$465,000	$160,000
Annual Cost Reduction	$1,070,000	$1,070,000	$1,070,000
Total Annual Benefits	$1,070,000	$1,070,000	$1,070,000
Net Benefits	$0	$605,000	$910,000
Benefit/Cost Ratio	1.00	2.30	6.69

Summary of IH-45 Proposal

The investigations performed to evaluate the feasibility of rerouting the Trinity River at the IH-45 bridge indicate that such a proposal is warranted. As indicated on page A-25, Appendix A, the proposed realigned channel has been designed to closely approximate the channel flow capacity and flow velocities of the existing channel. The new channel length would also be almost identical to the existing length. Reestablishment of streambank riparian vegetation would also be accomplished. With these factors considered, the proposal would have no hydraulic effect on the project, either upstream or downstream, and no inundation reduction benefits have been included for this proposal. Due to the independent nature of this work effort, from a flood damage reduction standpoint, this proposal can be implemented in conjunction with any of the plans included in the final array of alternatives. Therefore, the costs and benefits of this proposal are not included in the economic comparisons of these alternatives, but will be added to the final Recommended Plan.

FINAL ARRAY OF ALTERNATIVES

In accordance with Section 102 (2) of the National Environmental Policy Act (NEPA) of 1969, as amended, a final alternative incorporating non-structural measures was evaluated and included in the final array of alternatives, which includes the following:

- No Action Plan
- NED Plan
- Combination Non-Structural / Structural Plan
- Tentative Federally Supportable Plan
- Locally Preferred Plan

In addition, for comparison purposes, the 1965 Authorized Plan was analyzed to ascertain the economic viability of this plan under current conditions. All plans in the final array are compared against the No Action Plan.

Combination Non-Structural / Structural Plan

The combination non-structural / structural plan investigated for the final array of alternatives would involve the acquisition and removal of homes in the Cadillac Heights area (Reach 5), in lieu of the construction of a Cadillac Heights Levee, as the last-added increment of an overall plan also including the construction of the chain of wetlands and the SPF Lamar Levee. This buyout was analyzed for the 2-, 5-, 10-, 25-, 50-, and 100-year flood zones. The economic analysis of this non-structural increment of the overall combination structural / non-structural plan is shown in table 4-21. For comparative analysis, also included in this table are the incremental costs and benefits of constructing a last-added 100-year levee in the Cadillac Heights area.

The table reveals that the greatest incremental net benefits of a non-structural plan in the Cadillac Heights area would occur for a buyout of the 10-year flood zone. This alternative would have an estimated first cost of $2.5 million, would produce incremental benefits of $179,700, and would include the acquisition of seven structures. Comparatively, the 100-year Cadillac Heights Levee would have an estimated first cost of $2.7 million, would produce incremental net benefits of $96,600, and would protect 158 structures. From the perspective of desiring to remove people and property from the risk of flood damage, the levee alternative would be much more cost effective.

Table 4-21
Economic Analysis of Non-Structural Increment in Final Array of Alternatives
(January 1997 prices, 7.375% interest, 50-year period of analysis)

Flood Zone	Chain of Wetlands Plus Lamar Levee Plus Buyout of Cadillac Heights Area (Buyout Increment Only)	Chain of Wetlands Plus Lamar Levee Plus 100-Yr. Cadillac Heights Levee (Levee Increment Only)
0 - 2 Year Zone		
No. of Structures	0	0
0 - 5 Year Zone		
No. of Structures	3	0
Total Costs	$1,176,000	$0
Annual Costs	$79,100	$0
Annual Benefits	$194,100	$0
Net Benefits	$115,000	$0
BCR	2.5	N/A
0 - 10 Year Zone		
No. of Structures	7	0
Total Costs	$2,463,100	$0
Annual Costs	$165,300	$0
Annual Benefits	$345,000	$0
Net Benefits	$179,700	$0
BCR	2.1	N/A
0 - 25 Year Zone		
No. of Structures	24	0
Total Costs	$5,052,700	$0
Annual Costs	$334,900	$0
Annual Benefits	$365,900	$0
Net Benefits	$31,000	$0
BCR	1.1	N/A
0 - 50 Year Zone		
No. of Structures	126	0
Total Costs	$12,851,600	$0
Annual Costs	$823,600	$0
Annual Benefits	$401,100	$0
Net Benefits	($422,500)	$0
BCR	0.5	N/A
0 - 100 Year Zone		
No. of Structures	160	158
Total Costs	$19,388,000	$2,704,500
Annual Costs	$1,311,200	$456,200
Annual Benefits	$404,900	$522,800
Net Benefits	($906,300)	$96,600
BCR	0.3	1.3

ENVIRONMENTAL IMPACTS OF ALTERNATIVES

Overview

Table 4-22 shows the current status of studies in relation to requirements for environmental policy compliance. The report is in compliance for most of these requirements for this phase of the study process.

The most positive impacts that would result from the decision to develop a flood damage reduction project with restoration of emergent/deepwater wetlands would be that the flooding that threatens lives, damages residential and business properties and causes general disruptions to traffic and economic vitality of the area would not continue to occur. The economic benefits of the project would extend well beyond the area of proposed construction to include the downtown Central Business District (CBD). The environmental restoration aspect of the chain of wetlands would develop emergent wetlands that would be managed to provide important feeding and winter cover for migratory waterfowl, shorebirds and wading birds, in addition to supporting neotropical songbirds. Negative impacts resulting from development of either the combination non-structural / structural plan, the TFSP or the LPP include the loss of bottomland hardwood forest values, including fish and wildlife habitat and potential loss of archeological resources.

Four environmental and cultural resource items were identified by state, local and federal agencies and the public during the EIS scoping process as important in the overall decision-meking process. These resources include emergent wetlands, aquatic resources, forested areas and cultural/historic resources. The comparative impacts of the investigated alternatives to these key resources are discussed below and shown comparatively in table 4-23. During review of the Draft EIS, a number of other concerns were identified which required additional analysis and discussion. Among those concerns were land use impacts, visual and aesthetic impacts, and impacts on utilities. Discussion of the proposed project impacts on these and other resources is contained in the following sections.

Emergent Wetlands

Emergent wetlands in the study area are currently lacking. Some areas of permanent and semi-permanent water exist, primarily resulting from past excavations. However, these areas do not provide appropriate conditions for development of emergent wetland vegetation. An area adjacent to IH-45, between IH-45 and Highway 310 on the south side of the river, has been excavated to provide mitigation for impacts associated with a previous Section 404 permitted activity associated with the Central Wastewater Treatment Plant. Emergent and wetland vegetation occasionally dominate approximately 11.25 acres of this excavation. This area would not be impacted by any of the proposed project alternatives. The only alternative feature considered that could be constructed as a single component that provides an impact to emergent wetlands is the chain of wetlands. The combination non-structural / structural plan, the TFSP, or the LPP alternative, with the environmental restoration features included, would provide an additional 123 acres of emergent wetland that would be managed by providing a dependable water source and appropriate water elevation control structures. None of the alternatives (the NED Plan, the TFSP, the LPP, or the combination non-structural / structural plan) would result in a negative impact to emergent wetlands.

Aquatic Resources

It is envisioned that only minor changes in the aquatic resources would occur without the project, as sedimentation fills excavated ponding areas during the 50-year period of analysis. The NED Plan would cause the largest negative impact to aquatic resources by removing 16 acres of aquatic area. The chain of wetlands would provide a positive impact by adding eight acres of permanent water area as a part of the environmental restoration plan. The Lamar Levee would impact five acres of ponded water and the Cadillac Levee would impact an additional one acre. The proposed realignment of the Trinity under the IH-45 bridge would result in the loss of approximately eight acres of existing river channel. As part of the combination non-structural / structural plan, the TFSP, or the LPP, this area would be restored within the diversion channel, resulting in no net loss of channel area. The impact from construction activities to the aquatic environment of the channel would be temporary. Additional information related to the temporary nature of these impacts is addressed in the Section 404(b)(1) guidelines analysis in Appendix F, and in the following sections.

Table 4-22
Extent of Plan Compliance with Environmental Requirements

Federal Policies	NED Plan	TFSP / LPP (By Increment)			Non-Structural / Structural Plan	IH-45 Diversion
		Chain of Wetlands	Lamar Levee	Cadillac Levee		
Fish and Wildlife Coordination Act	All plans in full compliance					
Endangered Species Act	All plans in full compliance					
National Historic Preservation Act of 1966	All plans in full compliance					
Archaeological and Historic Preservation Act	All plans in full compliance					
Wild and Scenic Rivers Act	Not applicable					
National Environmental Policy Act	Full compliance					
Clean Water Act	All plans in full compliance					
Clean Air Act	All plans in full compliance					
Coastal Zone Management Act	Not applicable					
Coastal Barrier Resources Act	Not applicable					
Floodplain Management (E.O. 11988)	All plans in full compliance					
Protection of Wetlands (E.O. 11990)	All plans in full compliance					
Farmland Protection Policy Act/EPA Policy to protect environmentally significant agricultural lands	No prime or environmentally significant agricultural lands in study area					
Wilderness Act	Not applicable					
Sections 9 and 10 of Rivers and Harbors Act	All plans in full compliance. Only temporary navigation obstructions would occur.					
Land and Water Conservation Fund Act	All plans in full compliance.					
Native American Graves Protection and Repatriation Act	All plans in full compliance.					
Environmental Justice, E.O. 12898	All plans in full compliance.					

Table 4-23
Comparative Impacts of Alternatives
Future condition with feature in place exclusive of mitigation
(Indicates net gain or losses)

	Emergent Wetlands (Acres)	Aquatic Resources (Acres)	Forested Area (Acres)	Cultural/Historic Sites
Existing Conditions	11.25	233	5,956	41 known archaeological and 748 architectural sites
MEASURES				
Chain of Wetlands	(+123)134.25	(+8) 241	(-90*) 5,866	unknown
IH-45 Diversion Channel	(0) 11.25	(+1) 234	(-9*) 5,947	No known added sites or structures; survey required
Lamar Levee Increment	(0)11.25	(-5) 228	(-53*) 5,903	unknown
100-Yr. Cadillac Heights Levee/ Floodwall Increment	(0) 11.25	(0) 233	(-2.4*) 5,954	unknown
SPF Cadillac Heights Levee Increment	(0) 11.25	(-1) 232	(-9.4*) 5,947	unknown
ALTERNATIVES				
No-Action Plan (Future Without)	11.25	minor change	minor change	unknown
NED Plan	(0) 11.25	(-16) 217	(-504**)5,452	not evaluated
Combination Non-Structural / Structural	(+123)134.25	(+3) 236	(-143*) 5,813	unknown
TFSP	(+123)134.25	(+3) 236	(-155*) 5,801	27 archaeological and 699 architectural sites
LPP	(+123)134.25	(+2) 235	(-162*) 5,794	27 archaeological and 699 architectural sites

** Approximately 50% of bottomland hardwood forests in area are forested wetlands*
*** Approximately 90% of bottomland hardwood forest in NED footprint are forested wetlands*

Forested Areas

The most significant resource issue raised by the public was the concern about loss of bottomland hardwood forest within the project area. The forest has developed during the past three to four decades around a remnant stringer of mature trees along the river bank and on isolated high grounds that had minimal disturbance in the past. The forested area has filled in most of the old field areas that have been abandoned, so it is believed that little additional forest would accrue in the future without-project condition. No decreases in forested area are expected to occur without the project.

The NED Plan would cause the most significant impacts, resulting in a direct loss of 504 acres through clearing and grading, and cumulative impacts through fragmentation of habitat to an additional 99 acres of bottomland hardwood. Because of the adverse impacts of the NED, additional planning was conducted to design a project which would be economically favorable and produce less negative

impacts. The chain of wetlands would negatively impact bottomland hardwoods by removal of approximately 90 acres of forest by clearing, of which approximately 50%, or 45 acres, are forested wetlands. The Lamar Levee would provide an additional impact of 53 acres by removal of trees within the footprint and temporary work area along the levee and within the proposed sumps. Construction of the Cadillac Heights Levee would impact through removal of approximately nine acres of bottomland hardwood forest. The levees, by design, would reduce overbank flow to some small areas of forest; however, the bottomland forests that would be protected from overbank flow are along relatively high elevations and would not be adversely impacted by the reduction in flows from overbank conditions. In addition, tributary flows would not be impacted and the riparian stringers within the protected zone of the levees would not be adversely impacted. The combination of these three measures as part of the LPP would negatively impact 153 acres of bottomland hardwoods, of which approximately 81 acres are forested wetlands. The proposal to realign the river under the IH-45 bridge would result in nine acres of impact to bottomland hardwoods. Furthermore, the realignment would necessitate encroachment into the riparian buffer containing mature forest along the river bank. This total impact of 162 acres would be significantly less than that caused by the NED Plan; however, this loss was considered significant and required development of a compensatory environmental mitigation plan.

The combination non-structural / structural plan would impact approximately nine fewer acres of forest than the LPP. In addition to evaluation of the loss of forested area per se, evaluation of the effect of those losses on local climate, air quality and other resource issues are discussed in the following sections.

Water Quality

With no action, 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 floodplain 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. This trend is expected to continue without the project.

Any and all of the project alternatives considered which would include Corps of Engineers participation would require preparation of a comprehensive floodplain management plan by the project sponsor. This management plan is a requirement of Section 202 of the Water Resources Development Act of 1996, which requires that project sponsors develop plans within one year of entering into a Project Cost Sharing Agreement with the Corps of Engineers. The comprehensive floodplain management plan, at a minimum, must conform to the requirements of the Federal Emergency Management Agency's requirements for participation in the National Flood Insurance Program. But more than that, the plan must consider watershed management strategies which will not worsen flood runoff conditions in the future. This requirement has implications for both future flood elevations and runoff water quality with implementation of a Federal project. These plans must be reviewed and approved by the Corps prior to completion of construction and must be implemented within one year of completion of construction.

The water quality of the Trinity River would not be altered as a result of implementing the combination non-structural / structural alternative. Future development adjacent to the project or utilization of the areas included in the non-structural measures would be consistent with a comprehensive floodplain management plan, and could positively influence water quality in the DFE segment of the Trinity River. Sump areas, project lands, and the emergent wetlands of the chain-of-wetlands would all have a positive effect on retention times and nutrient and pollutant uptake prior to local runoff entering the Trinity River. During high flow events, these project features should have a slight positive effect on water quality.

Water quality impacts resulting from the NED alternative, development of a 1,200-foot bottom width overland swale, would occur from the removal of trees and soil disturbances. A reduction in the number of trees within the floodplain would temporarily increase water turbidity and nutrient loads from rain events during construction. 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 possible decrease in dissolved oxygen levels could temporarily impact water quality in the river during the first minutes of a flushing event. Over the long term, adverse impacts associated with loss of woody vegetation should be offset by the establishment of grasslands and some emergent wetlands within the swale, and by implementation of a floodplain management plan by the City of Dallas.

Placement of levees in the DFE area with the TFSP or the LPP could increase the velocity of river water during flood events; however, the levees would not be constructed without a compensating swale with chain-of-wetlands, 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 non-flood 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 Wastewater 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. The net effect would be similar to tertiary cleaning of some of the Central Wastewater Treatment Plant's treated effluent prior to it being reintroduced into the Trinity River. During rare conditions of low sunlight, high water temperature, no wind, and low wetland exchange rate, dissolved oxygen concentrations in the chain of wetlands could be low and the Biochemical Oxygen Demand (BOD) of the water high from the organic matter generated. During the early stages of flushing events under these conditions, water flowing from the wetlands into the Trinity River might cause temporary adverse impacts to the water quality of the river at the point of entry and downstream from oxidation of wetland organic matter. Should adverse conditions develop as described, pumpage of water through the wetlands could be altered as necessary to improve water quality within the wetland effluent. It is anticipated that over time, management of the wetlands can be fine tuned to the point that adverse impacts from the wetlands can be eliminated. It is also anticipated that the wetland water quality, vegetational assemblages and use by local and migratory wildlife would benefit from use of the wastewater effluent. Currently, the entire effluent passes through an existing lake prior to discharging into the Trinity River. The lake supports largemouth bass and channel catfish according to locals who have been observed fishing when access is available. It is not anticipated that water quality would adversely impact the proposed wetlands. During construction of the wetland outflow points on the river channel, there would be temporary increases in the turbidity of Trinity River.

During construction and initial stabilization of the Trinity River realignment at the IH-45 bridge, a short-term increase in river turbidity would occur in and immediately downstream of the project. A temporary increase in Biochemical Oxygen Demand (BOD) or Chemical Oxygen Demand (COD) could 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

Under without-project conditions, the development of comprehensive watershed management plans in the upper watershed would allow the aquatic habitat of the mainstem of the Trinity River, within the project area, to continue to improve corresponding to the improvement in the water quality. The diversity and number of aquatic invertebrate and fish species would continue to increase in the DFE segment of the river as the pollution-sensitive aquatic organisms return to occupy former niches.

The condition of the aquatic habitat and fisheries resources following implementation of the combination non-structural / structural alternative would not be significantly changed in the DFE segment of the Trinity River from conditions without the project. Beneficial or negative impacts to the aquatic habitat, aquatic invertebrates and fishes would be dependent on future land use changes and development of areas adjacent to the proposed project. The project could be expected to intensify adjacent development, resulting in some increased imperviousness. It is anticipated, however, that such land use changes induced by the economic stimulus of the project would result in less litter, oil and grease, and general debris, and no significant degradation of runoff water quality. Furthermore, sumps provided inland of the levee would increase retention time for storm water runoff and project lands, and the created emergent wetlands would serve to further reduce loadings to the river, thereby resulting in slight positive impacts to aquatic habitat and fisheries resources.

Impacts resulting from the development of a 1,200-foot bottom width overland swale would occur from the changes in water quality associated with tree removal and soil disturbances. Decreases in aquatic habitat quality would occur under environmental conditions incurred from the implementation of the NED alternative. There could be some loss in fisheries spawning areas that could result in overall reduction of fish production as the smooth nature of the swale area, when flooded, would not provide the spawning habitat associated with tree stumps, roots, and other structure in the forested area. However, the swale would not alleviate flooding conditions on other forested areas of the floodplain and, therefore, it is not anticipated that there would be a significant corresponding reduction in the species diversity of aquatic invertebrates and fish.

Placement of levees in the DFE area, as part of the TFSP or LPP, 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 runoff 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. Effluent from the Central Wastewater Treatment Plant currently enter the Trinity River near the IH-45 bridge after flow through a small lake. Diversion of some of the water through the proposed chain of wetlands would result in some loss of water due to infiltration and transpiration and evaporation. 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 resultant overall improvement of water quality that ultimately would reach the river would offset any losses in quantity. 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 mainstem of the river. Riprap 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 mainstem of the 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.

As previously discussed in terms of water quality, inducement of more intensive use or redevelopment of lands adjacent to the proposed project as a result of the economic stimulus of the project would not be expected to have any negative effect on aquatic organisms. These development activities within the watershed would have no direct effect on the physical component of aquatic habitats. Likewise, the increased utilization of the project area and project lands for recreation pursuits would not be anticipated to result in any net negative impacts to aquatic organisms and fisheries habitats. In fact, use of project lands for recreation should result in less loading of trash and debris as a result of controls on illegal dumping. Any adverse impacts resulting from adjacent land use redevelopment and projected recreation use planned for the project should be more than offset by the

positive effects of project features, increased operation and maintenance of the resource base, and by the comprehensive floodplain management plan developed and implemented by the City of Dallas.

Realigning the Trinity River at the IH-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. Recolonization of the new channel and the impacted area downstream should begin immediately after completion of construction, and diversity should be restored within a one- to two-year time period. Moving the river channel to avoid bridge pilings would adversely impact the aquatic habitat by removing a feature which would provide structure for colonization by aquatic invertebrate communities, and a feeding area and congregational focal point for fish. The removal of the small area of habitat associated with the pilings would not be significant.

Micro-Climate Effects

One of the concerns raised by citizens and environmental groups was the impact that removing trees would have on micro-climate conditions of adjacent areas. McPherson, Nowak, and Rowntree (1994) (See Appendix F), 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) (See Appendix F) for Dallas County, but it must be understood that the micro-climate 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, micro-climate 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 micro-climate 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 and thereby increase local temperatures. The raplacement of trees by herbaceous vegetation would not have this effect.

Implementation of the TFSP or the LPP is expected to create an economic stimulus within the project area. This economic stimulus, combined with the flood damage reduction afforded by the project will no doubt result in redevelopment and land use intensification on lands adjacent to project features. Some of the types of redevelopment which are being considered might include a police station, reuse of industrial areas for condominium apartments, along with along with residential and commercial services redevelopment, and possibly some light industry. There is also the possibility that commercial services in support of new recreation opportunities could be part of the projected redevelopment. Given the past uses of lands on both the Lamar Street and Cadillac Heights sides of the project, it could be anticipated that most redevelopment projects will incorporate existing vegetation into their landscapes to the extent feasible. Further, it is highly probable that any industrial redevelopment that may be induced will be "cleaner" in terms of physical presence as well as products and waste by-products produced. The net effect of these changes on micro-climate should be negligible from the without project condition.

The economic development of adjacent neighborhoods would be further spurred on by the portion of TxDOT's proposed Trinity Parkway which would extend from Hwy 175 along the proposed Lamar Street Levee alignment. This proposed project could have an effect, on it's own, to the micro-climate of the project area. Those effects will have to be considered and ameliorated to the extent that they can by TxDOT as they move forward with their own compliance under the National Environmental Policy Act. The cumulative effect of this proposed highway project on the micro-climate would likely be some measurable increase in ambient temperatures immediately adjacent to the highway due to increased reflective surface, and some reduction in shading due to some slight loss of tree or other

vegetative cover. It is important to note, however, that neither the TFSP nor the LPP is dependent upon TxDOT's proposed roadway, that the effects of the TFSP or LPP on their own are not significant, and that TxDOT will be required to address the impacts of it's actions, and to mitigate any adverse effects to the extent practicable.

Air Quality

The "Future Without-Project (No Action) 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 floodplain regulations imposed by the city of Dallas within the 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. Construction of the portion of the Trinity Parkway along the proposed Lamar Levee alignment, as proposed by TxDOT, could result in increases in pollutant levels, regardless of whether or not the proposed levee was built.

The development of some additional tree canopy in the area, without the project, 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, Appendix F).

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 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 project area with this alternative implemented indicate there would be a 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, Appendix F). 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.

The implementation of the TFSP 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 construction would be accomplished only as permitted by the Texas Natural Resources Conservation Commission (TNRCC). Maintenance activities required for the TFSP 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,

Appendix F, 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. Impacts of tree removal to assimilative capacities as a result of implementing elements of the TFSP are delineated in table 4-24.

As can be seen from Table 4-24, impacts to all parameters are minimal. In addition, acquisition and preservation of the proposed fish and wildlife mitigation area would greatly exceed the losses from implementation of the project features. The proposal to implement mitigation features 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 project features, individually or cumulatively. The TFSP plan would call for re-vegetation of the cleared swale and levee areas. The new 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.

Air quality impacts associated with implementing the combination non-structural / structural alternative would be very similar to those impacts previously described for the TFSP. The only differences in air quality impacts between the TFSP and the non-structural alternative would result from the reduction in construction activity associated with the Cadillac Heights Levee. Not building this levee as part of the 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 tree canopy in the areas delineated for mitigation would provide beneficial impacts through removal of regulated gaseous air pollutants. The addition of the tree canopy in the mitigation areas to that of the canopy area in the TFSP would increase the total pollutant removal capability over each area individually.

The impacts of the LPP alternative would be similar to those of the TFSP, as described above. The difference between the two alternatives would be the size of the Cadillac Heights Levee. Neither of the Cadillac Heights Levee alternatives would impact large areas of existing forest and, therefore, their impacts to air quality would be minimal.

Land use changes adjacent to the project area, which would likely be an indirect result of the project, would have some effect, though likely unmeasurable, on air quality of the study area. Given that lands outside the immediate project area are already mostly urbanized, consisting of residential, commercial strip development, and some industrial, it is projected that most changes will be in the form of redevelopment and reuse of already developed lands. These land use changes would likely be an intensification of current uses adjacent to the proposed project. Acreage changes from one land use to another should not be significant as a result of project implementation. Reduction of recurring flood damages, combined with an economy stimulated by construction dollars, is projected to increase real estate sales, renovations, and reuse. Effect of this redevelopment on vegetation and natural processes controlling air quality parameters is expected to be minimal.

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 area. Table 4-25 shows the impacts for the construction alternatives in terms of tree quality and numbers. Pecan-Oak bottomland hardwoods (BLH) would be considered high quality, while Elm-Ash BLH would be considered medium quality. These designations were taken from data derived from vegetation cover and land use maps. The average number of trees per acre was estimated from data collected on-site. These figures were then used to estimate the number of trees impacted by the various alternatives.

Table 4-24
Annual Removal Rates of Regulated Air Pollutants By Trees
(Tons / Year)

Site	Carbon Monoxide	Sulfur Dioxide	Nitrogen Dioxide	Particulate Matter (10um)	Ozone
Chain of Wetlands, Upper Swale	-0.15	-0.14	-0.38	-0.89	-1.67
Chain of Wetlands, Lower Swale	-0.09	-0.08	-0.21	-0.49	-0.93
Cadillac Heights Levee (TFSP)	-0.01	-0.01	-0.01	-0.03	-0.06
Cadillac Heights Levee (LPP)	-0.02	-0.02	-0.06	-0.13	-0.25
Lamar Street Levee	-0.13	-0.11	-0.32	-0.76	-1.42
IH-45 Channel Realignment	-0.02	-0.02	-0.05	-0.13	-0.24
Total Impact for TFSP	-0.40	-0.36	-0.97	-2.30	-4.32
Total Impact for LPP	-0.41	-0.37	-1.02	-2.40	-4.51
Total Impact for Combination Non- Structural / Structural Alternative	-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 Mitigation Area (TFSP)	+0.55	+0.48	+1.36	+3.18	+5.98
Conversion of Grasslands to Forest in Mitigation Area (LPP)	+0.57	+0.50	+1.41	+3.30	+6.21

Table 4-25
Bottomland Hardwood For st Impact Analysis

	NED Plan	Chain of Wetlands	Lamar Levee	SPF Cadillac	100-Yr Cadillac	Combination Plan	IH-45	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	134.0	141.0
Avg. Number of Trees per Acre - Pecan-Oak BLH	196	196	196	196	196	196	196	196	196
Avg. Number of Trees per Acre - Ash-Elm BLH	218	218	218	218	218	218	218	218	218
Total Number of Trees Impacted - Pecan-Oak BLH (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 BLH (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

Long-term survivability of the bottomland hardwood forest within the proposed project area, without a project, would depend on the City of Dallas' Floodplain 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 will increase in size and quality over time without the project.

Approximately nine fewer acres of trees would be impacted by the federal project if the combination non-structural / structural alternative were implemented instead of the LPP. Unless this area is protected through other regulatory means, however, they could be impacted by any future development.

The NED 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 BLH and 357 acres of Ash-Elm BLH 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 which 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, which could also lead to losses in bottomland hardwood dwelling species who are then not able to adequately compete against the new invader species.

The TFSP 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 TFSP would, for the most part and by design, be located in an area which is of lesser habitat quality than the NED Plan. Implementing the TFSP rather than the NED Plan would save over 73 percent of the bottomland hardwood acres that have been identified as being within the NED project area. Perhaps more importantly, over 90 percent of the bottomland hardwood forest acres determined to be Pecan Oak (high quality) habitat within the study area would be protected through public ownership. Roughly 50 percent of the forested land that would be impacted by the TFSP would be considered forested wetlands by U.S. Army Corps of Engineers determinations. The impact of the LPP would be very similar to that of the TFSP, as described above, but would impact seven acres more bottomland hardwoods than the TFSP.

Fish and Wildlife Habitat

The plan formulation process carefully followed a step-wise progression leading to minimization of impacts to bottomland hardwoods and other significant resources. Planning leading to the determination of the NED Plan eliminated channelization plans for flood damage reduction from 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 significant losses to bottomland hardwoods, was developed. These swales were 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 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 continued avoidance of Pecan-Oak forested areas and minimization of impact to any bottomland hardwood forested areas. The alignment within the upper reach was moved to the west as far as technically and economically justifiable. The alignments of the Cadillac Heights and Lamar Levees have also been extensively considered, and it has been determined that no other reasonable alignments would produce less impacts to important resources. Alignment of the Cadillac Heights Levee was adjusted during plan formulation to avoid direct impacts to an existing rookery located adjacent to Rector Street. Additional investigations would be done during future detailed planning to adjust the alignment if possible should the rookery expand into existing woodlands that the levee would remove.

Based upon experience, and lessons learned dealing with other levees in the area, it has been determined that the more gradual slope of the proposed levees, although causing slight additional impact due to a widened footprint, would be 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 4-26 provides a breakdown by project feature indicating the extent of impacts (losses of acres of habitat) to important resources that would occur if the project or feature were implemented.

Table 4-26
Impacts to Significant Resources
(Acres)

Resource	NED Plan	Chain of Wetlands	Lamar Levee	SPF Cadillac	100-Yr Cadillac	Combination Plan	IH-45	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	134.0	141.0
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 project within White Rock Creek floodplain.*

Using these assumptions, the Corps of Engineers and the U.S. Fish and Wildlife Service modeled future with- and without-project conditions to determine impact to fish and wildlife habitat. The losses in habitat are directly related to losses in wildlife species that utilize the specific habitat. The Habitat Evaluation Procedures (HEP) were used to evaluate several plans to determine impacts to wildlife resources and to satisfy mitigation requirements for bottomland hardwood forest habitats impacted by the proposed project. A basic assumption of the HEP is that species habitat requirements can be modeled and that selection of representative species for analysis can better account for impacts to the numerous species of wildlife that utilize various components of the habitat than trying to discuss the individual species requirements. According to these studies, the project features of the LPP, including the IH-45 channel realignment 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. Details of the HEP analysis are provided in Appendix G (USFWS Coordination Act Report). The HEP indicated that these impacts 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. Alternative mitigation plans were developed to provide no net loss of bottomland hardwood habitat. The recommended mitigation plan would impact the area by setting aside a specific area for long term management for fish and wildlife resources. There would also be positive impacts of the mitigation plan, as evidenced not only by meeting policy of no net loss of bottomland hardwood habitat values, but also by providing long-term stability of the structural and functional values of what has been termed the Great Trinity Forest, including air pollutant removal capacity, and fish and wildlife resource values.

Forest Mitigation Plan

Three potential mitigation tracts, which remain in private ownership, were identified in coordination with the U.S. Fish and Wildlife Service (USFWS), and evaluated for their potential to offset the losses to fish and wildlife habitat that would result from implementation of the plan which would have the largest footprint, and therefore, the largest impact to important resources. This plan was identified as the LPP and the IH-45 Diversion. These tracts are located within the Trinity River floodplain near the proposed project (See figure F-3 in Appendix F). These tracts contain grasslands that have potential for conversion to bottomland hardwoods and areas of Ash-Elm BLH and Pecan-Oak BLH habitat.

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 would occur from grassland conversion, the cost associated with this conversion, including land acquisition, would be the most expensive per acre. Also, within the tracts identified there is a limited amount of grassland available for conversion. Table 4-27 presents the costs and average annual benefits associated with the three mitigation plans evaluated. Target mitigation values were based on habitat losses of 14 Average Annual Habitat Units (AAHU) to pecan/oak forest and 91 AAHU to ash/elm forest.

Table 4-27
Incremental Mitigation Analysis
USFWS Plan

Mitigation Plan Alternative	Average Annual Habitat Units		Average Annual Mitigation Cost	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

Mitigation Plan A would consist 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 would consist of conversion of 86 acres of grassland to bottomland hardwood, preservation of 10 acres of grassland, and improvement to habitat quality on 753 acres of existing bottomland hardwood.

Plan B would consist of adding an additional 34-acre tract located on the west side of the Trinity, adjacent to the proposed lower chain of wetlands. This site was identified as potentially multi-purpose, and would serve as a surplus soil disposal and mitigation area. The management proposal would be to convert the entire tract to bottomland hardwood.

Plan C would be a combination of Plan B and addition of a 271-acre tract near IH-635, within the floodplain near the southern end of the Dallas city limits boundary. Management in this tract would include conversion of 88 acres of grassland to bottomland hardwood, improvement of habitat quality on 173 acres and preservation of an additional 10 acres of grassland. Plan C would consist of a total of 1,154 acres with prescribed management practices that would fully mitigate projected losses to bottomland hardwoods attributable to the LPP and the IH-45 river 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 would be more costly per gain and would not provide the mitigation required to offset losses.

Subsequent evaluations by the Corps of Engineers indicated a more cost effective management approach for conversion of grasslands to forest would entail planting of bare-root seedlings in lieu of containerized trees and shrubs, as recommended by the USFWS, even though

additional acreage would be required to satisfy the mitigation requirements. A detailed description of this Corps analysis is included in Appendix F.

Table 4-28 indicates the mitigation requirements by project feature, including the NED, for this revised mitigation plan, as proposed by the Corps. The analysis is another indicator of the relatively larger impacts that would be caused by the NED Plan as opposed to the TFSP or LPP.

Table 4-28
Required Mitigation by Alternative
(Acres)

Alternative	Mitigation Required
Chain of Wetlands	649
IH-45 Channel Realignment	71
Lamar Levee	400
Cadillac Heights Levee (TFSP)	15
Cadillac Heights Levee (LPP)	59
Tentative Federally Supportable Plan	1,135
Locally Preferred Plan	1,179
Combination Non-Structural / Structural	1,027
NED	3,200

Impacts to Threatened and Endangered Species

Following review of available information, including that provided by the U.S. Fish and Wildlife Service, it has been determined that the endangered black-capped vireo and interior least tern are the only federally listed species known to actively occupy suitable habitat for substantial periods of time other than as pure migratory birds. Both species are know to actively nest in Dallas County. Mountain plover is a candidate species of potential occurrence. There is no preferred habitat for the vireo or tern within the proposed project area. In addition, there is a lack of suitable habitat within the area for the mountain plover during its spring and fall migratory movements. Therefore, it has been concluded that the federally listed and candidate species are unlikely to be adversely affected by the proposed project.

Geology and Soils

Fluvial terrace deposits and alluvial deposits of the Quaternary Age occupy the floodplain area of the Trinity River within the study area. These deposits consist of gravel, sand, silt, and clay deposits. There has been no significant channel migration, bank stability problems or erosion document in the last fifty years within the project reach in spite of many man induced alterations from sand gravel operations, modifications associated with the Central Wastewater Treatment Plant or numerous other intrusions into the floodway. The construction of the project features would utilize soil derived from the project area and would be stabilized to reduce erosion during in-channel and overbank flows. During overbank flow events, much of the water would be routed through the chain

of wetlands, which would resist erosion due to the nature of the established vegetation and construction design. The realignment of the river channel through the IH-45 bridge would result in a channel segment of equivalent length, depth and width as the existing channel. The bank of the channel would be stabilized with turf grasses and replanted with woody vegetation that would work together to stabilize the new segment. The levees and sumps would also be stabilized to reduce erosion. The combined effect of chain of wetlands, levees and sumps, and realignment of Trinity River channel would result in some increases in water velocity along the right over bank during the larger, but more rare events, such as the 100-year and SPF events; however, these flows would not substantially increase erosion within the project area.

Cultural Resources

Eight of the archaeological sites identified in the project footprint are considered eligible for the National Register of Historic Places (NRHP). They appear to retain the intact deposits that return data valuable in scientific research. Although additional work will be necessary to make a determination of eligibility, they will be treated as eligible rather than eligibility unknown until the additional investigations are completed. Seven of the sites are buried prehistoric occupations exposed in banks or cut profiles. They are covered with approximately 5 - 10 feet of alluvium. These resources will require additional study through data recovery prior to construction. One of the sites is historic. Four of the prehistoric sites would be in the chain of wetlands project element and three others would be impacted by the Cadillac Heights Levee construction. The single historic site would be in the western portion of the Lamar Levee element and is identified as a City of Dallas dump in use between 1890 and 1940. In addition, brief analyses of several historic maps, such as Sam Street's Map of Dallas County dated 1900 and U.S.G.S. Soil Survey of 1920, indicate numerous additional historic sites would be impacted by the project.

Six of the historic buildings and structures identified in the project footprint as potentially eligible for the NRHP will require additional evaluation, including documentation by an archivist and a historic architect. Five of the six structures would be in the Cadillac Heights Levee and chain of wetlands elements. The sixth would be adjacent to a proposed sump near the southern end of the proposed Lamar Levee element.

The potential for additional buried prehistoric sites is high. As noted above, extrapolation from the historic maps indicate the potential for historic sites throughout the project footprint is also considered high. Consequently, a two stage program has been designed for the project footprint which addresses the differences in the proposed undertakings. In the Cadillac Heights Levee and Lamar Street Levee elements, the work would be oriented to an intensive survey of the upper 2.5 feet, since excavation would be minor. By contrast, the Lamar sump areas and the chain of wetlands would require some sampling using probes, cores and backhoe trenches to identify and expose buried sites, as well as an intensive survey for historic period components. However, since the central channel in the chain of wetlands would extend to between 8 - 10 feet below surface, construction would be monitored and impacts to any uncovered or exposed sites would be mitigated in consultation with the Texas State Historic Preservation Officer (SHPO). Finally, the depth and width of the proposed river realignment under the IH-45 bridge would preclude deep trenching as a survey strategy. Although the upper one meter of deposit would be intensively surveyed for historic period sites, the remaining deposits would be initially investigated using probes and cores. The recovered data would be used to guide the more intensive oversight monitoring and possible mitigation during construction. Consultation with the SHPO is ongoing and would continue throughout the project.

Transportation Impacts

A detailed description of traffic corridors including railroads that would be impacted by construction and during operation of the project is described in Appendix C, beginning on page C-5. Implementation of the alternatives investigated would result in short term use of local streets for access to the construction locations and for access to major routes leading to disposal sites for material

excavated from the project area or from removal of building materials associated with the non-structural plan. In addition, transportation would be impacted directly during construction of the levees and appurtenant features. The Lamar Levee would intersect with the Union Pacific Railroad owned lines in the area (MKT and and Southern Pacific). Rail traffic would be shifted between the two railroads as work was being conducted that interfered with traffic on the other. The Cadillac Heights Levee would cross the MKT line at two separate locations. Transportation impacts to IH-45 would not occur as a result of the channel realignment under the IH-45 bridge; however, allowing the threat to the major transportation corridor to continue would ultimately result in substantial impacts to use of the bridge. Also, other alternatives considered, such as strengthening the piers or refurbishing the bridge by shifting structural support locations would result in extensive periods of time when the structure would be unusable.

The Cadillac Heights Levee, as proposed in the TFSP, would not result in need for a closure across Martin Luther King (MLK) Blvd; however, the LPP would require a closure. The Lamar Levee would not require a closure at MLK for either plan. Central Expressway would not be impacted, provided the owner raises abutments as currently planned. No alteration to the IH-45 bridge is expected for any project alternative. The southern end of Sargent road would be abandoned with implementation of the LPP, requiring a permanent rerouting of traffic to other routes. The eastern terminus of the existing Rector Road, which has only occasional traffic, would be eliminated during the construction of the LPP, but would not under the TFSP, since the levee segment through this area would not be required for the TFSP. At locations where levees would cross through streets, traffic would have to rerouted during periods of flooding, since the gates would have to be closed to prevent flood damage to structures. However, these areas are already subject to closure when flooding occurs. Therefore, the impacts to traffic are negligible other than those caused by the permanent closing of Sargent Road. Traffic flow through this area is normally light and other streets should be sufficient to offset the losses.

Land Use Impacts

Each project alternative considered which would include Corps of Engineers participation would, by law, require preparation of a comprehensive floodplain management plan by the project sponsor. Section 202 of the Water Resources Development Act of 1996 requires that project sponsors develop comprehensive floodplain management plans for implementation within one year of completion of construction. The plans must not only conform to the requirements of the Federal Emergency Management Agency's requirements for participation in the National Flood Insurance Program, which had been a requirement prior to 1996, but the plans must also give consideration to watershed management strategies as they relate to future flooding and water quality.

The economic stimulus associated with development of the TFSP or LPP, combined with the reduction in frequency and intensity of flood damages, will result in economic development of lands adjacent to the project. The area of secondary or induced impact will not be limited to those lands immediately adjacent to the project but will be most visible there. Since most of this area is already in residential and light commercial and industrial development, the most obvious changes will be more in the form of redevelopment and reuse than outright land use changes. This redevelopment will likely be more gradual than abrupt, but noticeable over several years. Based upon the current state of development of these lands, the intensification of use should be minor. It cannot be determined with any degree of certainty at this time what specific, or even what general type of development may occur in any given area. Because the City of Dallas would be required to prepare a floodplain management plan addressing land uses within the watershed, it is likely that there will be opportunity for public input to any potential zoning changes.

Some of the developments which are currently being considered include a police station, reuse of industrial buildings and complexes for condominium apartments and attendant commercial services, refurbishing of residential neighborhoods within and adjacent to the Cadillac Heights, Rochester Park, and Joppa neighborhoods, along with residential and commercial services redevelopment, and

possibly some light industry. There is also the possibility that commercial services in support of new recreation opportunities could be part of the projected redevelopment.

Prior to any new development or any redevelopment of currently developed lands, liability requirements for any environmental contamination must be addressed. This would include compliance with both Environmental Protection Agency and Texas Natural Resources Conservation Service requirements, as well as consistency with such programs as the "Brownfields" initiatives administered by those agencies. Although no specific proposals have been identified, it is probable that any industrial redevelopment that may be induced will be "cleaner" than former industrial development in the study area.

Redevelopment of adjacent neighborhoods could be further induced by the portion of TxDOT's proposed Trinity Parkway, which would extend from Hwy 175 along the Lamar Street Levee alignment. This proposed project could have an effect, depending upon number and location of access ramps, on the type of development adjacent to the project. In general, it would seem intuitive that light commercial and industrial developments might be more likely to occur at the access points, as opposed to both high and low density residential development being more appropriate away from major highway access points. Those effects will be considered by TxDOT as they move forward with their own compliance under the National Environmental Policy Act. One certain cumulative effect of the proposed roadway project on land uses in the project vicinity would be an additional economic stimulus. There would be some economic effect of the TxDOT project on land use, whether or not the TFSP or LPP proposal is constructed, but the two together would have a combined effect. It should be noted again, however, that neither the TFSP nor the LPP is dependent upon TxDOT's proposed highway project. TxDOT will be required to plan for, and to mitigate, any adverse impacts of it's actions on land use to the extent practicable, regardless of the ultimate fate of the DFE project.

Increased utilization of the project area and project lands for recreation pursuits is anticipated and, in fact, is designed into the project. The Corps of Engineers would participate in certain types of low density recreation activities such as hike and bike trails and day use facilities, which would result in a slight land use change on project lands which are currently within the floodplain. These lands will remain in the floodplain as open space but would be available for compatible public uses with the project. Corps policy provides for compatible low density recreation to occur on lands acquired and managed for habitat mitigation, provided that it is consistent with the wildlife management purpose. Recreation trails through the habitat mitigation area, therefore, are considered to be consistent with that land use. Development of more intensive recreation facilities is planned by the project sponsor for certain areas within the lands required for the project. This would include such facilities as athletic fields and a community center. Direct land use changes caused by the proposed project would be compatible with floodplain functions and should have no negative effects on floodplain uses without the project.

Noise Impacts

Implementation of any of the alternatives investigated in this study is not expected to adversely impact the noise-environment over the long-term. However, analysis of the alternatives in regards to temporary noise levels during the construction phase of the project was conducted, especially given the proximity of some of the proposed features to residential areas, specifically the Cadillac Heights and the Joppa neighborhoods.

Of concern are impacts on people near the construction sites who are performing activities which are totally unrelated to construction activities (e.g., area residents, office workers, schoolchildren, etc.). Important factors in determining noise levels that would potentially impact such populations include distance from the noise source; natural or man-made barriers between the source and the impacted population; weather conditions which could potentially absorb, reflect or focus sound (such as wind speed and direction and temperature inversions); and the scale and intensity of the particular construction phase (e.g., excavation, building or finishing).

The Noise Control Act of 1972, one of the earliest legislative bills to address noise concerns, directed the Environmental Protection Agency (EPA) to promote an environment for all Americans that is free from noise that jeopardizes their health and welfare. Several key federal agencies, including the EPA, Department of Transportation (FAA and FHWA), Department of Defense, and Department of Housing and Urban Development (HUD) agreed to a joint effort to incorporate noise considerations in development planning. This cooperation resulted in noise-impact-related data such as noise-zone classifications and land-use compatibility guidelines.

The most frequently used measure currently in general use to describe noise level impacts is the day night average sound level system, abbreviated as DNL and symbolized mathematically as L_{dn}. The day night average sound level is the 24 hour average sound level, expressed in decibels (dB), obtained after the addition of a 10 decibel penalty for sound levels which occur at night between 10PM and 7AM. This nighttime penalty is based on the fact that many studies have shown that people are much more disturbed by noise at night than at any other time. According to general guidelines established by the EPA, residential land use is deemed acceptable for noise exposures up to 65 L_{dn}. The noise exposure at this level may be of some concern but common building construction will make the indoor environment acceptable, and the outdoor environment will be reasonably pleasant for recreation and play.

The noise levels associated with heavy, earth moving equipment such as would be used in construction of levees and swale and wetland excavations range between 72 and 96 dBA (decibel readings weighted to average frequencies heard by the human ear) at a distance of 50 feet. Since sound travels through the air in waves, as the wave spreads (moves away from the sound source) the intensity of the sound at any given point diminishes. Because of the relatively large distances between the proposed construction sites and the nearest residential neighborhoods, most of the alternative plans investigated in this study were readily eliminated from consideration for significantly adverse noise impacts.

Two exceptions to this elimination from consideration were the alternatives proposing construction of either the 100-year or SPF levee around Cadillac Heights and the alternatives proposing the construction of a swale, with or without wetlands, adjacent to the Joppa neighborhood. In the Cadillac Heights neighborhood, more detailed noise analysis of the proposed levee alignments revealed that the only location where the noise levels from construction activities rise above the acceptable 65 L_{dn} would be in the residential area immediately across 11th Street from the end of the levee. The distance between the edge of the levee construction site and the nearest homes in this area is approximately 200 feet which means that construction noise levels outside these homes could vary between 60 and 80 dBA. The distance between the edge of the construction zone and the nearest residences in the Joppa neighborhood is approximately 400 feet. The construction noise levels outside the homes in this area varies between 54 and 76 dBA. Noise levels from earth moving equipment would not remain at a constant level but would fluctuate up and down as the equipment moves closer or farther away, so none of the nearby residents would be subjected to constant high noise levels for extended periods of time. Even though this is the case, it has been determined that where noise levels would consistently extend above the 65 L_{dn}, limits would be placed on the hours of construction operations. Work would not start before 7 AM and would be shut down by 6PM in these areas of concern.

Long-term adverse impacts to the noise environment in the areas adjacent to the proposed project site would not be significant upon completion of the construction phase of the project. Operations and maintenance (O&M) activities, such as mowing, would be conducted on a periodic basis, but the noise from these activities is not expected to reach levels above 65 L_{dn}. In addition, the topographic variations in land as a result of the construction of the proposed swales, wetlands and levees would serve as man-made barriers to noise in the areas surrounding project lands.

Visual Impacts

Visual and aesthetic resources and the interpretation of impacts to resources is varied due to the differences of opinions in what constitutes non-quantifiable elements, such as beauty or pleasantness of the surrounding vista. The proposed chain of wetlands would provide flood damage reduction by removal of forests that impede flow. This could be determined by some to be an adverse visual impact. However, the emergent wetlands would encourage various shore birds, wading birds, waterfowl and other wildlife to utilize the area. The grasslands surrounding the wetland complexes blending into the remaining woodlands should constitute a desirable visual quality even if not preferred by some. The levees would intrude visually into area due to their height. At the same time, development of the entire area as open space providing access to the area, the ability to observe the floodplain resources from atop the levees would be a benefit. Recently considerable growth of wildflowers has been observed on the existing Dallas Floodway levees. The natural propagation of wildflowers along the levees could also develop on the proposed levee extension. The realignment of the river under the IH-45 bridge would initially have adverse visual qualities, but over time as the banks stabilize and the forest is re-established on the banks, the new segment would take on the appearance of the existing channel through the area.

Utility Impacts

The linear levees, as proposed, would cross a number of utilities, such as sanitary sewers, storm drains, water lines, electric transmission towers, fiber optic or other communication cables. A detailed analysis of the known relocations of utilities that would be required is described in Appendix C, beginning on page C-8. The impacts associated with the utilities relocations would be minor. Only temporary disruptions in service would be expected. The utility relocations would be isolated to the immediate area near the construction site, and no additional impacts to important resources would occur. In addition, safeguards would be added to the relocated utilities as a means to lessen problems associated with operation of the project. For example, closure valves would be included for sewer pipelines reconstructed under the levees to be utilized in the event of a rupture. Storm drains would be equipped with emergency closure valves at each levee crossing to prevent flooding in the event of a malfunction of the flap gates. Water supply lines would be relocated to the upper surface of the levees, buried a minimum of two feet deep.

Hazardous, Toxic and Radioactive Waste (HTRW) Impacts

The goal of any design for a flood damage reduction project is to avoid construction in HTRW-contaminated areas and in areas where impact to an HTRW-contaminated site would occur. Avoidance of construction in these areas prevents releases to the environment from occurring. Should it be determined that a project feature must be constructed within an HTRW-contaminated area, or within an area which would have an impact on an HTRW-contaminated site, then a response action is taken to remediate or remove the site in order to eliminate the potential for a release and subsequent impact. This response action would be undertaken in accordance with applicable EPA and state regulations, with the total cost for the response borne by the local sponsor. Therefore, every effort is made to identify potential HTRW-contaminated areas as early as possible during the development of any flood control project design, so that project features can be adjusted to avoid these areas.

The no action alternative for this project would result in no HTRW environmental impact because no construction would occur. The regulatory community would continue to address HTRW-contaminated sites in accordance with the appropriate policies, and liability for environmental releases and impacts would remain with the responsible parties. All other alternatives could result in a potential for HTRW impact due to the construction which must occur for project features, which could result in a hazardous substance release to the environment. Alternatives allowing for the most flexibility in adjusting project features to avoid HTRW-contaminated sites would have the least potential for HTRW impact. The NED Plan is the alternative which would allow the least flexibility for avoiding HTRW-

contaminated sites due to the large width and extent of the swale areas to be constructed. The other alternatives (Combination non-structural / structural plan, TFSP, and LPP) would allow the most flexibility for avoiding HTRW-contaminated sites due to its variety of project features and their various locations which allow for adjustments with minimal cost or project impacts.

The potential for HTRW impact from past and current activities within the study area is extensive. However, efforts to identify, investigate, and adjust project features will continue, with the intent of creating no environmental impact for the project due to HTRW-contaminated areas.

Disposal Impacts

The impacts of placement of excavated material along the alignment of the proposed levees have been addressed as part of the evaluation of these project features. The disposal site for surplus, non-contaminated material was selected because it had been previously approved as a disposal site and would cause not adverse impacts to environmental or cultural resources. The disposal site for contaminated, non-hazardous materials, as described in Appendix J, was tentatively selected because of its known capability to handle the type of wastes identified. The most significant impacts would be related to the hauling of material to these sites, including temporary increases in air pollutants, and the irretrievable commitments of non-renewable resources such as fuel for the hauling equipment.

ECONOMIC ANALYSIS FOR FINAL ARRAY OF ALTERNATIVES

Table 4-29 presents the comparative economic analysis of the flood control features for the final array of alternatives.

The 1965 Authorized Plan, as shown, was analyzed with the original interest rate of 3.25%, and with the January 1997 interest rate of 7.375%. This plan would no longer be economically justified, with current flood control first costs of $199.2 million, annual food control first costs of $17.1 million, negative annual net flood control benefits of $4.1 million, and a BCR of 0.76.

The NED Plan would have an estimated flood control first cost of $50.0 million, annual flood control first costs of $5.5 million, annual net flood control benefits of $8.1 million, and a BCR of 2.46.

The combination non-structural / structural plan reflects the costs and benefits of a plan which would include the chain of wetlands, the SPF Lamar Levee, and the 10-year buyout of the Cadillac Heights area. For equitable comparison of the non-structural plan with the NED and LPP, the costs and benefits of the economically justified CWWTP Levee upgrade and "compatible" Rochester Park Levees are also included in this plan. This plan has estimated flood control first costs of $67.0 million, annual flood control first costs of $7.6 million, annual net flood control benefits of $5.3 million, and a BCR of 1.70.

The TFSP would have estimated flood control first costs of $67.2 million, annual flood control first costs of $7.6 million, annual net flood control benefits of $6.2 million, and a BCR of 1.82.

The LPP would have estimated flood control first costs of $76.8 million, annual flood control first costs of $8.7 million, annual net flood control benefits of $2.9 million, and a BCR of 1.33.

Table 4-29
Economic Analysis of Final Array of Alternatives - Flood Control Only
(January 1997 prices, 7.375% interest, 50-year period of analysis)

	Authorized Plan		NED Plan	Combination Plan *	TFSP	LPP
	Original Rate	Current Rate				
INVESTMENT						
Estimated First Cost	$199,214,200	$199,214,200	$50,022,173	$86,983,587	$67,224,987	$76,780,782
Annual Interest Rate	0.0325	0.0738	0.0738	0.0738	0.0738	0.0738
Project Life (years)	100	50	50	50	50	50
Construction Period (months)	36	36	24	24	24	36
Compound Interest Factor	37.75981	40.15579	25.77523	25.77523	25.77523	40.15579
Capital Recovery Factor	0.0339	0.0759	0.0759	0.0759	0.0759	0.0759
Interest During Construction	$9,870,297	$22,860,317	$3,734,394	$5,000,645	$5,018,668	$8,810,783
Cost of non-Federal Levees			$14,220,000	$23,120,000	$23,120,000	$23,120,000
Investment Cost	$209,084,497	$222,074,517	$67,976,567	$95,104,232	$95,363,654	$108,711,565
ANNUAL CHARGES						
Interest	$6,795,246	$16,377,996	$5,013,272	$7,013,937	$7,033,069	$8,017,478
Amortization	$289,268	$480,458	$147,067	$205,758	$206,319	$235,197
Operation/Maintenance ($/year)	$250,000	$250,000	$375,000	$405,000	$370,000	$495,000
Replacements	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	**$7,334,515**	**$17,108,454**	**$5,535,339**	**$7,624,695**	**$7,609,388**	**$8,747,675**
ANNUAL BENEFITS						
Inundation Reduction	$13,016,900	$13,016,900	$4,014,700	$4,134,600	$5,272,300	$5,222,700
Existing Dallas Floodway			$9,576,900	$8,789,500	$8,567,000	$6,454,573
TOTAL ANNUAL BENEFITS	**$13,016,900**	**$13,016,900**	**$13,591,600**	**$12,924,100**	**$13,839,300**	**$11,677,273**
NET ANNUAL BENEFITS	**$5,682,400**	**(4,091,600)**	**$8,056,261**	**$5,299,405**	**$6,229,911**	**$2,929,598**
BENEFIT-COST RATIO	**1.77**	**0.76**	**2.46**	**1.70**	**1.82**	**1.33**
No. of Structures No Longer At Risk From a SPF Event		Unknown	580	504	504	688

** Combination plan includes the chain of wetlands, the SPF Lamar Levee, and a 10-year buyout of the Cadillac Heights area*

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SUMMARY

Due to the environmentally controversial nature of the NED Plan, implementation of this plan was deemed unfavorable by the local sponsor. The Tentative Federally Supportable Plan would yield greater net benefits than any of the other alternatives investigated, and will be considered in further detail in Chapter 5 of this document. In addition, due to the sponsor's desire to implement the LPP, more detailed designs and costs will be developed for this plan, as well.

CHAPTER 5

SELECTION OF THE RECOMMENDED PLAN

CHAPTER 5
SELECTION OF THE RECOMMENDED PLAN

This chapter presents data and rationale supporting designation of the Recommended Plan. The results of the plan formulation process, as described in the preceding chapter, were derived from preliminary cost estimates and economic benefits assuming current conditions. The costs and benefits presented in this chapter are not comparable to those shown in chapter 4, Plan Formulation, for the following reasons:

- The costs presented in this chapter reflect more detailed design and analysis of the proposed project's flood control, environmental mitigation, environmental restoration, and recreation features, and were estimated at April 1998 prices levels. Economic analyses were performed utilizing the fiscal year (FY) 1998 Federal interest rate of 7-1/8%.

- The economic benefits presented in this chapter reflect average annual equivalent benefits, which account for future changes in urbanization and hydrology. Comparatively, the benefits shown in chapter 4 were expected average annual benefits, which do not incorporate future conditions.

- The economic benefits in this chapter also include the addition of insurance subsidy benefits, defined as the annual savings in operating expenses for the administration of the flood insurance programs, due to the implementation of the proposed project.

In addition to these differences, a risk-based analysis was incorporated into all assumptions and benefit calculations. This type of analysis was also used in the latter phases of the plan formulation process, as explained on page 4-22 of this document. Traditional expression of the frequency of flood events has been in terms of the recurrence interval in years, such as, the "100-Year Flood". The more appropriate expression of the probability of a particular flood magnitude is in terms of "percent chance exceedance", especially as it relates to a risk-based analysis. Therefore, the "100-Year Flood", which is defined as "the magnitude of flooding which has a 1 percent probability of being equaled or exceeded in any given year" would be expressed as the "1 percent chance flood". For comparison purposes, the nine flood events computed for this study, traditionally referred to as the 1-year, 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, 500-year, and the Standard Project Flood (SPF), would be referred to, in probabilistic terms, as the 99 percent, 50 percent, 20 percent, 10 percent, 4 percent, 2 percent, 1 percent, 0.2 percent chance flood, and the SPF, respectively. Although the analyses contained herein were performed as risk-based analyses, results of these investigations are expressed in traditional terms for the benefit of the reader.

OPTIMIZATION OF THE LAMAR AND CADILLAC HEIGHTS LEVEES

Although the SPF Lamar and 100-year Cadillac Heights Levees were deemed incrementally justified in the preceding chapter, more detailed analysis was conducted to ensure optimization of the levee heights, thereby validating their proper inclusion in the Tentative Federally Supportable Plan.

CADILLAC HEIGHTS LEVEE

Height Limitations

The Cadillac Heights Levee being proposed as part of the Tentative Federally Supportable Plan, known as the "100-year levee," was set to a profile corresponding to elevation 412.15 at the economic index point. This compares to a Standard Project Flood (SPF) elevation of approximately 419.85, a difference of 7.7 feet. A key engineering constraint limits the levee from any further increases in height without adverse impacts upstream. Hydraulic analyses indicate that a higher levee in the Cadillac Heights area begins to cause an increase in the upstream SPF profile, which is the design profile for the existing Dallas Floodway. As shown in the incremental analysis of the SPF levee for Cadillac Heights, the economic analysis is extremely sensitive to changes in upstream conditions,

primarily due to the billions of dollars in property being protected by the Dallas Floodway. Thus, any increase in upstream water surface for the SPF design flow immediately squelches any hope of higher net benefits for the Cadillac Heights Levee.

Inelastic Levee Costs

As a general rule, levee features have a certain amount of initial, constant costs which can be attributed to lands, easements, interior drainage requirements, relocations, etc. A significant variable in computing costs for various levee heights is usually the amount of select fill required. However, due to the chain of wetlands excavation, the proposed project is rather unique in this regard. Overall, there is actually an excess of material which, unless used in some way, must be hauled away and disposed. The detailed cost analysis indicates that it costs more to haul and dispose the excess material than it does to place it as select fill in the Cadillac Heights Levee. As a result, the cost curve for levee heights below elevation 412.15 is highly inelastic.

The inelastic levee costs were validated by computing a detailed cost of a levee with two feet less height than the previously investigated 100-year levee. The lower levee was estimated to have an incremental first cost (added to the chain of wetlands) of $4,795,400. This is $320,000 more than the higher levee.

There is, however, a point at which a substantial increase in levee length would be required to provide closure. This is the primary reason for the increased cost of the levee with index elevation 421.85.

Benefit Analysis

The computer program HEC-FDA was used to determine the amount of gross benefits which would be foregone in the Cadillac Heights area if a levee of two feet less height were constructed. The analysis indicates that residual damages (year 2000 only analyzed) would increase, thereby reducing benefits, by $51,600. Additionally, floodplain user benefits totaling $15,500 could no longer be claimed because no structures would be removed from FEMA's 100-year floodplain. Total benefits foregone would be approximately $67,100 annually.

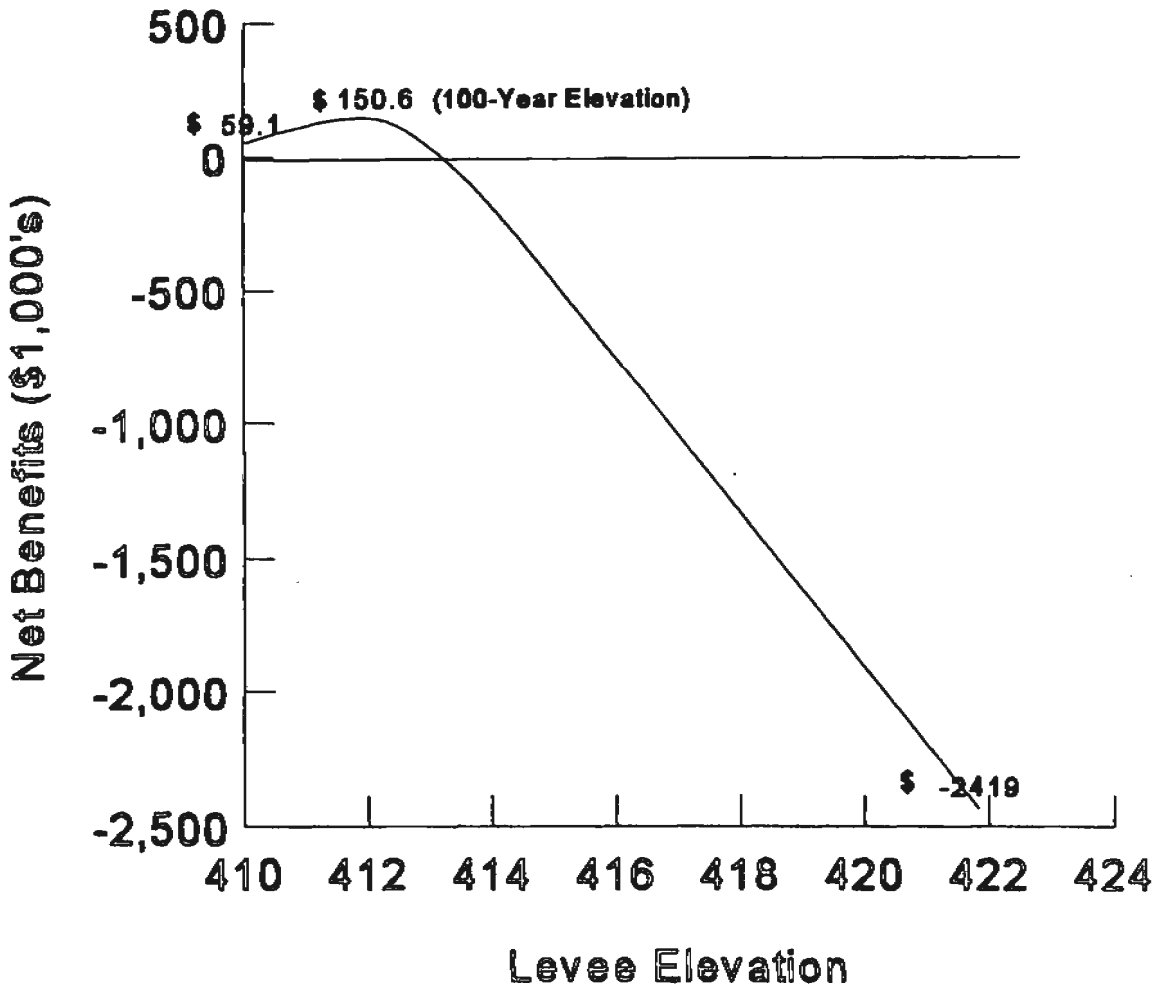
Conclusion

Net benefits continue to increase as the Cadillac Heights Levee increases, fueled by a unique scenario where benefits increase and costs decrease for a higher levee providing protection around Cadillac Heights. However, at a height roughly equal to that of the levee currently being proposed as part of the Tentative Federally Supportable Plan, hydraulic impacts upstream result in an abrupt downturn in the total benefits being achieved. This is summarized in the optimization table 5-1 shown below, and graphically represented in the optimization curve in figure 5-1. This analysis confirms the inclusion of the 100-year Cadillac Heights Levee in the Tentative Federally Supportable Plan.

Table 5-1
Cadillac Heights Levee
Incremental Costs and Benefits for Various Heights
(April 1998 prices, 7.125% interest, 50-year period of analysis)

Levee Elevation at Index Point	Incremental First Costs	Annualized Cost	Incremental Benefits	Net Benefits of Levee
410.15	$4,795,400	$364,100	$408,700	$44,600
412.15	$4,474,900	$339,700	$475,800	$136,100
421.85	$9,112,700	$691,700	($1,738,800)	($2,430,500)

* *Interest during construction not included*



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

OPTIMIZATION CURVE - CADILLAC HEIGHTS LEVEE

FIGURE 5-1

LAMAR LEVEE

As with the Cadillac Heights Levee, the Locally Preferred Plan calls for a levee of sufficient height to provide essentially the same level protection as was originally provided by the existing Dallas Floodway. However, the two levees differ substantially in their performance and effects to upstream areas. The design of the Lamar Street Levee is such that the critical breach elevation of the existing East Levee, located immediately upstream and adjoining the Lamar Levee, is increased by constructing the Lamar Levee to the same height as the existing East Levee. Significant benefits are realized by the Lamar Levee as a result. If, however, the height of the Lamar Levee is decreased, benefits to the upstream reach are also decreased. To validate this assumption, a Lamar Street Levee with 3.1 feet less height than the proposed Tentative Federally Supportable Plan was analyzed. This height matches the current critical breach elevation of the East Levee in the existing Floodway. No levee with a height greater than the Tentative Federally Supportable Plan was analyzed, as this is also the levee height of the Locally Preferred Plan.

Costs of a Lower Levee

The costs associated with a lower levee protecting the Lamar Street area would increase in a similar manner to those of the Cadillac Heights Levee described above, when analyzed on an incremental basis with the chain of wetlands. Due to the amount of excess material present, the incremental cost to construct a lower levee is actually greater than the cost of a higher levee. The first cost of the Lamar Street Levee with a height of 3.1 feet less than the assumed Tentative Federally Supportable Plan is $18,511,200. This is $498,700 more than the cost of the higher levee.

Benefit Analysis

The computer program HEC-FDA was again used to determine the amount of gross benefits which would be foregone if a Lamar Street Levee of 3.1 feet less height were constructed. The analysis indicates that residual damages (year 2000 only analyzed) would increase (benefits would decrease) by $2,471,600.

Conclusion

Table 5-2 compares the costs and benefits of a levee protecting the Lamar Street area for two heights, the greater of which is the proposed Tentative Federally Supportable Plan as well as the Locally Preferred Plan. Since the higher levee is the largest plan being pursued by the sponsor, and in accordance with Planning Guidance Letter 97-10, no levee with a greater height than this was analyzed. The comparison shown in the table, and presented in figure 5-2, clearly indicates that the levee height identified in the proposed Tentative Federally Supportable Plan achieves higher net benefits.

Table 5-2
Lamar Street Levee
Incremental Costs and Benefits for Various Heights
(April 1998 prices, 7.125% interest, 50-year period of analysis)

Levee Elevation at Index Point	Incremental First Costs	Annualized Cost	Incremental Benefits	Net Benefits of Levee
417.90	$18,511,200	$1,405,300	$134,500	($1,270,800)
421.00	$18,012,500	$1,367,400	$2,606,100	$1,238,700

* *Cost of Existing Rochester Park Levee not included*
** *Interest during construction not included*

This analysis confirms the inclusion of the SPF Lamar Levee, as did the analysis of the 100-year Cadillac Heights Levee, in the Tentative Federally Supportable Plan.

CONFIRMATION OF INCREMENTAL JUSTIFICATION

Due to the development of more detailed designs and cost estimates for the TFSP and the LPP, a re-analysis of the flood control components of these plans was performed to confirm incremental justification. The costs and benefits of the IH-45 proposal have been included in the chain of wetlands increment for this analysis.

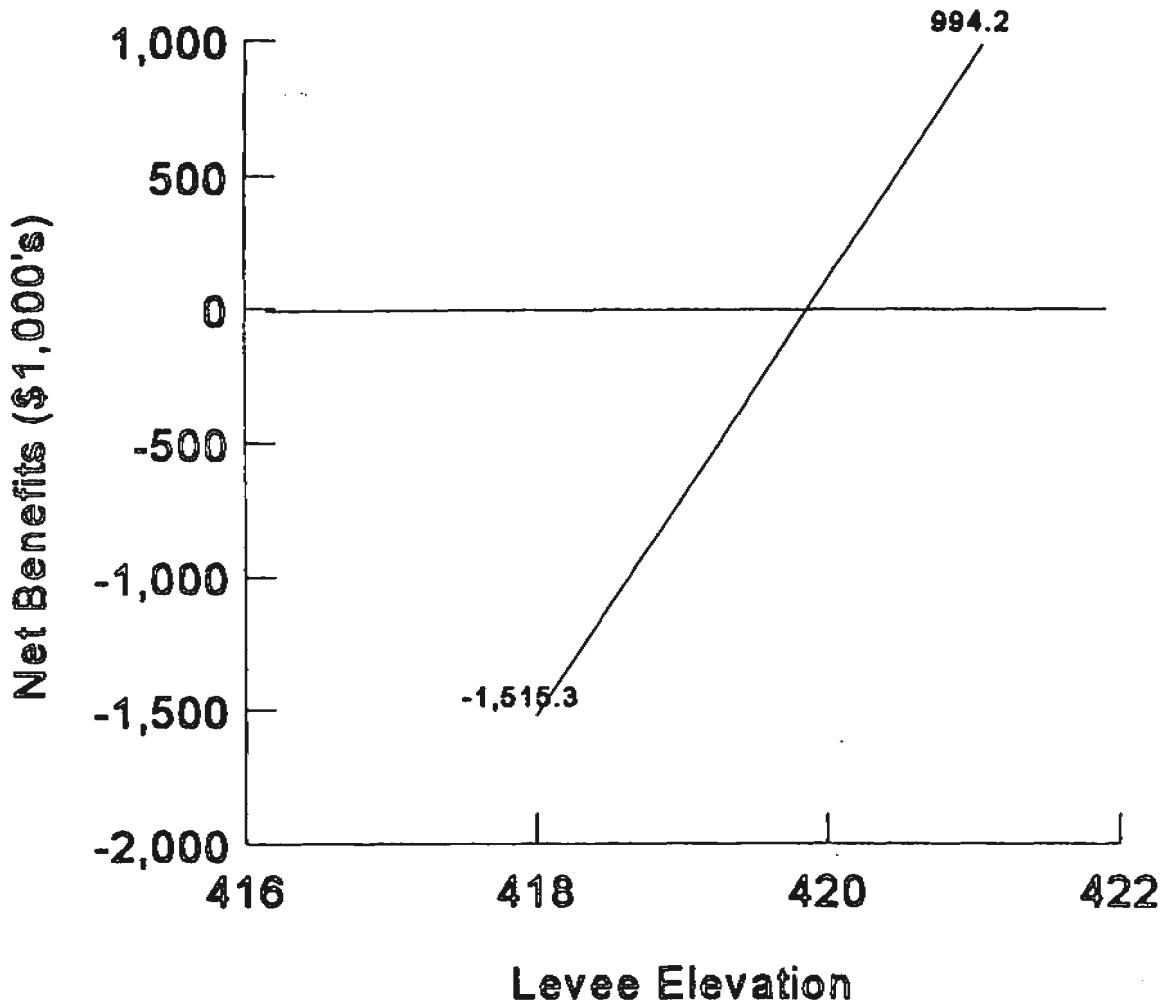
Equivalent annual damages (EAD) were calculated for the TFSP and the LPP to account for changes in urbanization and hydrology. The analysis was performed over a 50-year period from the year 2000 to 2050. All remaining economic analyses presented in this report reflect equivalent annual damages.

In addition to direct inundation reduction benefits to both the immediate study area and the upstream Dallas Floodway area, an annual savings in administration of the flood insurance programs operating expenses would be realized for any structures removed from the 100-year (one percent annual chance of exceedance) floodplain. Estimates of these savings were calculated for each increment of these plans, and incorporated into the overall flood control benefits.

Due to the magnitude and complexity of the proposed plans, phased construction is anticipated. The "Interest During Construction" (IDC) used for the economic analyses was, therefore, calculated in such a manner as to reflect this phased construction, as shown in table 5-3.

Table 5-3
Computation of Interest During Construction
For Incremental Analysis
(April 1998 prices, 7.125% interest, 50-year period of analysis)

Plan	First Cost	Construction Period (months)	Interest During Construction
Chain of Wetlands Only	**$56,034,200**	21	**$3,514,100**
Chain of Wetlands + Lamar	**$74,046,700**		**$3,601,500**
Phase 1	$38,803,400	15	$1,718,000
Phase 2	$35,243,300	18	$1,883,500
Chain of Wetlands, Lamar and 100-year Cadillac Heights (TFSP)	**$78,521,600**		**$3,840,600**
Phase 1	$38,803,400	15	$1,718,000
Phase 2	$39,717,300	18	$2,122,600
Chain of Wetlands, Lamar and SPF Cadillac Heights (LPP)	**$83,159,400**		**$4,499,800**
Phase 1	$38,803,400	15	$1,718,000
Phase 2	$44,356,000	21	$2,781,800



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

OPTIMIZATION CURVE - LAMAR LEVEE

FIGURE 5-2

It was assumed that, if the chain of wetlands were the only increment of this project to actually be implemented, construction would be performed under one contract. As shown in table 5-3, the IDC for this effort would total approximately $3.5 million.

It was decided that the addition of levee work, however, would most effectively be designed and managed by breaking the construction into phases. The lower swale, downstream of IH-45, was viewed as the most favorable element to be constructed first. Hydraulic impacts to other project areas would be minimal, and any minor adjustments to design would not likely significantly affect other project features, such as the levees. The cost of constructing the lower swale was estimated at $38.8 million, yielding an IDC amount of approximately $1.7 million. This construction is shown as Phase 1 in table 5-3, for each plan.

For each added increment of the TFSP and the LPP, the incremental cost difference between total construction and the construction of the lower swale is shown as Phase 2, with corresponding IDC amounts. The IDC calculated for each phase of a plan were then added to determine total IDC for implementation of that particular plan.

Table 5-4 presents the incremental economic analysis for the flood control features of the TFSP and the LPP. As shown, the Lamar Levee remains economically justified, with $369,400 in net annual flood control benefits and a BCR of 1.17. The 100-year Cadillac Heights Levee also remains economically justified, with $62,900 in net annual flood control benefits and a BCR of 1.15. The SPF Cadillac Heights Levee is not incrementally justified.

BASIS FOR REQUEST FOR EXCEPTION

Based on these findings, the only difference between the Tentative Federally Supportable Plan and the Locally Preferred Plan would be the incremental height difference between the 100-year (.01 probability of exceedance) Cadillac Heights Levee and the SPF (.00125 probability of exceedance) levee. The corresponding incremental cost difference between the two plans would be the responsibility of the local sponsor, unless an exception is granted from ASA(CW), allowing full Federal participation in the LPP.

In light of sensitive social equity issues which would arise from the city's support for building a project providing less protection to the neighborhood on one side of the river than on the other, the city requested full Federal participation in the LPP, which would include the non-justified increment of the Cadillac Heights Levee from the 100-year level of protection to the SPF level. The following sections provide comparative data between the two plans, and rationale for such an exception.

ECONOMIC COMPARISON OF PLANS

Table 5-5 presents a side-by-side comparison of the proposed TFSP and the LPP. As a total system, the Tentative Federally Supportable Plan would have net annual flood control benefits of $6.6 million, with a BCR of 1.81. Comparatively, the LPP would have net annual flood control benefits of $4.1 million, with a BCR of 1.46. These lower net benefits for the LPP would be attributable to higher water surface elevations caused by greater confinement of extreme-event flows with SPF levees.

DIFFERENCES BETWEEN THE TENTATIVE FEDERALLY SUPPORTABLE PLAN AND THE LPP

The improvements which the LPP would give to the project area above the Tentative Federally Supportable Plan are as follows:

- The LPP would provide a higher level of protection to the project area (Cadillac Heights).

- The Tentative Federally Supportable Plan would leave a portion of the study area subject to flooding from major events above 100-year frequencies. Comparatively, the LPP would provide SPF protection to the major damage centers within the study area. With implementation of the LPP, 287 structures in the Cadillac Heights area would no longer be at risk from the SPF event. Construction of the Tentative Federally Supportable Plan would allow that 207 structures would no longer be at risk from the 100-year flood event within the same area, but would leave 271 structures subject to inundation in SPF events.

- The Tentative Federally Supportable Plan would provide lower levels of protection to one side of the river, while the LPP would provide equal SPF protection to both sides.

- The environmental impacts to critical natural resources, such as bottomland hardwoods and/or wetlands, would not increase when going from the Tentative Federally Supportable Plan to the LPP.

- The LPP would add $0.5 million in annual costs and would reduce annual net benefits by $2.7 million. The length of the Cadillac Heights levee is 1.1 miles (TFSP) and 2.25 miles (LPP).

- The Tentative Federally Supportable Plan would not fully offset the adverse hydraulic impacts to the residential areas in the Floodway Extension area that have resulted from construction of upstream portions of the existing Dallas Floodway and from upstream changes in watershed development. The LPP would fully offset these impacts.

Trade-offs exist between the two plans. The Tentative Federally Supportable Plan offers more net flood damage reduction benefits, whereas, the LPP offers flood protection greater than 100-year at a small increase in cost.

The LPP would reduce expected annual flood damages in the study area by $13.1 million from baseline conditions. Comparatively, the Tentative Federally Supportable Plan would reduce expected annual flood damages by $15.3 million, or $2.2 million more. The LPP would reduce flood protection for extreme events upstream in the existing Dallas Floodway, while increasing the level of protection for rare, but relatively more frequent events, to the people in the Cadillac Heights neighborhood.

Table 5-4
Incremental Analysis of the TFSP and LPP - Flood Control Only
(April 1998 prices, 7.125% interest, 50-year period of analysis)

Description	Chain of Wetlands	Chain of Wetlands Plus SPF Lamar	SPF Lamar Incremental	Tentative Federally Supportable Plan	100-Year Cadillac Incremental	Locally Preferred Plan	SPF Cadillac Incremental
INVESTMENT							
Estimated First Cost	$56,034,200	$74,046,700	$18,012,500	$78,521,600	$4,474,900	$83,159,400	$9,112,700
Interest During Construction	$3,514,100	$3,601,500	$87,400	$3,840,600	$239,100	$4,499,800	$898,300
Cost of Non-Federal Levees	$14,220,000	$23,120,000	$8,900,000	$23,120,000	$0	$23,120,000	$0
Investment Cost	$73,768,300	$100,768,200	$26,999,900	$105,482,200	$4,714,000	$110,779,200	$10,011,000
ANNUAL CHARGES							
Interest	$5,256,000	$7,179,800	$1,991,300	$7,779,300	$347,700	$8,169,900	$738,300
Amortization	$173,900	$237,500	$58,400	$228,200	$10,200	$239,700	$21,700
O&M ($/year)	$199,000	$386,000	$187,000	$441,000	$55,000	$527,000	$141,000
Replacements	$0	$0	$0	$0	$0	$0	$0
TOTAL ANNUAL CHARGES	**$5,628,900**	**$7,803,300**	**$2,236,700**	**$8,448,500**	**$412,900**	**$8,936,600**	**$901,000**
ANNUAL BENEFITS							
Inundation Reduction	$3,798,200	$4,876,700	$1,078,500	$5,337,000	$460,300	$5,286,800	$410,100
Insurance Subsidy	$30,500	$78,700	$48,200	$94,200	$15,500	$94,200	$15,500
Existing Dallas Floodway	$7,311,400	$8,790,800	$1,479,400	$8,790,800	$0	$6,626,400	($2,164,400)
IH-45 Proposal	$1,043,500	$1,043,500	$0	$1,043,500	$0	$1,043,500	$0
TOTAL ANNUAL BENEFITS	**$12,183,600**	**$14,789,700**	**$2,606,100**	**$15,265,500**	**$475,800**	**$13,050,900**	**($1,738,800)**
NET ANNUAL BENEFITS	**$6,554,700**	**$6,986,400**	**$369,400**	**$6,817,000**	**$62,800**	**$4,114,300**	**($2,639,800)**
BENEFIT - COST RATIO	**2.16**	**1.90**	**1.17**	**1.81**	**1.16**	**1.46**	**-1.93**

NOTE: Costs and benefits shown are not comparable to those presented in tables 4-27 and 4-28, due to the incorporation, in this table, of more detailed cost estimates, the addition of insurance subsidy benefits, and the inclusion of average annual equivalent benefits, which account for future changes in urbanization and hydrology.

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Table 5-5
Benefit-Cost Comparison of Tentative Federally Supportable Plan and LPP
Flood Control Only
(April 1998 prices, 7.125% interest, 50-year period of analysis)

Project Alternatives Include Land/Mitigation & HTRW Costs	TFSP	LPP
INVESTMENT		
Estimated First Cost	$78,521,600	$83,159,400
Interest During Construction	$3,840,600	$4,499,800
Cost of Non-Federal Levees	$23,120,000	$23,120,000
Investment Cost	$105,482,200	$110,779,200
ANNUAL CHARGES		
Interest	$7,779,300	$8,169,900
Amortization	$228,200	$239,700
Operation/Maintenance ($/year)	$441,000	$527,000
Replacements	$0	$0
TOTAL ANNUAL CHARGES	$8,448,500	$8,936,600
ANNUAL BENEFITS		
Inundation Reduction	$5,337,000	$5,286,800
Insurance Subsidy	$94,200	$94,200
Existing Dallas Floodway	$8,790,800	$6,626,400
IH-45 Proposal	$1,043,500	$1,043,500
TOTAL BENEFITS	$15,265,500	$13,050,900
NET BENEFITS	$6,817,000	$4,114,300
BENEFIT-COST RATIO	1.81	1.46

OTHER SPECIAL CONSIDERATIONS

- The original Dallas Floodway Extension project, authorized in 1965, contained levees, channels, and lake features designed to provide SPF protection to both the northern and southern portions of the city of Dallas. The Locally Preferred Plan would provide for similar outputs at a lower total project cost. The estimated cost of the authorized improvements to the Dallas Floodway Extension area, at April 1998 price levels, would be $199.2 million. The TFSP, at the same price levels, was estimated to cost $118.5 million, including $23.1 million for compatible portions of previously constructed non-Federal levees. The LPP was estimated to cost $123.2 million, including $23.1 million for compatible portions of previously constructed non-Federal levees.

- The existing Dallas Floodway (which consists of levees and channels) was built in the 1950's to the SPF level of protection. The upstream channels convey flood waters downstream more quickly and the upstream levees confine flood waters which previously spread out over the upstream floodplain. Both factors have raised the downstream water surfaces and led to more severe flooding in the Dallas Floodway Extension area when storm events occur.

- The DFE areas to receive increased flood protection include Cadillac Heights, Joppa, South Dallas, and Lamar Street Industrial area. These areas are mainly low income minority residential neighborhoods and light industrial facilities.

- Flood records clearly demonstrate the need for downstream improvements. Over the years repeated flooding has caused losses of life, and led to significant financial losses to residences, businesses, and infrastructure in the Dallas Floodway Extension area. In addition, repeated flooding has created undesirable physical conditions within the area forcing some people and businesses to relocate from the area. Such conditions have also prevented economic growth and adversely affected community economic health.

- The Texas Department of Transportation initiated a Major Investment Study of the traffic congestion in the Dallas area in June 1996. This study recommends improvements estimated to cost in excess of $1 billion, and include a road way (Trinity Parkway Reliever) within the existing floodway and extend southward utilizing a portion of the proposed Dallas Floodway Extension project. Construction of the SPF levee around the Cadillac Heights area would protect both existing roads as well as any new improvements from catastrophic flood events.

ASA(CW) DECISION REGARDING REQUEST FOR EXCEPTION

This section describes the pertinent information submitted to the ASA(CW) for use in making a decision regarding the Request for Exception. **It is noted that the plan identified as the Tentative Federally Supportable Plan (TFSP) in the preceding sections, and in Chapter 4, of this report, was referred to as the Federally Supportable Plan in the April 1998 draft GRR/EIS. This designation was in accordance with the District's interpretation of current policy guidelines. The formal Request for Exception, and all supplemental information submitted to the Office of the ASA(CW) subsequent to the release of the draft GRR/EIS, as discussed below, reflect the designation of this plan (which includes the one percent Cadillac Heights Levee) as the Federally Supportable Plan. The final decision regarding the appropriately designated Federally Supportable Plan is presented below.**

FORMAL SUBMITTAL OF REQUEST FOR EXCEPTION

On June 3, 1998, a formal Request for Exception was submitted by the Fort Worth District, Corps of Engineers, to the Southwestern Division Commander, which presented comparative data between the Federally Supportable Plan (as identified in the draft GRR/EIS) and the Locally Preferred Plan, and recommended that the request be granted, thereby allowing the LPP to be constructed with full Federal cost sharing. This request, accompanied by the Division Commander's endorsement, is included in Appendix M herein. This document contained the information shown in the "BASIS FOR REQUEST FOR EXCEPTION" section above, and additional information required by paragraph 5.17 of ER 1105-2-100. The pertinent information contained in the request, beyond that previously presented, included the following:

- **Urban Flood Protection:** Neither the FSP nor the LPP would leave urban areas within the post-project 100-year floodplain, although the confidence limits applied to the protection of Cadillac Heights would be rather low. The FSP would, however, leave a portion of the study area, including the Cadillac Heights area, subject to flooding from major events above the one percent probability of exceedance.

- **Cost Sharing Impacts:** Based on the data and price levels presented in the draft GRR/EIS, table 5-6 presents the total Federal / non-Federal cost apportionment data, after application of the levee credit, for the FSP, the LPP with an exception, and the LPP without an exception.

Table 5-6
Comparative Cost Apportionment Data in Request for Exception
(April 1998 prices)

Cost Apportionment	FSP *	LPP With Exception	LPP Without Exception
Federal Cost	$101,019,300	$102,216,600	$101,019,300
Non-Federal Cost	$17,470,200	$20,942,600	$22,139,900
Total Cost	$118,489,500	$123,159,200	$123,159,200

** FSP, as identified in the April 1998 draft GRR/EIS, which included the one percent Cadillac Heights Levee*

- **Residual Damages:** The SPF Cadillac Heights Levee in the LPP is less likely to overtop and fail due to its increased height relative to the one percent levee in the FSP. Annual residual damages from the Trinity River, in the Cadillac Heights area, would be $100,500 with the one percent levee and $17,100 with the SPF levee. Annual residual damages for the entire project area would be $6.0 million with the one percent levee and $8.2 million with the SPF levee.

- **Concentration of Damages:** The proposed Lamar Levee is justified at the SPF level. Implementing the Cadillac Heights Levee at a comparatively lower height would cause flood damages to concentrate in the Cadillac Heights area when flood events exceed the one percent annual chance of exceedance (ACE).

- **Characteristics of Protected Area:** The Cadillac Heights Levee would protect an area with a mix of commercial, residential, and public infrastructure facilities. However, the primary beneficiaries of the increased flood protection would be the residents. The sponsor's commitment to providing equal protection to the residents is highlighted by their desire to pursue higher flood protection for Cadillac Heights, while electing not to pursue increased flood protection to the city-owned Central Wastewater Treatment Plant.

- **Concerns of Others:** The sponsor was very concerned about the social inequity and public acceptability issues that construction of the FSP could generate. Social inequity is already an issue due to perceptions that the Dallas Floodway project shifted flood damages from the central business district to low-income and minority neighborhoods.

The Request for Exception was reviewed by Headquarters, U.S. Army Corps of Engineers (HQUSACE), and forwarded to the Office of the Assistant Secretary of the Army (Civil Works), by letter dated August 18, 1998. This letter, which is included in Appendix M herein, provided additional discussion regarding the FSP (as identified in the draft GRR/EIS) and the LPP, and identified three cost sharing options, as presented below:

- **Federally Supportable Plan (FSP):** The FSP would restore SPF level of protection to the existing Federal levees, would provide the same to the Lamar Street Community, but would only provide protection from the 1.0% ACE (100-year) flood for the Cadillac Heights Community. With implementation of the FSP, a flood event greater than the 1.0% ACE flood would overtop at the Cadillac Heights Levee and subject the community to a real possibility of loss of life. The Cadillac Heights Levee, being lower, would overtop prior to the other higher levees. A 1.0% ACE flood would likely overtop the proposed FSP Cadillac Heights Levee. About 131 residential and 29 commercial structures would incur damages, putting approximately 328 people at risk. The maximum flood depth, which is measured at the lowest protected structure, would be 10.7 feet. A Standard Project Flood would overtop the FSP at the Cadillac Heights levee by over 9 feet. About 215 residential and 66 commercial structures would incur damages, putting approximately 538 people at risk. The maximum flood depth would be approximately 20 feet.

- **Locally Preferred Plan (LPP):** The LPP would provide the same level of protection to the Cadillac Heights Community as would be provided to the Lamar Levee, and to the East and West Levees of the existing Dallas Floodway. Current risk and uncertainty modeling programs, which calculate levels of confidence only up to a 0.2% ACE (500-year) flood, show that these levees would provide protection from the 0.2% ACE (500-year) flood, with confidence levels varying from 86% to 92%. They would pass the SPF with lesser confidence levels. It is likely that the LPP will be the recommended plan in the final report, as the sponsor is not willing to implement the FSP. The non-Federal sponsor is fully aware that the LPP would provide a lesser, but consistent level of protection for the four leveed areas. In all cases, the level of protection that would be provided by the LPP would be far greater than that provided without a project. The community is willing to accept this trade-off condition. The Sponsor, and community at large, do not feel that the Federally Supportable Plan (as identified in the draft GRR/EIS) is implementable because of the social impacts that are evident; that is, providing a lower level of protection, and higher risk of loss of life, to the low-income, minority community of Cadillac Heights.

- **Options:**

  1. Construct the FSP with traditional cost sharing (75% Federal; 25% non-Federal).
  2. Construct the LPP at 100 percent non-Federal cost above the FSP level.
  3. Construct the LPP at full traditional cost sharing (75% Federal; 25% non-Federal).

The recommendation of HQUSACE was for selection of Option 3, as it was felt that not only would the FSP be socially unacceptable from the sponsor's point of view, but the economic cost of the LPP should not be weighed against the increased risk to life in a low-income, minority community, while a higher level of protection and lower risk to life would be provided to the rest of the community. By selecting the LPP, emphasis would be placed on lives, people, equality and implementability.

SUPPLEMENTAL INFORMATION

Prior to finalizing a decision regarding the request for exception, additional information was requested by the office of the ASA(CW). This supplemental information was provided, as seen in Appendix M, and included the following: a tabularized listing of flow capacity (design discharge) and level of protection for the authorized plan, for existing conditions, and for future conditions without the project, with the FSP, and with the LPP; data regarding levels of confidence for the various levees; hydrologic conditions (current or future) upon which the levels of confidence are

based; information regarding whether the FSP Cadillac Heights Levee would meet FEMA certification requirements; determination of whether the Cadillac Heights Levee is needed to mitigate the effects of other elements of the project; and, comparative socio-economic data between the Cadillac Heights neighborhood and the city of Dallas.

In response to these requests, the following information was provided:

- Table 5-7 presents the flow capacity and level of protection for various scenarios and provides a general understanding of the changing conditions.

Table 5-7
Flow Capacity and Level of Protection for Various Scenarios

Scenario	Flow Capacity (cfs)		Level of Protection	
Existing Dallas Floodway (1960)	226,000 (design)		SPF	
Authorized Plan	270,000 (design)		SPF	
Current Conditions	212,000		550-year (Floodway only)	
Year 2050 without Project	192,000		400-year (Floodway only)	
Year 2000 with FSP	Cadillac	Remainder	Cadillac	Remainder
	115,200	269,200	100	SPF
Year 2000 with LPP	269,200		SPF	

- Two tables in the GRR/EIS (Tables D-34 and D-35 in Appendix D) provide the levels of confidence for the levees in the FSP and the LPP, respectively. These tables do not provide confidence levels for the SPF. The model used for the computation, HEC-FDA, does not provide this information primarily because the SPF varies in frequency from watershed to watershed. Table 5-8 presents a comparative summary of the levels of confidence for passage of the 100-year (1% ACE) and the 500-year (0.2% ACE) flood events in the critical reaches (Cadillac Heights, Lamar Street, East Levee of existing Floodway, West Levee of existing Floodway) of the study area with implementation of the FSP and the LPP.

Table 5-8
Levels of Confidence for Levees

Levee / Reach	FSP		LPP	
	100-Year Flood (1% ACE)	500-Year Flood (0.2% ACE)	100-Year Flood (1% ACE)	500-Year Flood (0.2% ACE)
Lamar	98%	80%	99%	92%
Cadillac Heights	34%	5%	99%	91%
East Levee	99%	92%	99%	86%
West Levee	99%	90%	99%	86%

- The levels of protection cited in the Request for Exception are based on year 2000 hydrology. Year 2050 hydrology was used in the development of average annual equivalent economic damages. In summary, the LPP would provide essentially consistent levels of protection to all reaches except the Central Wastewater Treatment Plant (CWWTP). The FSP would provide consistent levels of protection to all reaches except the CWWTP and Cadillac Heights. If the FSP were built, the 100-year Cadillac Heights Levee would be the only urban flood levee within the Fort Worth District to have a design level lower than SPF.

- The height of the Cadillac Heights Levee in the FSP was derived during the economic optimization process, without regard to the FEMA certification requirements. For this levee to meet FEMA's requirements, it would have to be approximately three feet higher than formulated. Therefore, the economic benefits ($15,500) previously attributed to the FSP Cadillac Heights for reduction in administration costs for insurance subsidy programs would be invalid. This reduction in benefits, however, would not change the economic feasibility of the levee.

- It is the District's belief that the Cadillac Heights Levee would not be constructed as mitigation for other project elements, and that from an economic and hydraulic perspective, this levee is a separable element. However, from the public perspective, its separability is questionable due to the public belief that the lower Cadillac Heights Levee was designed as a safety valve to protect the Central Business District and the north side of the Trinity River at the expense of the minority population in the poorer Cadillac Heights neighborhood.

- Table 5-9, provided by the City of Dallas, presents comparative socio-economic data between the Cadillac Heights neighborhood and city as a whole.

Table 5-9
Comparative Socio-Economic Data - Cadillac Heights vs. City of Dallas

	Cadillac Heights	City of Dallas
Number of Homes	416	479,622
High / Low Price of Homes	$53,500 / $3,960	$11,949,900 / NA
Average Appraised Value	$17,500	$64,700
Percent Homeowners	51.5%	44.1%
Percent Single-Family Units	64.9%	47.5%
Percent Multi-Family Units	31.0%	50.4%
Number of Persons	1,168	1,052,300
Percent Persons Under 18	35.5%	25.0%
Percent Persons Over 65	6.8%	9.7%
Total Percent Hispanic	58.0%	20.3%
Total Percent Black	40.9%	29.5%
Total Percent White	1.0%	47.7%
Total Percent Without High School Degree	73.4%	26.5%
Total Percent Unemployed	9.1%	7.4%
Average Income	$15,089	$27,489
Percent Households on Public Assistance	35.4%	5.7%
Number of Persons Below Poverty Level	46.6%	17.8%

FINAL IDENTIFICATION OF FEDERALLY SUPPORTABLE PLAN

Upon evaluation of the request to recommend a Standard Project Flood (SPF) level of protection for the DFE project, and based upon the data submitted in support of this recommendation, the Assistant Secretary of the Army (Civil Works), by letter dated November 9, 1998, decided that the project providing a consistent SPF level of protection did not require an exception to policy guidelines, but is the Federally Supportable Plan. In other words, the Locally Preferred Plan is the Federally Supportable Plan.

This decision was made for the following reasons. First, the alternative levee for the Cadillac Heights neighborhood would not meet the Federal Emergency Management Agency standards for protecting the area from a flood that would have a 1.0 percent annual chance of exceedance (ACE), nor would it provide an acceptable level of reliability, particularly when compared with other project elements. Second, the alternative levee for Cadillac Heights would allow continued damages in this area from major, although infrequent floods (greater than the 1.0% ACE), due to the construction of other project levees. Finally, Congress has already authorized the project, including the Cadillac Heights Levee, at a SPF level of protection.

IDENTIFICATION OF THE RECOMMENDED PLAN

In accordance with the decision of the Assistant Secretary of the Army (Civil Works) designating the Locally Preferred Plan as the Federally Supportable Plan, this plan is therefore designated the Recommended Plan, and is recommended for implementation. This plan would consist of the following elements:

- **Chain of Wetlands:** The chain of wetlands increment would consist of upper and lower swales, separated at Interstate Highway (IH) 45. The upper swale would have an average 400-foot bottom width and would extend from Cedar Creek to the oxbow lake at IH-45, a distance of about 1.5 miles. The lower swale would have an average 600-foot bottom width, would extend between IH-45 and Loop 12, a distance of about 2.2 miles, and would be aligned through the Linfield Landfill and Sleepy Hollow Golf Course to minimize impacts to forested areas and nearby residential areas. Excavated wetlands and vegetative plantings would be added as environmental restoration features within the footprint of the swales to form a "chain of wetlands."

- **Channel Realignment at IH-45:** The channel realignment at IH-45, as proposed by TxDOT, would allow the river to flow within a wider span of the IH-45 bridge which was better designed to accommodate river flows. This realignment would reduce the risk of catastrophic failure of this vital bridge, and would significantly reduce current annual maintenance costs associated with debris removal around the bridge columns.

- **SPF Lamar Levee:** This increment would include construction of an earthen levee providing SPF protection (.00125 probability of exceedance) for the Lamar Street area. This levee would extend from the existing Dallas Floodway East Levee to the previously constructed Rochester Park Levee, a distance of 2.9 miles.

- **SPF Cadillac Heights Levee:** This increment would include an earthen levee and providing SPF protection (.00125 probability of exceedance) for the Cadillac Heights area. This levee would extend from near Cedar Creek to the Central Wastewater Treatment Plant (CWWTP), would utilize and raise of portion of the northwest comer of the CWWTP Levee, and would extend to high ground near the intersection of Kiest Boulevard and McGowan Avenue, a total distance of approximately 2.2 miles.

- **Non-Federal Levees:** In addition to the levees described above, the Recommended Plan would also include the costs and benefits of the portions of the previously constructed non-Federal levees. The total cost for the compatible portions of these levees was estimated at $23.1 million ($14.2 million for the CWWTP Levee upgrade and $8.9 million for the compatible portion of the Rochester Park Levee).

- **Recreation Features:** The Recommended Plan would include recreation amenities compatible with the regional recreation master plan, including hike/bike trails, equestrian trails, nature trails and pavilions.

At April 1998 price levels, the flood control first cost of the Recommended Plan was estimated at approximately $78.5 million, plus $23.1 million for the non-Federal levees, for a total economic flood control first cost of $101.6 million. Annual flood control costs were estimated at $8.4 million, with net annual flood control benefits of $6.8 million, and a BCR of 1.81.

Additional details and costs for the Recommended Plan are presented in Chapter 6 of this document.

CHAPTER 6

RECOMMENDED PLAN

CHAPTER 6
RECOMMENDED PLAN

This chapter provides details on the Recommended Plan, as determined in the preceding chapters of this report, and as modified per the comments received from higher Corps authorities, the public, and various local, state and Federal agencies during the 90-day public review period, which ended August 14, 1998. These comments, with appropriate responses, are included in Appendix N of this document. The revised, detailed cost estimate for this plan is shown in Appendix K. In addition, the costs and economic analyses presented in this chapter were updated to reflect October 1998 price levels and the current Federal interest rate of 6-7/8%. Federal and non-Federal cost apportionment data for implementation of the plan are also presented.

The Recommended Plan would consist of flood damage reduction features, with associated environmental mitigation requirements, environmental restoration features, including a chain of wetlands, and recreation amenities. Due to the complexities of displaying all the features at a legible scale, figure 6-1 presents the features of the Recommended Plan, excluding recreation. Figure 6-2 shows all the project features of the Recommended Plan, but at a reduced scale.

PLAN FEATURES

CHAIN OF WETLANDS AND CHANNEL REALIGNMENT AT IH-45

The chain of wetlands portion of the proposed project would consist of an upper wetland chain, with four separate wetland cells, and a lower wetland chain, with three separate cells, each of various lengths and shapes. During flooding, the upper and lower chains would act as flood control channels to convey flood waters to outfalls east of IH-45 and north of Loop 12, respectively. During non-flood periods, the chains would serve as wetland areas for various wildlife and aquatic growth. Each cell would have a concrete stoplog inlet control structure and a standard concrete headwall outlet structure, connected by 36-inch diameter reinforced pipe. The typical section of a wetland cell would vary in depth from 1.5 feet to 7 feet, with various slopes and shelves to support aquatic life and vegetation. These wetland cells are described and shown in more detail in Appendix C.

Flooding from the Trinity River would be the main source of water for the wetland cells; however, in times of low flows or drought, water would be pumped from an existing wetland cell just north of the Central Wastewater Treatment Plant.

Drilling and testing operations were conducted in the proposed project area to ascertain geotechnical data, HTRW date, and cultural resource information. Geotechnical parameters developed as a result of this drilling and testing are discussed in Appendix B. Results of HTRW testing are explained in detail in Appendix J, while significant cultural/historic resource information is presented in Appendix H.

Quantities and costs for the chain of wetlands are provided in Appendix K. Since the chain of wetlands would include both flood control features and environmental restoration features, these quantities were calculated separately. Real estate costs for the swale were estimated at $13.7 million, including $2.6 million for mitigation lands. Environmental mitigation costs for the flood control portion of the chain of wetlands, excluding lands, were estimated at $0.3 million.

A review of preliminary HTRW investigations indicated the presence of lead-containing leachate at the Linfield Landfill site, through which the lower chain of wetlands would traverse. Avoidance of this area has been restricted by the presence of a historic neighborhood on the west side of the landfill, and the river on the east. The chain of wetlands has been designed at the extreme western boundary of the landfill in order to avoid more hazardous materials thought to be present in the eastern portions of the landfill. Alternatives which would provide for construction of a channel on the east side of the river, opposite the landfill, have been vigorously opposed due to

the environmental significance of the "Great Trinity Forest" which encompasses that area. A slurry trench was designed to prohibit leachate from entering the swale from the landfill during and after construction, and a three-foot cover of select material was proposed for the exposed material within the swale. More detailed investigations completed in November 1998 concluded that the leachate did not warrant classification as hazardous waste, but could be handled as Class I industrial waste. Detailed results of the HTRW investigations are provided in Appendix J.

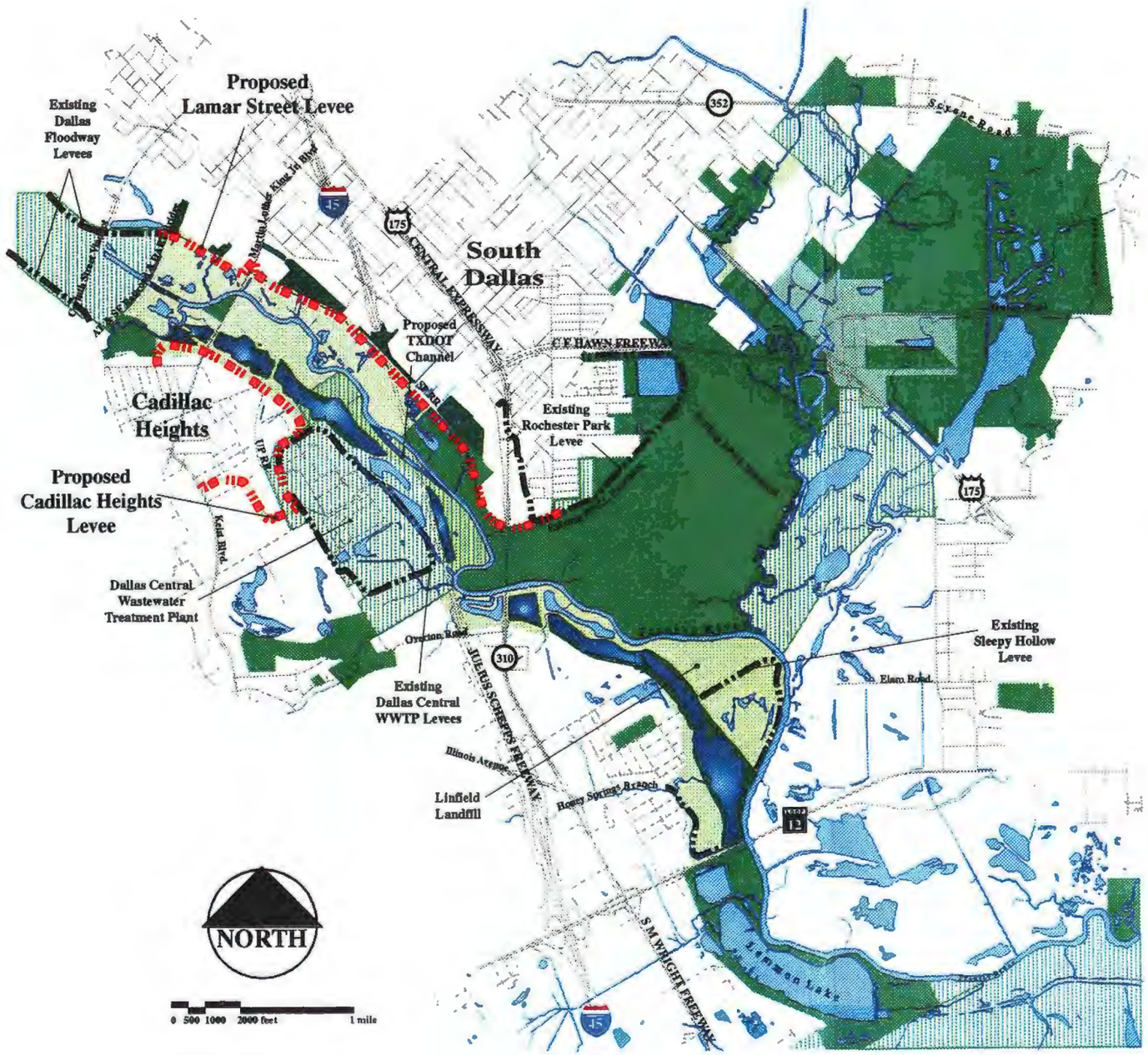
Channel Realignment at IH-45 Bridge

The proposed trapezoidal channel would be approximately 3,300 feet in length, with a 30-foot bottom width, 3H:1V side slopes, and a top width of approximately 180 feet. The existing river channel in the reach where the realignment is proposed has an average bottom slope that is nearly zero. Therefore, the proposed channel realignment section has been designed with a zero bottom slope from beginning to end. The proposed channel would have an average depth of 15 feet and has been designed to closely approximate the channel flow capacity and the flow velocities of the existing river channel. The proposed channel alignment would be centered between the nearest 320-foot span of the IH-45 bridge. Excavation around the piers would not be required. The proposed realignment will result in the channel being moved laterally a maximum distance of about 350 feet.

The existing channel would be filled to the existing top of bank elevation 396.0 to prevent further collection of debris. Relocation of the channel would result in modifications to the existing Central Mitigation Swale, which would be reduced in size by filling of the portion of the swale near the proposed channel realignment. A minimum of 150 feet from the top of bank of the proposed river channel realignment to the top of the bank of the Central Mitigation Swale would be required.

Several alternatives regarding filling of the old river channel have been investigated. The investigated alternatives would accomplish the primary goals of the IH-45 bridge channel realignment project to some degree, but the proposed plan for the channel realignment would accomplish these goals with a minimal risk to the bridge structure and a minimal filling of the old channel. The primary objectives of the project would be to reduce the risk of damage to the bridge piers from floating debris and reduce or eliminate the cost of continual maintenance to remove the debris and periodically repair the structure. The proposed plan to fill the old channel would be to fill from the upstream diversion of the river channel to the downstream side of the bridge. The fill would be placed up to the level of the existing overbank areas at the approximate elevation of 396.0 and would be placed around the existing bridge piers located within the old channel. This alternative was deemed the only partial channel fill plan that would ensure complete diversion of channel confined flows and minimize the risk to the existing bridge piers. The channel fill would terminate at the downstream end with a very gradual slope to the streambed of the old channel just downstream of the bridge piers. A portion of the old channel downstream of the IH-45 bridge would remain unfilled. This unfilled portion of the old channel would provide a slack water area for use as a possible river access point, and may provide some habitat diversity near the river. The filled portion of the old river channel would maximize the diversion of channel confined river flows to the new channel alignment, stabilize the bridge piers in the old channel, and minimize the risk of floating debris collecting on the bridge piers. TxDOT maintains an access road directly beneath the IH-45 bridge which provides access to the river channel from either side of the river. Filling of the old river channel beneath the bridge, as proposed, would provide continued access to the river channel for inspection and maintenance. A plan view of the proposed relocation of the Trinity River channel at IH-45 may be found in Appendix C.

Approximately 287,200 cy of excavation would be required for this channel, and approximately 60,300 cy of fill would be placed within the existing channel, as described above. The total construction cost for the channel realignment proposal was estimated at approximately $2.0 million, and would provide annual benefits of $1.0 million. Approximately 71 acres of mitigation would be required for this work effort.



Legend

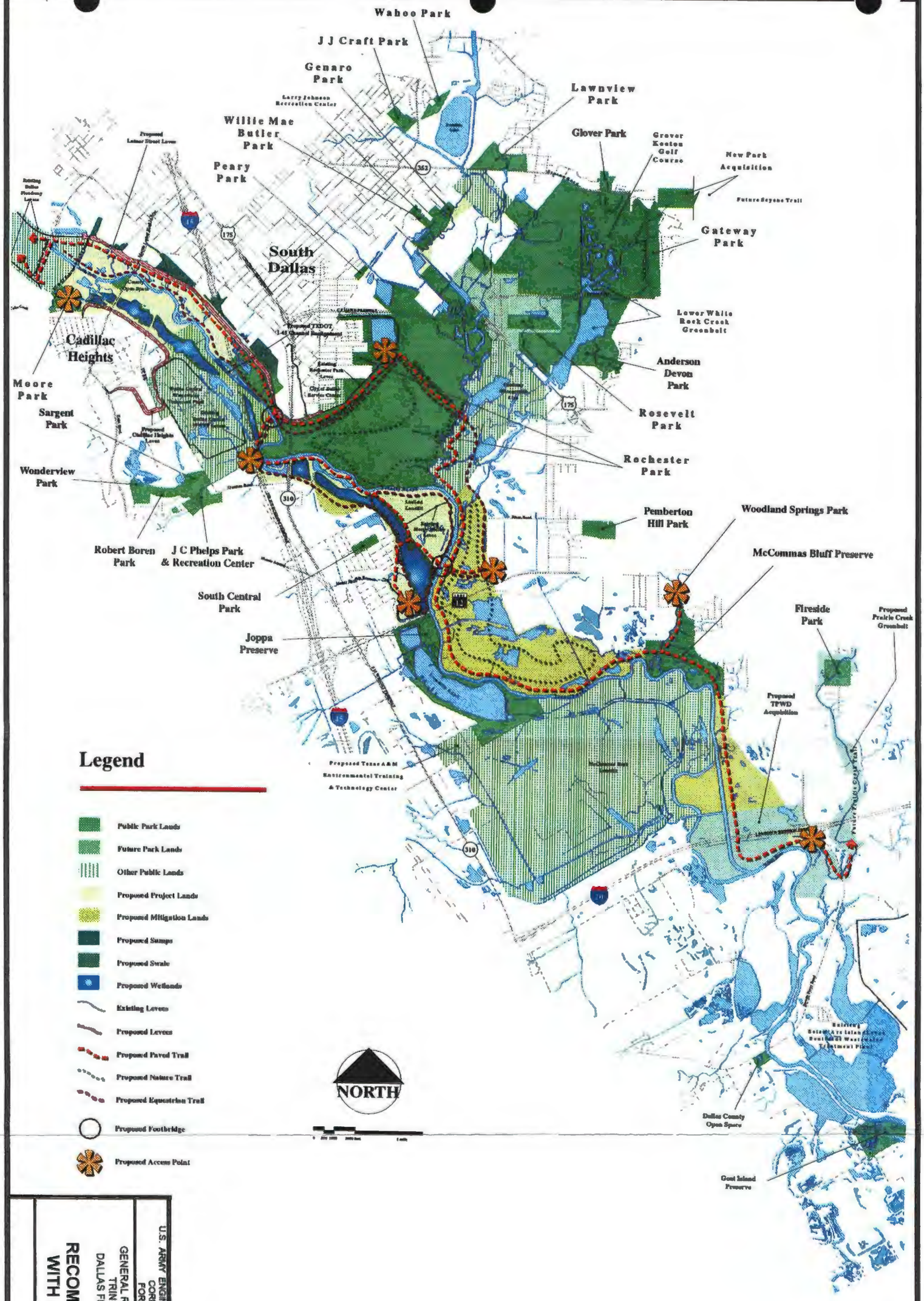
- Public Park Lands
- Other Public Lands
- Proposed Project Lands
- Proposed Sumps
- Proposed Swale
- Proposed Wetlands
- Existing Levees
- Proposed Levees

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

RECOMMENDED PLAN

FIGURE 6-1



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

GENERAL REEVALUATION REPORT
TRINITY RIVER, TEXAS
DALLAS FLOODWAY EXTENSION

RECOMMENDED PLAN WITH RECREATION

FIGURE 6-2

Summary

Total costs for the flood control portion of the chain of wetlands and channel realignment at IH-45, including preconstruction engineering and design and construction management were estimated at approximately $59.1 million. The addition of $14.2 million for the non-Federal CWWTP Levee upgrade, in accordance with Section 351 of WRDA 1996, brought the total estimated cost for the flood control portion of the chain of wetlands increment of the Recommended Plan to approximately $73.3 million.

The detailed cost estimate for the environmental restoration features of the chain of wetlands increment of the Recommended Plan, including preconstruction engineering and design and construction management was calculated at approximately $5.6 million, with an annualized cost of approximately $465,800. Table 6-1 presents the breakdown of costs per unit of output for the final environmental restoration plan, as derived through incremental analyses in Chapter 4, and in Appendix F, of this document.

Table 6-1
Analysis of Environmental Restoration Features
(October 1998 prices, 6.875% interest, 50-year period of analysis)

	Annual Cost	AAHU Output	Cost / AAHU
Environmental Restoration	$465,800	184	$2,532

LAMAR LEVEE

The proposed Lamar Levee would extend over a total length of 16,419 feet, with top of levee elevations varying from 417.0 at the downstream end to 426.0 at the upstream end. The average height of the levee would be 17.6 feet, with a maximum height of 31.0 feet. A 20-foot crown width and 1 vertical to 4 horizontal side slopes would be utilized, based on performance of existing levees within the area, and on a slope stability analysis. The alignment of the levee would impact the Southern Pacific (S.P.) Railroad at one location and the Missouri-Kansas-Texas (M.K.T.) Railroad at one location, requiring 20-foot wide stoplog structures at each site, with heights of 8 feet and 14 feet, respectively. No major roads would be impacted by gated structures; however, at the junction of the levee with Martin Luther King Boulevard, the levee was realigned to reach a higher ground tie-in point. The downstream end of the levee would tie into the previously constructed Rochester Park Levee. This non-Federal levee has a top of levee elevation of only 415.0, thereby requiring raising of a portion of the Rochester Park Levee to transition into the downstream Lamar Levee elevation of 417.0. Two major freeway bridges would cross the proposed levee, but would require no modification since the low chord beam elevations would be well above the top of the levee. Detailed descriptions and drawings of this levee are included in Appendix C of this report. Excavation of almost 600,00 cubic yards of material would be required for construction of sumps behind the levees, as described in Appendix A.

Various utilities would be affected by the alignment of the levee and the location of the sumps, and relocation procedures would be required prior to construction. Sanitary sewer lines, storm sewer lines, and fiber optic cables would require relocation, as described in Appendix C. Relocation costs were estimated to total approximately $3.4 million for the Lamar Levee. In addition, five sluice structures would be required for discharge of sump areas through the levees. These structures, as well as all closure structures, are described and presented in Appendix C. The geotechnical design and structural design parameters are provided in Appendix B and Appendix C, respectively.

Real estate costs for the Lamar Levee were estimated at approximately $5.8 million, of which $1.0 million would be relocation assistance costs for displaced persons and business, and $1.4 million would be for mitigation lands. Environmental mitigation costs, not including lands, were estimated at $0.2 million. The breakdown of these costs is provided in Appendix E, and in the detailed cost estimate shown in Appendix K.

No known HTRW sites would be affected by construction of this levee and associated sumps, as the sumps have been relocated to avoid potential HTRW sites. It is noted, however, that further testing may reveal HTRW sites which are unknown at this time. Should such sites be discovered, for which avoidance were not possible, the costs for removal of the contaminated material would be the responsibility of the sponsor. More detailed results of the HTRW investigations are presented in Appendix J.

The total economic costs for the Lamar Levee increment of the Recommended Plan were estimated at $18.3 million, including preconstruction engineering and design and construction management. Since a portion of the Rochester Park Levee would be compatible with the Lamar Levee, the costs for this compatible portion, totaling approximately $8.9 million, were added to the Lamar Levee. The total cost of the Lamar Levee, therefore, was estimated at $27.2 million.

CADILLAC HEIGHTS LEVEE

The Cadillac Heights Levee would extend over a total length of 11,891 feet, with top of levee elevations varying from 421.5 at the downstream end to 426.0 at the upstream end. The average height would be 14.9 feet, with a maximum height of 25.75 feet. The crown width would be 20 feet, with side slopes of 1 vertical to 4 horizontal, based on performance of existing levees within the area, and on a slope stability analysis. Four flood control closure structures would be required at railroad and street crossings. The M.K.T. Railroad would cross the levee three times, thereby requiring three 20-foot wide stoplog structures, the heights of which would vary from 6.5 feet to 17.5 feet. One floodgate would be required at Martin Luther King Boulevard, and would measure 65 feet wide and 5 feet high.

Approximately 600 feet of the existing non-Federal levee surrounding the CWWTP, near the entrance, would be utilized by raising the levee six feet.

Sump requirements for the Cadillac Heights Levee would be non-existent; however, four sluice structures would be provided for drainage of the areas behind the levees.

Various sanitary sewer lines, storm sewer lines, water supply lines, electrical supply towers, and the roadway entrance to the CWWTP would require relocation and/or reconstruction.

Detailed drawings and descriptions of each of these design and relocation elements are presented in Appendix C.

Real estate costs for the Cadillac Heights levee were estimated to be $6.1 million, of which $3.1 million would be for relocation of displaced persons and businesses, and $0.2 million would be for mitigation lands. Environmental mitigation costs, not including lands, were estimated at $0.02 million.

Preliminary investigations, prior to the release of the draft GRR/EIS in May 1998, indicated no known HTRW sites would be affected by construction of this levee. After release of the draft GRR/EIS, and prior to the preparation of the Final GRR, follow-on site visits in the vicinity of Area 9 (as defined in Appendix J) identified construction underway in the southern portion of Area 9 (Darling International). Examination of TNRCC files was conducted to determine the purpose and nature of the activities in the southern portion of Area 9. The examinations revealed new documents that confirm the presence of hazardous levels of lead in the southern portion of Area 9. Given a similar site history, it is likely that hazardous levels of lead exist in the northern portion of

Area 9 (Energy Conversion Systems). The current owners of the northern portion of Area 9 will be performing investigations, but results are not yet available.

The hazardous levels of lead at Area 9 appear to be associated with buried lead slag and battery casings. It does not appear that the high levels of lead extend beyond the immediate area being capped. This conclusion is supported by data obtained from construction of an adjacent 120-inch interceptor line by the City of Dallas. The interceptor line runs parallel to the Trinity River and immediately adjacent to Area 9. Data developed for the City of Dallas along the new interceptor line indicate total lead levels up to 1000 mg/Kg to a depth of 6 feet. These samples tested to be non-hazardous, however, with a maximum Toxicity Characteristic Leaching Procedure (TCLP) value of only 0.22 mg/L. TCLP values that are equal to or greater than 5.0 mg/L are considered to be hazardous for lead.

Refinement of the Cadillac Heights levee alignment in this area will be a priority for future investigations. Final design will balance disturbance of known contaminants, costs for handling and disposal of special wastes, and impacts to natural resources.

The economic costs for the Cadillac Heights Levee increment of the Recommended Plan were estimated at $9.3 million, including preconstruction engineering and design and construction management.

INTERIOR DRAINAGE - SUMP AREAS

In the final analyses of the Recommended Plan, specific efforts were undertaken to evaluate the potential for increasing the economic effectiveness of the initial design proposals. However, based on current USACE policy, only the subtle changes in potential flood damages around the interior drainage facilities which result from variation of the proposed design were eligible as measures of the benefits to be gained (or lost) under alternative design scenarios. Since many of the adjacent improved properties are comprised of warehouse-style construction, significant increases in the residual flood damages would require that the potential pool levels in the interior facilities be raised several feet, causing impoundment over substantially larger acreages than that resulting from the initial design conditions. The larger flooding area, in and of itself, is not reflected in direct flood damages, under the current economic assessment strategy. Residual flooding damages for a 500-year interior flood event are presented in table 6-2 for the sump areas behind the Lamar Levee. As shown in the table, and for the reasons noted above, the residual damages are very minimal for this area. It was estimated that there would be no annualized residual damages in the Cadillac Heights sump areas.

It is clear that larger interior drainage facilities can not be economically justified, given these constraints. Smaller facilities may be economically justified, but those alternatives would not meet the provision that the minimum facilities meet the local sponsor's design standards, as established by ordinance, and would be impractical. The City of Dallas' "Drainage Design Manual" (May 1993) and the "Dallas Development Code" require a 100-year frequency (0.01 probability of exceedance) design level for these types of facilities.

Table 6-2
Cumulative Residual Single-Event and Annualized Damages For Lamar Levee Sumps

(October 1998 prices, 6.875% interest, 50-year period of analysis)

% ACE Event	Sump 1	Sump 2	Sump 3	Sump 4	Sump 5	Total
<100	$0	$0	$0	$0	$0	$0
50	$0	$0	$0	$0	$0	$0
20	$0	$0	$0	$0	$0	$0
10	$0	$0	$0	$0	$0	$0
4	$0	$0	$0	$0	$0	$0
2	$0	$0	$0	$0	$0	$0
1	$0	$0	$0	$0	$0	$0
.4	$43,396	$11,411	$223,538	$0	$0	$278,345
.2	$60,344	$119,551	$331,458	$0	$0	$511,353
Annualized *	$700	$910	$5,810	$0	$240	$7,660

** The annualized damages were derived using the risk and uncertainty program, while cumulative single-event damages were not. Damages were shown for Sump 5 only upon application of the risk and uncertainly analysis. It was estimated that there would be no residual damages for the Cadillac Heights sump areas.*

As stated previously, the sumps along the proposed Lamar Street Levee would be situated from upstream to downstream as follows, and as shown in figure 6-1. The first would be located immediately southeast of the Dallas Area Rapid Transit (DART) rail line. It would require no excavation, but would inundate 1.68 acres under the design condition. The second would be located at the southwest "dead" end of Forest Avenue. It would require some limited excavation (on the southwest side of an existing commercial activity) and would inundate 1.80 acres under the design condition. The third would straddle the Missouri-Kansas-Texas (MKT) Railway and occupy the long triangular area bounded by that railway, the Southern-Pacific (SP) Railway, and the proposed Lamar Street Levee. It would require extensive excavation and would inundate 17.10 acres under the design condition. The fourth would be located beneath the north end of the Interstate Highway 45 (Julius Schepps Freeway) bridge over the Trinity River valley. It would require no excavation, but would inundate 8.08 acres under the design condition. The fifth would be located along the northeast side of the SP Railway, behind the active commercial entities along the more southeastern end of Lamar Street. It would require substantial excavation and would inundate 12.20 acres under the design condition.

The interior drainage facilities (sluice structures) along the proposed Cadillac Heights Levee, none of which would require significant excavation or would be expected to create a significant area of inundation, would be situated from upstream to downstream as follows. The first would be located west of Martin Luther King Jr. (Cedar Crest) Boulevard. The second would be located adjacent to the west side of the MKT Railway, at the point where it crosses the northeastern leg of the proposed levee alignment. The third would be located several hundred feet east of the MKT Railway. The fourth would be located adjacent to the MKT Railway, at the point where it crosses the southern leg of the proposed levee alignment.

Those sump areas which would be excavated would have three-on-one side slopes, and generally flat bottoms (sloped very slightly to the outlet). The outlet sluice facilities are proposed as simple rectangular conduits with both a flapgate (at the outlet end) and a manually operated sluice gate. Pertinent data on the sumps and outlet sluice structures, including hydrologic effects, are presented in table A-9 of Appendix A.

RECREATION AMENITIES

The recreation plan for the proposed project was designed to meet existing needs for passive and non-structured recreational activities within the regional service area, and to address state and regional shortfalls in facilities for walking, hiking, cycling, and jogging, as identified in the TORP. Facilities proposed for this project would be necessary to provide public access, protect sensitive environmental resources and promote safe use of the area. The proposed plan would create linkages between existing recreational areas and public open space areas, both existing and necessary for the DFE project. Proposed access points would take advantage of existing facilities within local parks and preserves, to the extent possible. The plan would be consistent with locally adopted recommendations for long range development of a "Great Trinity Forest Park" within the DFE area. Facilities proposed for the recreation plan are described below. More detailed discussions and drawings of this proposed plan and the regional recreation master plan are presented in Appendix I.

Trails and Access Points

The proposed project would include 18 miles of 10-foot wide, 4-inch thick reinforced concrete on compacted subgrade. The plan would also include 8.5 miles of natural surface equestrian trails and 5 miles of natural surface nature trails. A total of seven access areas are proposed, three of which would be located at existing parks or areas with adequate existing parking areas. These areas are located at Moore Park near Cedar Creek, at Woodland Springs Park near the McCommas Bluff Preserve, and at IH-45 near the Central Wastewater Treatment Plant. Each of these areas would need an entry sign, a 30-foot by 60-foot picnic pavilion, and a trailhead with an informational kiosk. The clubhouse at the Sleepy Hollow Golf Course is included as an access point, but would require no modifications. One of the three new access areas would be located near the upstream end of the existing Rochester Park levee, with another located on the east side of the Trinity River across from Lemmon Lake, and the final one located at the southern end of the study area near IH-20. The new access areas would require concrete entry drives and parking spaces to accommodate 20 cars each, with adequate turn-around space for busses and trailers. Each area would also need an entry sign, a 30-foot by 60-foot picnic pavilion, a trailhead with an informational kiosk, security lighting, and a drinking fountain and hose bib. Typical details for the concrete hike/bike trail and access areas are shown on Plate C33 in Appendix C.

Structures

Two pedestrian bridge structures would be provided for access across the river channel. The bridges would typically consist of three 50-foot prestressed concrete beams and would be designed to support light maintenance vehicles. Plate C33 in Appendix C shows typical details for the proposed structures.

Costs for the recreation amenities, including preconstruction engineering and design and construction management were estimated at $6.8 million.

OPERATION, MAINTENANCE, REPAIR, REPLACEMENT AND REHABILITATION

The Federal Government and the city of Dallas will enter into a local cooperation agreement under which the city will accept the project after completion of construction, and insure operation and maintenance in accordance with Federal regulations. The major items of operation and maintenance include mowing of the levees and sumps, weed control along the concrete trail and nature trail, management of the open space within the project, operation and maintenance of the pumping station and inlet and outlet control structures within the chain of wetlands, and operation and maintenance of stoplog structures and floodgates throughout the project. Table 6-3 provides a breakdown of the estimated OMRR&R costs. An operation and maintenance manual will be prepared by the Fort Worth District after completion of the project, which will include specific,

detailed requirements for the operation and management of the levees, chain of wetlands, and fish and wildlife mitigation areas. These requirements will be developed through coordination with state and federal resource agencies to assure that environmental attributes of the project meet regulatory and agency mandates. In addition to routine operation and maintenance, the city will be responsible for repair, replacement and/or rehabilitation of all components and features of this project. Periodic inspections will be performed to insure that all required maintenance is being performed.

Table 6-3
Breakdown of OMRR&R Costs
(October 1998 prices)

	ESTIMATED ANNUAL COST
CHAIN OF WETLANDS:	
Mowing/clearing	*$20,000*
Debris clean-up	*$18,000*
Pump replacement (once every 25 years)	*$2,000*
Inlet/outlet structure operation/maintenance	*$10,000*
Mitigation areas for chain of wetlands	*$24,000*
Total - Chain of Wetlands	***$74,000***
LEVEES (including Rochester Park & CWWTP)	
Mowing - levees	*$200,000*
Mowing - sumps	*$75,000*
Repair of maintenance road on levees	*$35,000*
Debris removal - sumps	*$75,000*
Floodgates / closure structures maintenance	*$25,000*
Sluice structure operation/maintenance	*$35,000*
Mitigation areas for levees	*$8,000*
Total - Levees	***$453,000***
RECREATION:	
Maintenance / debris clean-up at pavilions	*$4,000*
Replacement of trail at 25-years	*$50,000*
Maintenance / cleaning of trails / bridges	*$8,000*
Resurfacing / restriping of access areas at 10-year intervals	*$6,000*
Sign repair / lighting	*$5,000*
Total - Recreation	***$73,000***
TOTAL	***$800,000***

ENVIRONMENTAL COMPLIANCE

EXECUTIVE ORDER 11988 - FLOODPLAIN 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 floodplain of the Trinity River, and measures have been considered to minimize impacts to the floodplain through project design. Additionally, the city of Dallas currently has several programs for management of the Trinity River 100-year floodplain following 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 Central Texas Council of Governments (NCTCOG), has a Flood Warning System for the Trinity River Basin and a Flood Plain Ordinance which regulates development in the floodplain.

Future floodplain impacts will be controlled through the development of a comprehensive Floodplain Management Plan (FPMP). An FPMP will be developed by the city 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 will be developed within one year after the signing of the Project Cost Sharing Agreement and implemented within one year after completion of construction of the 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 and prior to authorization or appropriation of funds for project construction. A Section 404(b)(1) analysis has been completed and is presented in Appendix F.

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 mainstem of the Trinity River at Dallas is navigable; however, no commercial navigation occurs on the Upper Trinity reach. Recreational use in the form of canoeing, fishing and pleasure boating occurs, but only to a limited extent and then only during less than flood flow events. The proposed project features would have minimal affect to navigation. The footprint of the chain of wetlands lies in the floodplain adjacent to the mainstem.

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 gave strong indications that there are potential cumulative impacts associated with individual floodplain 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 floodplain management should stabilize the flood hazard at existing levels through regulation and efforts of both the Corps and local organizations. 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 will 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 floodplain may not create or increase an erosive water velocity on or off site, and the floodplain 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 will prevent catastrophic failure of the levee system. Furthermore, the ROD 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 was 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 the Cadillac Heights and Lamar areas. 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, as requested by the sponsor, to protect a major roadway bridge from catastrophic failure would benefit all people and would not be of detriment to eny populations. The Recommended 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 the Recommended Plan, along with the river realignment at IH-45, would be in compliance with the intent and spirit of Executive Order 12898.

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 to the study area, when combined with other known actions in the vicinity of the Dallas Floodway Extension area, as described in the "INTERRELATIONSHIP WITH OTHER PROPOSED ACTIONS" section in Chapter 2. 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. As additional runoff from upstream areas has increased the frequency of flooding within the study area, and as adjacent urbanization has continued, floodplain land use has shifted away from agriculture, except for a few areas of pasture land. The large floodplain areas adjacent to the river are zoned for industrial development, but, with or without a project it is unlikely that substantial new development will occur in flood-prone areas due to extensive flooding and regulatory prohibitions which are currently in place. Past programs for voluntary removal of some residences and other structures in the more frequently flooded areas have also influenced floodplain land uses. Most abandoned floodplain areas have re-vegetated with grasses, followed by young forests. The proposed project would significantly reduce remaining flood damages which occur within the project area. Most of the areas that would be impacted by the proposed project features are currently in private ownership and would be shifted to public open space with the project. Physical features of the project would directly impact some forest lands 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 floodplain forests.

All lands acquired for project features including the area between the proposed levees, the footprint of all project features, and the mitigation areas would no longer be available for uses such as agricultural production or industrial use. These lands would remain in the floodplain as open space but would be available for public uses compatible with the project. The project would result in increased use of floodplain lands for recreation. Recreation trails and flood compatible day use facilities would be developed through project lands and the habitat mitigation area. Development of more intensive recreation facilities is planned by the project sponsor for certain areas within the lands required for the project, including athletic fields and a community center. Direct land use changes caused by the proposed project would be compatible with floodplain functions and should have no negative effects on floodplain uses compared to conditions without the project.

The proposed project would provide reduction in damages to areas in both the Lamar and Cadillac Heights areas that are currently susceptible to flooding. The economic stimulus associated with the project, combined with the reduction in frequency and intensity of flood damages, would result in economic development of lands which would be afforded protection or which are adjacent to the project. Redevelopment would not be expected to occur all at once but over a period of years. The most obvious changes would likely be in the form of redevelopment and reuse rather than direct change from one land use to another. Liability concerns for environmental contamination must be addressed prior to any major redevelopment. This would be largely the responsibility of the developer and would include compliance with both Environmental Protection Agency and Texas Natural Resources Conservation Service requirements, as well as consistency with such programs as the "Brownfields" initiatives administered by those agencies. Although no specific proposals have been identified, it is probable that any industrial redevelopment that may be induced will be "cleaner" than former industrial development in the study area.

With participation in the project, the City of Dallas would be required to prepare a comprehensive floodplain management plan which should address watershed land uses adjacent to and upstream of the project. A primary purpose of this comprehensive plan is to assure that future developments do not increase the potential for future flood damages. The plan would address conditions of the project as assumed to be in-place, along with any other proposals such as may be included in the Upper Trinity Feasibility Study or public or private proposals, such as highways or commercial, residential, or industrial development. Any potential zoning changes proposed by the City of Dallas in preparing this comprehensive floodplain management plan should provide opportunity for public input.

Redevelopment of adjacent neighborhoods and commercial and industrial areas would be cumulatively influenced by the portion of the Texas Department of Transportation's (TxDOT) proposed Trinity Parkway project which would extend from Hwy 175 to the existing Dallas Floodway along the Lamar Street Levee alignment. The number and location of access ramps, as well as aesthetic treatment and noise reduction measures that would be included with TxDOT's proposed extension will affect the type and extent of adjacent land use changes. Those effects will be considered by TxDOT as that agency moves forward with compliance under the National Environmental Policy Act. One certain effect of the proposed roadway project on land use in the project vicinity would be an economic stimulus resulting from construction. The economic effect of a TxDOT project on land use within the study area would occur even in the absence of the proposed flood damage reduction project. The two proposed projects together, however, would have a combined or cumulative effect on land use. The nature, location, and extent of land use changes or economic redevelopment that would occur cannot be predicted with certainty at this time. Economic development within the project study area will be greatly influenced by the City of Dallas' comprehensive floodplain management plan, and by features of TxDOT's proposal for the Trinity Parkway as they move along in the planning and public involvement process.

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. Should roadways be developed, by others, on or adjacent to existing or proposed levees, the additional movement of vehicles past the project area would result in an increase in ozone-forming precursors. The impacts associated with development of this or other proposals would be determined during detailed studies by the entities proposing the projects.

HYDROLOGY AND WATER RESOURCES

Hydrologic and hydraulic analysis to determine the impacts of valley storage changes resulting from implementation of the Recommended Plan was performed. Valley storage changes in the project reach would result from both the reduction of peak water surface elevations and the function of levees blocking flood water access to the areas of the floodplain that would be protected by the levees. The analysis indicates that a reduction in the valley storage in the project reach would result in an increase in the peak discharges. This increase has been computed and is expressed in terms of an increase in the peak water surface profile downstream of the project. The water surface profile elevations would be increased an average of 0.15 feet for the 1 percent chance flood and 0.3 feet for the SPF. Based on these small increases and the very limited potential for flood damages downstream of the project, a variance from the criteria requiring mitigation for reduction of valley storage and no allowable rise in the 1 percent chance flood and SPF elevations should be allowed. The variance from these requirements, as stated in the Corridor Development Certificate (CDC) Manual and the Trinity River Environmental Impact Statement Record of Decision (ROD), would be further justified in light of the very broad ranging economic benefits accruing to the residents, commercial activities and public service facilities within the project reach as well as upstream of the project reach. The proposed project would provide SPF protection to over 2,500 structures in the immediate study area, which currently have no such protection, and increase flood protection to over 10,000 structures in the reaches of the existing Dallas Floodway. Careful consideration of these factors indicate that the best overall public interest would be served by allowing such variance. The granting of variances from the CDC and ROD for this flood damage reduction project would not set a precedent that would alleviate the compliance requirements for other floodplain development alteration projects. The criteria would continue to significantly reduce cumulative impacts to hydrologic and hydraulic conditions. In addition, any future Corps project proposals would not reduce the hydrologic and hydraulic benefits which would be derived from implementation of the proposed DFE project.

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, would help reverse the trend of losses to this important resource.

ECONOMIC ANALYSIS

As stated in Chapter 5, equivalent annual damages (EAD) were calculated for the Recommended Plan to account for changes in urbanization and hydrology. The analysis was performed over a 50-year period from the year 2000 to 2050.

RECREATION BENEFITS

Benefits for the recreation plan developed for the final array of alternatives were derived using the unit day value method. This method of benefit calculation was selected based on the criteria set forth in ER 1105-2-100. Specifically, the regional model available is more than seven years old, annual visits are not expected to exceed 750,000, and recreation costs are not expected to exceed 25 percent of the total project costs.

A score of 40 points was assessed for the plan based on the professional judgement of both Federal and local recreation planners. Applying the current Planning Guidance Memorandum, a score of 40 points converts to $5.09 per visitor-day, at October 1998 price levels, for quantifiable features. The benefits were derived based on 31.5 miles of trails, 34 picnic tables and 6 picnic pavilions. Refer to Appendix I for complete details on the recreation master plan. Table 6-4 details the benefits calculated for the recreation plan by feature. The participation rate in the Dallas/Fort Worth area for multi-purpose trails and pavilions exceeds the facility capacity; therefore, it is assumed that participation equals capacity and a value of one was applied. Annual visitors per miles of equestrian and nature trails were adjusted by the participation rate for the local area.

Table 6-4
Dallas Floodway Extension Recreation Benefits
Unit Day Value Method
(October 1998 prices, 6.875% interest, 50-year period of analysis)

Feature	Amount	Participation Rate	Visitors	Rate	Annual Benefits
Hike\Bike Trail	18	1.0	57,662	$5.09	$5,280,500
Equestrian Trail	8.5	0.2	6,999	$5.09	$60,500
Nature Trail	5	0.6	7,402	$5.09	$113,000
Picnic Tables	34	1.0	1,575	$5.09	$272,400
Pavilion	6	1.0	1,665	$5.09	$50,800
			Total Benefits		$5,777,200

COST ANALYSIS

Project First Cost

The project first cost includes estimates for lands and damages, relocations, fish and wildlife facilities, channels (swale and chain of wetlands), levees, recreation facilities, cultural preservation, removal of hazardous and toxic waste, engineering and design, and construction management. Contingencies were added on selected items in accordance with the level of confidence associated with the item. Construction cost data were developed using material, equipment, and labor costs typical for work of this nature in the Dallas area. Real estate costs were developed after the Gross Appraisal was completed. A cost estimate summary for the Recommended Plan is found in table 6-5, and shows a total project cost of $127.2 million.

Annualized Cost

The project first cost was converted to an annual basis, using a 50-year amortization period and the current applicable Federal interest rate of 6.875 percent. Accrued interest during the construction period was calculated as described in Chapter 5 and taken into account to produce a total investment cost. The annualized costs for the plans were used for computation of the BCR.

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Table 6-5
Cost Estimate Summary for the Recommended Plan
(October 1998 prices)

Description	Construction	Contingency	Total
Lands and Damages	$20,581,600	$5,113,400	$25,695,000
Relocations	$4,655,400	$1,250,200	$5,905,600
Fish and Wildlife Facilities	$383,900	$96,000	$479,900
Channels and Canals	$24,434,300	$5,397,700	$29,832,000
Levees and Floodways	$13,865,500	$3,363,400	$17,228,900
Recreation Facilities	$4,139,400	$1,247,800	$5,387,200
Cultural Resources Preservation	$640,000	$160,000	$800,000
Planning; Engineering and Design	$10,014,900	$1,864,900	$11,879,800
Construction Management	$5,460,700	$1,365,200	$6,825,900
Sub-Totals	$84,175,700	$19,858,600	$104,034,300
Compatible Non-Federal Levees	$23,120,000	$0	$23,120,000
Total Project Costs	**$107,295,700**	**$19,858,600**	**$127,154,300**

ECONOMIC SUMMARY

Table 6-6 presents the economic summary for the combined flood control and recreation features of the Recommended Plan, while table 6-6a presents separate analyses of each of these project purposes. The outputs of the environmental restoration features are measured in non-monetary units; therefore, the costs associated with these features are not included in the economic analysis of the project. Additionally, costs for cultural resource preservation are 100 percent Federal costs, up to a limit of one percent of total Federal project costs, and are not included in the economic analysis of the project. As shown, the Recommended Plan is economically justified, with net annual benefits of $9.8 million, and a BCR of 2.06.

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Table 6-6
Economic Summary of the Recommended Plan
(October 1998 prices, 6.875% interest, 50-year period of analysis)

Project Costs	Financial Cost	Economic Cost
Lands and Damages	$21,604,800	$21,604,800
Relocation Assistance	$4,090,200	$0
Relocations (Utilities, etc.)	$5,905,600	$5,905,600
Fish and Wildlife Facilities	$479,900	$479,900
Construction (Flood Control)	$42,371,400	$42,371,400
Construction (Environmental Restoration)	$4,689,500	$0
Construction (Recreation)	$5,387,200	$5,387,200
Engineering and Design (Flood Control / Recreation)	$11,303,700	$11,303,700
Engineering and Design (Environmental Restoration)	$576,100	$0
Construction Management (Flood Control / Recreation)	$6,452,900	$6,452,900
Construction Management (Environmental Restoration)	$373,000	$0
Cultural Resources Preservation	$800,000	$0
Project First Cost	$104,034,300	$93,505,500
Interest During Construction		$4,753,000
Non-Federal Levees		$23,120,000
Total Investment		$121,378,500
Annual Costs		
Interest and Amortization		$8,656,300
OMRR&R		$600,000
Total Annual Cost		$9,256,300
Equivalent Annual Benefits		
Flood Control Benefits		$13,285,100
Recreation Benefits		$5,777,200
Total Equivalent Annual Benefits		$19,062,300
Net Equivalent Benefits		$9,806,000
Benefit-Cost Ratio		2.06

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Table 6-6a
Economic Analysis of Separate
Flood Control and Recreation Purposes
(October 1998 prices, 6.875% interest, 50-year period of analysis)

	Flood Control	Recreation
First Costs	$113,958,300	$6,757,400
Economic Costs *	$109,868,100	$6,757,400
Interest During Construction	$4,523,300	$229,700
Investment Cost	$114,391,400	$6,987,100
Interest and Amortization	$8,158,000	$498,300
OMRR&R	$527,000	$73,000
Annual Costs	$8,685,000	$571,300
Annual Benefits	$13,285,100	$5,777,200
Net Annual Benefits	$4,600,100	$5,205,900
Benefit-Cost Ratio (BCR)	1.53	10.11

** Economic costs for Flood Control do not include $4,090,200 in Relocation Assistance costs.*

PROJECT COST SHARING

The provisions of the Water Resources Development Act of 1986 (Public Law 99-662), approved November 17, 1986, and the Water Resources Development Act of 1996 (Public Law 104-303), approved October 12, 1996, stipulate cost sharing requirements which local sponsors must meet for the Federal Government to be involved with water resource projects. Cost sharing provisions for the flood control, environmental restoration, and recreational development purposes are outlined below. The costs of removing and/or preserving cultural resources which may be discovered during implementation of this project would be borne as a 100 percent Federal cost, up to a maximum of one percent of the total Federal project costs. Should the cost of cultural resource preservation exceed this one percent limit, cost sharing provisions would be implemented. An estimate of approximately $800,000 has been developed to cover the possibility of cultural resource preservation. These non-sharable costs have been shown in cost apportionment table 6-8.

FLOOD CONTROL

The identified feasible flood control project would be cost shared based on the provisions set forth in Public Law 99-662, as amended. The designated Sponsor would be required to formally approve the recommendations of the General Reevaluation Report before initiating the Preconstruction, Engineering, and Design Phase of the project.

For structural flood control projects, the non-Federal cost is to be a minimum of 25 percent and a maximum of 50 percent of total project costs. The non-Federal sponsor is responsible for 100 percent of the operation, maintenance and replacement costs of the project.

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ENVIRONMENTAL RESTORATION

Due to the requirement to obtain an amendment to the original 1965 authorization adding environmental restoration as a project purpose, environmental restoration will be cost shared in accordance with the provisions of Public Law 104-303 (WRDA 1996). Under this law, the non-Federal cost is to be 35 percent of the total environmental restoration project costs. The non-Federal sponsor is responsible for 100 percent of the operation, maintenance and replacement costs of the project.

RECREATIONAL DEVELOPMENT

Under the Federal Water Project Recreation Act of 1965 (Public Law 89-72), outdoor recreational facilities can be provided at Federal non-reservoir flood damage reduction projects. However, recreational developments must be within the lands acquired for the basic project, except for separable lands required for access, parking, potable water, sanitation and related developments for health, safety and public access. Also, the facilities for cost sharing must be accordance with the approved list in ER 1165-2-400. As stipulated in Public Law 99-662, recreational development including lands required for public access, health, and safety, are cost-shared on an equal (50/50 percent) basis between Federal and non-Federal public interests. The cost of lands provided by local interests for the basic project are not included for recreational cost sharing purposes. Operation, maintenance and replacement costs are also the responsibility of the non-Federal sponsor.

DIVISION OF PLAN RESPONSIBILITIES

COST APPORTIONMENT

Table 6-7 presents the project costs, by work item, for the Recommended Plan. Table 6-8 reflects the calculations performed to determine the Federal and non-Federal cost apportionments based on the appropriate laws and regulations, as described previously.

Table 6-9 shows the cost apportionment data for the Recommended Plan. The total cost of this plan was estimated at $127.2 million. As shown, the Federal cost would total approximately $83.6 million (65.7%), while the non-Federal cost would equal approximately $43.6 million (34.3%).

The costs shown in table 6-9 are based on standard requirements set forth in Public Law 99-662, as amended, for the flood control and recreation components of the Recommended Plan. Since environmental restoration was not a project purpose under the 1965 authorization, an amendment to the original authorization adding environmental restoration as a project purpose would necessitate the application of standard cost sharing requirements for environmental restoration set forth in Public Law 104-303. Under these laws, non-Federal interests would be required to furnish all lands, easements, rights-of-way, and disposal areas, and perform all relocations of bridges and utilities. Specifically, the non-Federal share of project costs are set at a minimum of 25 percent and a maximum of 50 percent of the total flood control costs, 35 percent of the environmental restoration costs, and 50 percent of the recreation costs. Non-Federal interests would also be responsible for the operation and maintenance of the project features after construction. The Federal Government would be responsible for a minimum of 50 percent and a maximum of 75 percent of the flood damage reduction costs, 65 percent of the environmental restoration costs, and 50 percent of the recreation costs.

In addition to the cost apportionment regulations cited above, the provisions of Section 351 of WRDA 1996 regarding credit toward the non-Federal share of the project for advanced construction of the Central Wastewater Treatment Plant Levee and the "compatible" portion of the Rochester Park Levee were incorporated into the remaining costs analysis shown in table 6-9a. The non-Federal share of project costs prior to application of the levee credit was such that all of

the costs for the compatible non-Federal levees were applied. The only non-Federal construction not credited was the portion of Rochester Park which was incompatible with the Recommended Plan.

Table 6-7
Project Costs for the Recommended Plan
(October 1998 prices)

	PROJECT COSTS
LERRD (Non-Federal Levees)	$946,000
RELOCATIONS/UTILITIES	
- Flood Control	$5,905,600
EXCAVATION / DISPOSAL	
- Flood Control	$28,804,800
- Environmental Restoration	$4,101,100
FILL	
- Flood Control	$1,893,200
OTHER CONSTRUCTION	
- Non-Federal Levees	$22,174,000
- Flood Control	$11,673,400
- Environmental Restoration	$588,400
- Recreation	$5,387,200
MITIGATION (W/O LAND)	
- Flood Control	$479,900
REAL ESTATE	
- Flood Control	$21,433,700
- Mitigation (Flood Control)	$4,261,300
CULTURAL RESOURCE PRESERVATION	$800,000
ENGINEERING & DESIGN	
- Flood Control	$10,472,000
- Environmental Restoration	$576,100
- Recreation	$831,700
CONSTRUCTION MANAGEMENT	
- Flood Control	$5,914,400
- Environmental Restoration	$373,000
- Recreation	$538,500
TOTAL PROJECT COSTS	**$127,154,300**
Flood Control Costs Only (Without Non-Federal Levees)	$90,838,300
Non-Federal Levee Costs Deemed "Compatible"	$23,120,000
Total Flood Control Costs	$113,958,300

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Table 6-8
Cost Apportionment Calculations for the Recommended Plan
(October 1998 prices)

COST APPORTIONMENT	FLOOD CONTROL	ENVIRONMENTAL RESTORATION	RECREATION
FEDERAL COST			
Excavation/Disposal	$28,804,800	$4,101,100	$0
Fill	$1,893,200	$0	$0
Other Construction	$11,673,400	$588,400	$5,387,200
Mitigation (w/o Land)	$479,900	$0	$0
Engineering & Design	$10,472,000	$576,100	$831,700
Construction Management	$5,914,400	$373,000	$538,500
Sub-Sub-Total	$59,237,700	$5,638,600	$6,757,400
*5% Cash Reduction **	($5,697,900)	$0	$0
Additional Cash	$0	($1,973,500)	($3,378,700)
Sub-Total	$53,539,800	$3,665,100	$3,378,700
Non-Federal Levee Credit	$22,174,000	$0	$0
TOTAL	$75,713,800	$3,665,100	$3,378,700
Cultural Resource Preservation	$800,000		
TOTAL FEDERAL PROJECT COSTS	**$83,557,600**		
Percent	65.7%		
NON-FEDERAL COST			
Non-Federal Levee Construction	$22,174,000	$0	$0
LERRD (Non-Federal Levees)	$946,000	$0	$0
Relocations / Utilities	$5,905,600	$0	$0
Real Estate - Project	$21,433,700	$0	$0
Real Estate - Mitigation	$4,261,300	$0	$0
Sub-Sub-Total	$54,720,600	$0	$0
*5% Cash Contribution **	$5,697,900	$0	$0
Additional Cash	$0	$1,973,500	$3,378,700
Sub-Total	$60,418,500	$1,973,500	$3,378,700
Non-Federal Levee Credit	($22,174,000)	$0	$0
TOTAL	$38,244,500	$1,973,500	$3,378,700
TOTAL NON-FEDERAL PROJECT COSTS	**$43,596,700**		
Percent	34.3%		
TOTAL PROJECT COSTS	**$127,154,300**		

** 5% Cash Contribution applied against flood control costs of $113,958,300* **Revised: 13 August 1999**

Table 6-9
Cost Apportionment Data for the Recommended Plan
(October 1998 prices)

Purpose	Federal Cost	Non-Federal Cost	Total Cost
Flood Damage Reduction	$75,713,800	$38,244,500	$113,958,300
Environmental Restoration	$3,665,100	$1,973,500	$5,638,600
Recreation	$3,378,700	$3,378,700	$6,757,400
Additional Federal Cost - Cultural Resource Preservation	$800,000	$0	$800,000
TOTAL	**$83,557,600**	**$43,596,700**	**$127,154,300**
Percentage	65.7	34.3	100

Table 6-9A
Remaining Federal / Non-Federal Costs for the Recommended Plan
(October 1998 prices)

Purpose	Federal Cost	Non-Federal Cost	Total Cost
Cost Apportionment	$83,557,600	$43,596,700	$127,154,300
Previously Expended	$0	$23,120,000	$23,120,000
Remaining Costs	**$83,557,600**	**$20,476,700**	**$104,034,300**

NON-FEDERAL RESPONSIBILITIES

Prior to commencement of construction, local interests must agree to meet the requirements for non-Federal responsibilities as outlined below and in future legal documents.

a. Provide between 25 percent and 50 percent of the separable project costs allocated to flood control, 35 percent of the separable project costs allocated to environmental restoration, and 50 percent of the costs separable project costs allocated to recreation, as further specified below:

(1) Provide, during construction, funds needed to cover the non-Federal share of preconstruction engineering and design costs;

(2) Provide, during construction, a cash contribution equal to 5 percent of total project costs allocable to flood control;

(3) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(4) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

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(5) Provide, during construction, any additional costs as necessary to make its total contribution equal to 25 percent of total project costs allocated to structural flood control, 35 percent of the separable project costs allocated to environmental restoration, and 50 percent of the costs separable project costs allocated to recreation.

b. Grant the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

c. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project including mitigation features, without cost to the Government, in a manner compatible with the project's authorized purposes, and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments.

d. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

e. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

f. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

g. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

h. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

i. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

j. Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

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Conducted by the Department of the Army," and Section 402 of the Water Resources Development Act of 1986, as amended.

m. Provide the non-Federal share of that portion of total cultural resource preservation mitigation and data recovery costs attributable to flood control, environmental restoration, and recreation that are in excess of one percent of the total amount authorized to be appropriated for flood control, environmental restoration, and recreation.

n. Participate in applicable flood insurance programs, and in accordance with Section 202(c) of the Water Resources Development Act of 1996, within 1 year after the date of signing a project cooperation agreement for construction of the project, prepare a floodplain management plan designed to reduce the impacts of future flood events in the project area, and implement such plan no later than 1 year after completion of construction of the project.

o. Provide and maintain necessary access roads, parking areas and other public use facilities, open and available to all on equal terms.

p. Prescribe and enforce regulations to prevent obstruction of or encroachment on the Project that would reduce the level of protection it affords or that would hinder operation or maintenance of the Project.

q. Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

PUBLIC INVOLVEMENT

This section briefly summarizes the results of public involvement activities undertaken as part of these General Reevaluation Report level investigations.

PURPOSE OF PROGRAM

This study focused on the development of an economically feasible, environmentally acceptable, and publicly supported solution to the flooding problems with the Dallas Floodway Extension area. Numerous meetings and conversations have been held with the various entities and interested citizens to share the latest possible information and to focus this study toward investigating the most viable alternatives. In addition, various public workshops/meetings were held in the study area for the citizens to give input into the problems and possible solutions, as stipulated by Public Law 99-662 and Public Law 104-303.

PARTICIPANTS

Study participants worked closely over a six-year period in an effort to inform and involve the concerned citizens in the study area. The agencies involved in this effort included the Fort Worth District (Corps of Engineers), City of Dallas, Texas Parks and Wildlife Department (TPWD), United States Fish and Wildlife Service (USFWS), and Texas Department of Transportation (TxDOT). The staff and representatives of these agencies have worked tirelessly to answer citizens questions and concerns, by hosting a series of workshops or information meetings.

PUBLIC WORKSHOPS

On May 21, 1991, an Environmental Impact Statement Scoping meeting was held in Dallas (Roosevelt High School). The purpose of this meeting was to inform the public of the proposal for work along the Dallas Floodway Extension and to solicit comments and information from the public to assist the Corps of Engineers in the preparation of a proposed solution to the problems within the area. Public attendance was poor.

During 1993 and 1994, the Dallas Floodway Extension Advisory Committee held numerous meetings concerning the potential solutions for the Dallas Floodway Extension flooding problems. At these meetings, Corps of Engineers representatives briefed the advisory committee on progress of the investigations and answered questions concerning the project.

Starting in the Summer of 1994 through the Spring of 1996, numerous meetings of the Trinity River Corridor Citizens Committee (TRCCC) were held to gather citizen input as to problems and solutions in the Trinity River Corridor within the city of Dallas. The areas discussed during these meetings included: environmental issues, flood damage reduction, recreation, economic development, and transportation. These meetings were attended by representatives of the city of Dallas and Corps of Engineers to provide technical input to the various groups within the TRCCC. Approximately 400 citizens participated in these meetings, and were from all areas of the city of Dallas (i.e. neighborhoods, business, environmental interests). The TRCCC produced a document expressing their desires for efforts within the Trinity River. A final report was prepared and published in May 1996 presenting their recommendations.

On June 18, 1996, the Corps of Engineers made a presentation to the Greater Dallas Planning Council concerning the on-going Corps of Engineers efforts in the Trinity River corridor within the city of Dallas. The topics of discussion were the Dallas Floodway Extension and the Upper Trinity River Feasibility Study.

On June 29, 1996, an Environmental and Recreation Assistance Committee (ENRAC) meeting was held at Reunion Tower in the city of Dallas, to present the status of on-going studies/projects within the Trinity River Basin (Fort Worth District). These projects included a detailed discussion of the Dallas Floodway Extension project. At this meeting, questions were addressed or noted and addressed in writing to the attendees.

On July 29, 1996, The Fort Worth District made a presentation to the Trinity River Corridor Citizens Committee concerning the Dallas Floodway Extension project status and proposals. This presentation and resulting questions were addressed by Colonel Peter Madsen. According to the City of Dallas, the meeting was attended by 115 people.

On August 13, 1996, The Fort Worth District made a presentation to the Trinity River Corridor Citizens Committee concerning questions raised at the July 29 meeting on the Dallas Floodway Extension project. This presentation and resulting questions were addressed by Colonel Peter Madsen. According to the City of Dallas, the meeting was attended by 135 people. Follow-on questions were answered and distributed later in the month.

On August 21, 1996, the Dallas City Council was briefed on the proposed Chain of Wetlands Plan as the Locally Preferred Plan. Several citizens addressed the City Council on the issue. On August 28, 1996, the Dallas City Council voted unanimously to adopt the Chain of Wetlands as the Locally Preferred Plan, with the stipulation to look at adding levees to the plan.

On August 22, 1996, Mayor Ron Kirk (Dallas) asked the representatives of various state and Federal agencies to meet and work together in the pursuit of improvements within the Trinity River corridor. These agencies included: City of Dallas, U.S. Army Corps of Engineers, Texas Department of Transportation, Environmental Protection Agency, Texas Parks and Wildlife Department, Texas Natural Resource Conservation Commission, Texas Turnpike Authority, Dallas County and the Assistant Secretary of the Army for Civil Works. This group agreed to cooperate and coordinate their efforts.

On November 16, 1996, an Environmental and Recreation Assistance Committee (ENRAC) meeting was held at Roosevelt High School in the city of Dallas, to present the status of on-going studies/projects within the Trinity River Basin (Fort Worth District). These projects included a detailed discussion of the Dallas Floodway Extension project. At this meeting, questions were addressed or noted and addressed in writing to the attendees.

On December 10, 1996, a Public Scoping meeting for the Dallas Floodway Extension Environmental Impact Statement (EIS) was held in Dallas, Texas. The purpose of this meeting was to solicit comments on the proposed project. This meeting was attended by 96 people. Comments received were addressed/incorporated into the EIS.

On February 8, 1997, a workshop was held at the Sleepy Hollow Golf Course Club House. This meeting was organized by the city of Dallas to provide information on the engineering analysis and evaluation of alternatives for the modified Chain of Wetlands and potential levees to affected property owners, neighborhood representatives, and key environmental group representatives. According to the City of Dallas, this workshop was attended by approximately 65 people.

On February 11, 1997, The Fort Worth District made a presentation to the Trinity River Corridor Citizens Committee concerning the Dallas Floodway Extension project status and proposals. This presentation and resulting questions were addressed by Colonel Peter Madsen and was attended by more than 250 people. Follow-on questions were answered and distributed later in the month.

On February 27, 1997, a neighborhood meeting was held at the Martin Luther King Seniors Center in South Dallas. This meeting was organized to inform the residents of the Lamar Street & Rochester Park areas of the proposed project for flood damage reduction in the area. The City of Dallas (City Council members and staff) and Corps of Engineers representatives made presentations and answered questions by the public, numbering 100 in attendance, according to the City of Dallas.

On March 4, 1997, a neighborhood meeting was held for the Cadillac Heights and Joppa neighborhoods. According to the City of Dallas, the meeting was attended by about 70 residents, and representatives from the City of Dallas (Council members and staff) and the Corps of Engineers. This meeting was used to inform the citizens of the proposed project and solicit their comments.

On March 19, 1997, the Dallas City Council was briefed on the proposal to add the Lamar Street and Cadillac Heights levees to the Locally Preferred Plan. Several citizens addressed the City Council on the issue. Then on March 26, 1997, the Dallas City Council voted unanimously to add the Lamar Street and Cadillac Heights levees to the Locally Preferred Plan.

On August 9, 1997, a presentation was made and questions were answered concerning the Locally Preferred Plan for the Dallas Floodway Extension. This seminar was held at the Sleepy Hollow Country Club in Dallas, Texas. This seminar was put on by the American Institute of Architects and entitled "A River Runs Through Us". This seminar was designed for educators (First Grade through Twelfth Grade) and had presentations by various agencies involved in projects within the Trinity River in Dallas. Agencies represented included: Office of State Archeologist, Environmental Protection Agency, City of Dallas, Texas Department of Transportation, and U.S. Army Corps of Engineers. Approximately 50 educators were present at this seminar.

Starting in the Fall 1996 and continuing through the present, meetings of the Interagency Executive Team (IET) are held in Dallas. This IET is made up of representatives of various agencies (State and Federal) who had jurisdiction or on-going work within the Trinity River Corridor. These agencies include: City of Dallas, U.S. Army Corps of Engineers, Texas Department of Transportation, Environmental Protection Agency, Texas Parks and Wildlife Department, Texas Natural Resource Conservation Commission, North Texas Tollway Authority, Dallas County and the North Central Texas Council of Governments. This group acts as a coordinating team between all agencies to optimize the efforts within the river corridor.

On August 21, 1997, Mayor Ron Kirk (Dallas) asked the representatives of various state and Federal agencies to again meet and discuss the advancements that had been made during the previous year since the last summit. These agencies included: City of Dallas, U.S. Army Corps of Engineers, Texas Department of Transportation, Office of the Secretary of the Army, Dallas County, Environmental Protection Agency, Texas Parks and Wildlife Department, Texas Natural Resource Conservation Commission, Texas Turnpike Authority, and North Central Texas Council of Governments.

During the life of the General Reevaluation Report/Environmental Impact Statement (GRR/EIS) preparation (1991 through 1998), numerous meetings with concerned individuals, groups, and affected property owners have been held to answer their questions and receive their feed back. Additionally, numerous letters and other correspondence have been transmitted to organizations and individuals to answer their questions and receive their feed back on the proposed project.

Upon completion of the draft GRR, a public meeting was held on June 9, 1998, to present the findings contained in the report and to receive public comments. The formal public review period ended on August 14, 1998. The comments received during this review period have been compiled, with appropriate responses, and included in this report in Appendix N.

FINANCIAL ANALYSIS

SOCIO-ECONOMIC EFFECTS OF PLAN IMPLEMENTATION

The potential economic and social effects of implementation of the investigated plan on the study area comprise the value of the long-term reduction in periodic flood damages, and direct and indirect short-term income and employment impact of project construction. The permanent reduction in periodic flood damages would effectively increase the income available to flood plain property owners for other purposes, such as (for example) improvements to homes, yards or personal property. Construction of SPF levees could encourage growth of existing business and entice new business to the area. This would improve employment conditions and expand the tax base of the area.

To the extent that this additional disposable income is spent within the surrounding area, it would result in a local "multiplier effect": increases in business revenues, employment, and personal income rippling through the local economy as each new dollar brought in is spent and respent. Property values, and local tax revenues, would also be expected to increase as a general result.

Short-term impacts associated with project construction results from the temporary presence of construction workers and expenditures for construction materials and services, as well as spending by the construction work force for food and other personal needs. These expenditures would be expected to result in a positive multiplier effect on the local economy and would last for about three years. The lasting economic and social effects of project implementation would be the benefits resulting from the permanent reduction in flood damages, as described above.

FINANCIAL CAPABILITY

A financial capability analysis of the City of Dallas was conducted in accordance with ER 1105-2-100 to ascertain the community's financial condition and its ability to meet the cost sharing responsibilities for the Floodway Extension Project. The assessment involved the calculation and analysis of nine key financial indicators. A number of interrelated economic, fiscal, and management factors support a local government's capacity to finance desired capital improvement projects. Those factors include the health of the local economy, the structure of its revenue base, the management of the community's operations, and the debt history of the community.

The Municipal Fiscal Officers Association has developed a number of financial warning indicators useful in determining the financial health of a community. These indicators are used to help determine the sponsor's current debt position and financial health. Financial indicator ratings are calculated for the city of Dallas and are compared to national averages as outlined in the Environmental Protection Agency's *Financial Capability Guidebook*, dated March 1984. The financial data used to calculate these ratings were obtained from the city of Dallas Office of Budget and Management. Other relevant facts and data which play a role in the analysis include population, per capita income and property tax information. Table 6-10 shows the indicator values and rating for the city of Dallas. The indicators, calculated values and corresponding rating have been updated to reflect the city's capability as of September 1997 and are summarized in table 6-11.

Table 6-10
Current Community Financial Indicator Values For The City Of Dallas

Indicator	Value	Rating
1. Annual rate of change in population	1.2%	Strong
2. Current surplus/deficit as a percent of total current expenditures	1.1%	Average
3. Real property tax collection rate	96.9%	Average
4. Property tax revenues as a percent of full market value of real property	0.5%	Strong
5. Overall net debt as a percent of full market value of real property	2.2%	Strong
6. Overall net debt outstanding as a percent of personal income	5.2%	Average
7. Direct net debt per capita	$609	Average
8. Overall net debt per capita	$1,267	Weak
9. Percent direct net debt outstanding due within next 5 years	77.0%	Strong

The annual rate of change in Dallas' population between 1980 and 1997 exhibits a strong 1.2 percent annual rate of change. The indicator stability in the economic base is useful because the economic base typically rises and falls with changes in the population. The proportion of surplus/deficit expenditures to total expenditures are also some significant indicators of the community's strength. Dallas is currently operating at a surplus with revenues exceeding expenditures by about 1.1 percent, which is in balance with the national average. The third indicator measures the efficiency of the city's tax collection system. The city is currently average in this area reporting a 1997 collection rate of 96.9 percent. The city's reliance on tax revenue, indicator four, shows the extensiveness of property taxation and the potential for future revenue growth from this source. A value of 0.5 percent is strong and indicates that the city does not appear to tax heavily in relation to property values in this area.

Indicators' five through nine are used to assess the community's debt capacity. Indicator five compares the amount of tax-supported debt to the full market value of real property. The city of Dallas is average with a value of 2.2 percent. Personal income can be used as a yardstick to judge the city's ability to repay debt. Per Capita income for January 1994 was $24,480. Indicator six shows net debt representing about 5.2 percent of total personal income, which is average for most cities. Indicators' seven and eight represent the per capita direct debt of almost $609 and overall net debt outstanding per capita of $1,267, which indicates a weakness in this area.

Finally, indicator nine compares the percentage of direct net debt due within five years to total outstanding direct net debt. The city's situation is strong with 77 percent of the outstanding debt being paid over the next five years. The overall net debt reported in 1997 was $1,326,830,670.

Based on the national averages the overall financial condition of the city of Dallas is currently in a healthy state. The only indicator falling within the weak range was for the amount of net debt outstanding per capita. However, the calculated value only exceeded the average limits by only $67. Based on this analysis, the city of Dallas appears to have room to expand their debt load to accommodate new capital projects.

Table 6-11
Summary of Financial Capability
Dallas Floodway Extension Dallas, Texas, General Evaluation

A. BOND RATINGS	Rating	Date
General Obligation	AAA/Aaa (S&P)	Nov-96
Revenue Bonds:		
Dallas Water Utilities	AA/Aa (S&P)	
Civic Center	A/A1	Apr-98

B. DEBT

	Outstanding	Projected	Total
General Obligation Bonds	$632,940,270	0	$632,940,270
Revenue Bonds	$1,026,993,000	0	$1,026,993,000
Gross Direct Debt	$1,659,933,270	0	$1,659,933,270
Direct Net Debt	$632,940,270	0	$632,940,270
Overlapping Net Debt 1/	$693,890,000	0	$693,890,000
Overall Net Debt	$1,326,830,270	0	$1,326,830,270

C. DEBT REPAYMENT SCHEDULE (principal only)

	Existing	This Project*	Total
Year 1: 1998	$110,829,408	0	$110,829,408
Year 2: 1999	$107,821,082	0	$107,821,082
Year 3: 2000	$100,014,486	0	$100,014,486
Year 4: 2001	$86,486,881	0	$86,486,881
Year 5: 2002	$80,955,880	0	$80,955,880
			$486,107,737

* Assumes project funding at $23.7 million and included in outstanding debts. General Obligation bonds authorized as of May 1997.

D. DEBT LIMITS

Constitutional and Charter Debt Limit: Ten percent of assessed value. Article 717K, Vernon's Annotated Texas Civil Status Constitution and Laws of the State of Texas. Approximately 16.83% of debt limit will be used.

[1] Overlapping net debt is the sponsor's share of taxes owed to other taxing bodies within the community, ie., a flood district.

[2] Other debt obligations include outstanding leases, unfunded pension liabilities, and notes with a maturity.

NON-FEDERAL FINANCIAL PLANNING

The purpose of strategic financial planning is to optimize the use of capital over time in response to long term financial goals. The three principal elements involved include cost recovery alternatives, if needed; selection of the preferred financing alternative; and implementation of the cost recovery approach. Although financing decisions are ultimately the sponsors', the Corps of Engineers can assist in the decision making through the provision of timely information on costs, benefits and cost recovery opportunities. The sponsor is responsible for making arrangements to finance the project sufficiently in advance of construction to enable the project schedule to be met.

ABILITY-TO PAY ANALYSIS

Based on ER 1165-2-121 an ability-to-pay test should be applied to all flood control projects. The test determines the eligibility of the study area to qualify for a reduction in the amount to be cost shared by the Non-Federal interest. To qualify for a reduction the results of both the benefit and income portions of the twofold ability-to-pay test must fall within the specified guidelines.

The benefits' test determines the maximum reduction, called the "benefits based floor" (BBF), in the level of non-Federal cost sharing for any project. The factor is determined by dividing the project B/C ratio by four. If the factor (expressed as a percentage) is less than the standard level of cost sharing, the project may be eligible for a reduction in the non-Federal share to this BBF. The standard level cost share for the Flood Protection project is a minimum of 25 percent. The recommended plan's B/C ratio of 2.06 was divided by four to yield a BBF of .515 or 51.5 percent.

The income test determines qualification for the reduction calculated in the benefit step. Qualification depends on a measure of the current economic resources of both the project area and the State in which the project is located.

In accordance with factors released in Economic Guidance 96-4, the income index factors for the state of Texas and Dallas County are 90.81 and 102.77, respectively. The Eligibility Factor (EF) for a flood control project is calculated according to the following formula:

$$EF = a - b_1 * (\text{State factor}) - b_2 * (\text{area factor})$$

where:

$a = 15.86794$

$b_1 = 0.06771$

$b_2 = 0.13543$

Utilizing the above formula, an EF of -4.2 was calculated for the City of Dallas. An EF less than zero indicates ineligibility for a reduction in construction cost sharing. As stated previously, a BBF factor for the investigated plan was calculated at 51.5 percent. To qualify for a reduction, the BBF factor must be less than the standard level of cost sharing. According to ER-1165-2-121 paragraph 5a(2), the City of Dallas does not meet the criteria for a reduction in construction cost because this project does not meet both of the tests; therefore, the City of Dallas must pay a minimum of 25 percent level of the total flood protection project cost.

CHAPTER 7

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 7
DISCUSSIONS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarizes the results of the investigations of the General Reevaluation of the water and related land resource problems and needs with the Dallas Floodway Extension study area.

DISCUSSIONS

The Dallas Floodway Extension project is one of five local flood protection projects authorized for construction in 1965. Further studies were conducted which assessed the plan in greater detail, but were never implemented. The current study was initiated in 1991 following significant flood events in 1989 and 1990.

The NED Plan identified in this reevaluation consisted of a 1,200-foot wide swale providing greater conveyance of flood waters through the area. The flood control portion of this plan had an estimated cost of $50.0 million. The vast majority of benefits for this plan were realized in the existing Dallas Floodway, upstream of the immediate study area. This plan, which was extremely controversial from an environmental resource perspective, would have directly impacted approximately 725 acres of environmental resources, including removal of approximately 504 acres of bottomland hardwoods, and would have required 3,200 acres of mitigation at an estimated cost of $13.5 million.

Because of the public input regarding the environmental impacts of the NED Plan, and due to the city's desire to provide greater protection to the immediate study area and to incorporate environmental restoration features into the project, the chain of wetlands concept was developed. The Chain of Wetlands Plan consisted of upper and lower flood control swales, divided by IH-45. These swales were reduced in width and relocated as far west as possible to avoid the higher quality forested areas. The Chain of Wetlands would require approximately 649 acres of mitigation at an estimated cost of $3.1 million. The Chain of Wetlands Plan was formally adopted as the initial Locally Preferred Plan (LPP) on August 28, 1996. In addition, due to the anticipated public acceptability issues associated with implementation of the NED Plan, the chain of wetlands was designated as the first increment of the Federally Supportable Plan, in lieu of the NED Plan. However, public and social pressure remained to provide flood protection to the study area comparable to the protection provided to the Central Business District by the existing Dallas Floodway.

The addition of SPF levees to the chain of wetlands concept was investigated. The Lamar Levee was deemed economically feasible and was, therefore, added to the chain of wetlands as part of the Federally Supportable Plan. Although the analysis of a SPF levee at Cadillac Heights showed that this levee was not incrementally justified, a 100-year levee (1.0 percent chance of exceedance in any one year) at this location proved to be feasible. However, sensitive social equity issues prompted the city to adopt a plan including SPF levees on both sides of the river. The Chain of Wetlands Plus SPF Levees Plan was formally adopted by the city as the final LPP on March 26, 1997.

In the April 1998 draft of this report, the Federally Supportable Plan (FSP) was identified as a plan that, except for the levee protecting the Cadillac Heights neighborhood, would provide a Standard Project Flood (SPF) level of protection at a high degree of reliability. In this plan, the Cadillac Heights Levee would only provide protection from the flood that would have a 1.0 percent chance of exceedance in any one year, with a 34.0 percent reliability. Upon further analysis and subsequent concurrence by the Assistant Secretary of the Army(Civil Works), it was determined that the FSP is that plan that provides SPF protection for the entire Dallas Floodway Extension project for the following reasons. First, the alternative levee for the Cadillac Heights neighborhood would not meet the Federal Emergency Management Agency standards for protecting the area from a flood that would have a 1.0 percent chance of exceedance in any one year, nor would it provide an acceptable level of reliability, particularly when compared with other project elements. Second, the

alternative levee for Cadillac Heights would allow continued damages in this area from major, although infrequent floods (greater than the flood that would have a 1.0 percent chance of exceedance in any one year), due to the construction of other project levees. Finally, Congress has already authorized the project, including the Cadillac Heights Levee, at a SPF level of protection. For the reasons noted above, the project providing a consistent SPF level of protection is the Federally Supportable Plan, and is therefore the Recommended Plan.

The original Dallas Floodway Extension project, authorized in 1965, contained levee, channel, and lake features designed to provide SPF protection to both the northern and southern portions of the city of Dallas. The current Recommended Plan provides for similar outputs at a lower total project cost. The estimated cost of the authorized improvements to the Dallas Floodway Extension area, at October 1998 price levels, would be approximately $202.7 million. Total annual benefits for the authorized project were estimated at $13.2 million. Under current economic conditions, the authorized project would have negative net benefits of $3.0 million, with a BCR of 0.82. The Recommended Plan, as presented herein is estimated to cost approximately $127.2 million, including $23.1 million for compatible portions of previously constructed non-Federal levees. This plan would yield total annual benefits of approximately $19.1 million, net annual benefits of $9.8 million, and a BCR of 2.06.

CONCLUSIONS

The following conclusions are based on the results of the investigations conducted for this study.

a. A significant need exists for a project within the Dallas Floodway Extension study area providing flood damage reduction benefits, environmental restoration features and recreation amenities.

b. The Recommended Plan is a multi-objective project consisting of a flood control swale, with an incorporated chain of wetlands for environmental restoration purposes, SPF levees protecting the Lamar and Cadillac Heights neighborhoods, environmental mitigation, and recreation facilities compatible with a larger, regional recreation master plan. Also included in this plan would be a proposed realignment of the existing river channel at the IH-45 bridge to prevent catastrophic failure of this designated national defense route, and to reduce significant annual maintenance costs due to debris accumulations at the bridge.

c. The City of Dallas has been identified as the local sponsor for the construction of the project. The Federal and non-Federal cost apportionments for the Recommended Plan are estimated at $83.6 million (65.7%) and $43.6 million (34.3%), respectively. A credit in the amount of approximately $22.2 million was applied toward the non-Federal share of the flood control project costs, in accordance with Section 351 of WRDA 1996.

d. It is noted that certain costs have been estimated which are not included as project costs, and which are not allowed to be cost shared. These costs include removal and/or preservation of cultural resources which may be discovered during implementation of this project, and which would be borne as a 100 percent Federal cost, up to a maximum of one percent of the total Federal project costs. Should the cost of cultural resource preservation exceed this one percent limit, cost sharing provisions would be implemented. An estimate of $800,000 has been developed to cover the possibility of cultural resource preservation. These costs have been included in the cost apportionments noted above.

e. Environmental restoration is not included as a project purpose in the original language of the 1965 authorization for this project. An amendment to the authorization, adding environmental restoration as a purpose for all Upper Trinity River studies, is required

f. Cultural investigations undertaken to provide basic information on the project have identified fourteen archaeological and architectural sites eligible for inclusion on the National Register of Historic Places. Although additional investigations will be necessary for a definitive determination of eligibility, the archaeological sites appear to retain intact deposits valuable in scientific research and are, therefore, being treated as eligible for the purposes of this project. The potential for additional intact historic sites and in situ buried prehistoric cultural deposits in the project footprint impact zone is very high. All efforts will be needed to locate and identify all significant heritage resources to be impacted by the proposed project and to develop contingencies to minimize or mitigate their loss. A Programmatic Agreement with the Advisory Council on Historic Preservation, Texas Historic Preservation Officer, and other interested parties has been developed to address cultural resources with due diligence. This agreement has been included in Appendix L of this report.

g. The Recommended Plan, as proposed, would provide completion of a significant portion of the Authorized Plan for the Dallas Floodway Extension. The plan is located within the originally chosen site, and includes smaller scale features of the authorized flood damage reduction plan. Future work efforts to more fully fulfill the scope of the authorized plan would not be adversely affected by the Recommended Plan.

RECOMMENDATIONS

I recommend that the original authorization for the Trinity River and Tributaries Basinwide Study be amended to include Environmental Restoration as a project purpose, and that the Recommended Plan, as described in this report, for flood damage reduction, environmental restoration and recreation development along the Trinity River within the city of Dallas, Texas, be constructed as a Federal project with such modifications thereof as in the discretion of the Commander, HQUSACE, may be advisable.

I also recommend that the non-Federal sponsor be authorized credit for the advanced non-Federal construction of the Central Wastewater Treatment Plant Levee upgrade and the portion of the Rochester Park Levee compatible with the Recommended Plan. The preliminary estimate for this compatible construction, subject to an audit for reasonableness, allocability, and allowability, is approximately $22,174,000.

The above recommendations are made with the provision that prior to project implementation, the non-Federal sponsor shall enter into a binding agreement with the Secretary of the Army to perform the following items of local cooperation:

a. Provide between 25 percent and 50 percent of the separable project costs allocated to flood control, 35 percent of the separable project costs allocated to environmental restoration, and 50 percent of the costs separable project costs allocated to recreation, as further specified below:

(1) Provide, during construction, funds needed to cover the non-Federal share of preconstruction engineering and design costs;

(2) Provide, during construction, a cash contribution equal to 5 percent of total project costs allocable to flood control;

(3) Provide all lands, easements, and rights-of-way, including suitable borrow and dredged or excavated material disposal areas, and perform or assure the performance of all relocations determined by the Government to be necessary for the construction, operation, and maintenance of the project;

(4) Provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring

features and stilling basins, that may be required at any dredged or excavated material disposal areas required for the construction, operation, and maintenance of the project; and

(5) Provide, during construction, any additional costs as necessary to make its total contribution equal to 25 percent of total project costs allocated to structural flood control, 35 percent of the separable project costs allocated to environmental restoration, and 50 percent of the separable project costs allocated to recreation.

b. Grant the Government a right to enter, at reasonable times and in a reasonable manner, upon land which the local sponsor owns or controls for access to the project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the project.

c. Assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project or completed functional portions of the project including mitigation features, without cost to the Government, in a manner compatible with the project's authorized purposes, and in accordance with applicable Federal and State laws and specific directions prescribed by the Government in the OMRR&R manual and any subsequent amendments.

d. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended, and Section 103 of the Water Resources Development Act of 1986, Public Law 99-662, as amended, which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until the non-Federal sponsor has entered into a written agreement to furnish its required cooperation for the project or separable element.

e. Hold and save the Government free from all damages arising for the construction, operation, maintenance, repair, replacement, and rehabilitation of the project and any project-related betterments, except for damages due to the fault or negligence of the Government or the Government's contractors.

f. Keep and maintain books, records, documents, and other evidence pertaining to costs and expenses incurred pursuant to the project to the extent and in such detail as will properly reflect total project costs.

g. Perform, or cause to be performed, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under lands, easements or rights-of-way necessary for the construction, operation, and maintenance of the project; except that the non-Federal sponsor shall not perform such investigations on lands, easements, or rights-of-way that the Government determines to be subject to the navigation servitude without prior specific written direction by the Government.

h. Assume complete financial responsibility for all necessary cleanup and response costs of any CERCLA regulated materials located in, on, or under lands, easements, or rights-of-way that the Government determines necessary for the construction, operation, or maintenance of the project.

i. To the maximum extent practicable, operate, maintain, repair, replace, and rehabilitate the project in a manner that will not cause liability to arise under CERCLA.

j. Prevent future encroachments on project lands, easements, and rights-of-way which might interfere with the proper functioning of the project.

k. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public law 91-646, as amended by title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR part 24, in acquiring lands, easements, and rights-of-way, and performing relocations for construction, operation, and maintenance of the project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said act.

l. Comply with all applicable Federal and State laws and regulations, including Section 601 of the Civil Rights Act of 1964, Public Law 88-352, and Department of Defense Directive 5500.11 issued pursuant thereto, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army," and Section 402 of the Water Resources Development Act of 1986, as amended.

m. Provide the non-Federal share of that portion of total cultural resource preservation mitigation and data recovery costs attributable to flood control, environmental restoration, and recreation that are in excess of one percent of the total Federal amount authorized to be appropriated for flood control, environmental restoration, and recreation.

n. Participate in applicable flood insurance programs, and in accordance with Section 202(c) of the Water Resources Development Act of 1996, within 1 year after the date of signing a project cooperation agreement for construction of the project, prepare a floodplain management plan designed to reduce the impacts of future flood events in the project area, and implement such plan no later than 1 year after completion of construction of the project.

o. Provide and maintain necessary access roads, parking areas and other public use facilities, open and available to all on equal terms.

p. Prescribe and enforce regulations to prevent obstruction of or encroachment on the Project that would reduce the level of protection it affords or that would hinder operation or maintenance of the Project.

q. Not use Federal funds to meet the non-Federal sponsor's share of total project costs unless the Federal granting agency verifies in writing that the expenditure of such funds is expressly authorized by statute.

The recommendations contained herein reflect the information available at this time and current Departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent to the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior to transmittal to the Congress, the sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

James S. Weller
Colonel, Corps of Engineers
District Engineer

Revised: 13 August 1999

DEPARTMENT OF THE ARMY
SOUTHWESTERN DIVISION, CORPS OF ENGINEERS
1114 COMMERCE STREET
DALLAS, TEXAS 75242-0216

REPLY TO ATTENTION OF

February 12, 1999

Engineering and Technical
Services Directorate

Lieutenant General Joe N. Ballard
Commander
U.S. Army Corps of Engineers
20 Massachusetts Avenue, NW
Washington, DC 20314-1000

Dear General Ballard:

I concur in the conclusions and recommendations of the District Engineer.

Sincerely,

Edwin J. Arnold, Jr. 12Feb99
Brigadier General, U.S. Army
Commanding General

LIST OF PREPARERS

The people who were primarily responsible for contributing to preparing this General Reevaluation Report and Integrated Environmental Impact Statement are listed in table 7-1.

Table 7-1
Dallas Floodway Extension
List of Preparers

NAME	DISCIPLINE/ EXPERTISE	EXPERIENCE	ROLE IN DOCUMENT
Gene T. Rice, Jr.	Civil Engineer	16 years, Corps of Engineers	Project Management
Kevin Craig	Civil Engineer	5 years, private sector; 2 years, TxDOT; 4 years, Corps of Engineers	Technical Management; Report Preparation
Paul M. Hathorn	Supervisory Environmental Resources Planner (Biology)	23 years, water resource planning, Corps of Engineers	Review and Supervision - EIS Preparation
Billy K. Colbert	Environmental Resource Planner	9 years, Corps of Engineers; 15 years, U.S. Fish and Wildlife Service	Report - EIS Preparation
Hank Jarboe	Environmental Biology	19 years, natural resource management	EIS - Data review, evaluation and Document preparation
Marcia Hackett	Biology	6 years, wetland and landscape ecology	EIS preparation
Linda Lopez	Environmental Specialist	2 years, Corps of Engineers	Section 404 (b) (1) for DFE
Mark Simmons	Chief; Environmental Design	19 years, Corps of Engineers	Supervised preparation of the HTRW Appendix
Jim Drysdale	Environmental Design	11 years, Corps of Engineers	HTRW analysis
A. Frank Servello	Cultural Resources	2 years, Corps of Engineers; 9 years, University; 16 years, private sector	Report - EIS Preparation;SHPO Concurrence; ACHP, COE and SHPO coordination
Jeffrey Comer	Civil Engineer	18 years, Corps of Engineers	Preparation of preliminary design of relocations

NAME	DISCIPLINE EXPERTISE	EXPERIENCE	ROLE IN DOCUMENT
Lisa Eskew	Civil Engineer	3 years, Corps of Engineers	Utility Relocations
Elston Eckhardt	Chief; Hydrology & Hydraulics	17 years, Corps of Engineers	Review - H&H; Risk-Based Analysis
David Wilson	Hydraulic Engineer	16 years, Corps of Engineers	Hydraulic analysis
Craig Loftin	Hydraulic Engineer	18 years, Corps of Engineers	Hydrologic and hydraulic analysis
Efren Martinez	Civil Engineer	15 years, Corps of Engineers	Civil Design
Gayla Gurley	Civil Engineer	16 years, Corps of Engineers	Civil Design
Charles Peter Matar	Civil Engineer	3 years, TxDOT; 6 years, Corps of Engineers	Civil Design
Lanora Wright	Economist	13 years, Corps of Engineers	Economics
Randy Roberts	Realty Specialist	15 years, real estate management and planning, Corps of Engineers	Real Estate
Warren Shaver	Structural Engineer	30 years, Corps of Engineers	Structural Design
Mark Sissoms	Structural Engineer	19 years, Corps of Engineers	Structural Design
Janet Hall	Geotechnical Engineer	7 years, Corps of Engineers	Geotechnical Design
Bill Cotten	Landscape Architect	11 years, Corps of Engineers	Recreation Planner
Jim Sears	Cost Estimating	43 years, Corps of Engineers	Cost estimating
Richard Keene	Cost Estimating	24 years, Corps of Engineers	Preparation - MCACES cost estimate

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