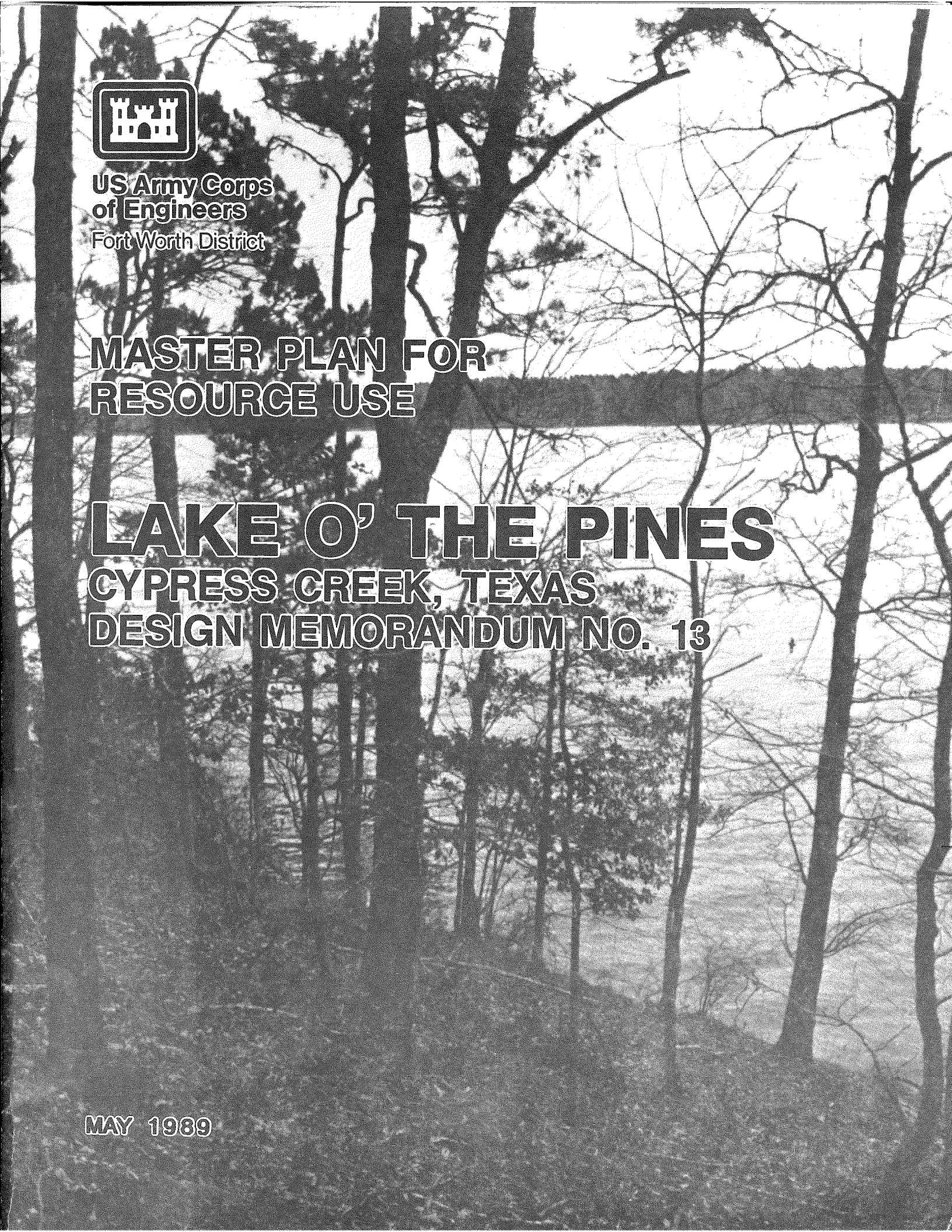


US Army Corps
of Engineers
Fort Worth District

MASTER PLAN FOR RESOURCE USE

LAKE O' THE PINES

CYPRESS CREEK, TEXAS
DESIGN MEMORANDUM NO. 13

MAY 1989

SWD COMMENTS
Lake O' The Pines Master Plan
DM. NO. 13

1. Project Land Use, paragraph 1-09. The flowage easement acreage listed in the table is incorrect. The correct acreage is 16,063 (see flowage easement acres cited in paragraph 4-05, page 83.

2. Archeological and Historic Resources, paragraph 3-11. This section should be more specificially related to discussions of resources actually located on project lands. The discussion should explain what information exists about the subject resources that could influence their effective management from the perspective of project management and the technical aspects of archeology. This should be the basis for giving direction to all future archeological activities of a managerial nature on this project. Listing all the laws and regulations is not necessary in the Master Plan. Referencing ER 1130-2-438 is sufficient.

3. Paragraph 6-25. The last line on Appendix 198, natural condition is repeated.

4. Watt's Island, Site Analysis A, paragraph 6-27. This section discusses shoreline erosion as a problem. Soil bioengineering methods of erosion control or shoreline stabilization can be very effective. Recommend the Master Plan identify those areas with a gradual slope and moderate erosion problems where opportunities for use of this method may exist. The details and selection of a particular application method of erosion control would be developed in the OMP.

5. Paragraph 7-01. EM 1110-2-400 is referenced as our current standard, this is not correct. The correct reference is EM 1110-1-400.

DEPARTMENT OF THE ARMY
FORT WORTH DISTRICT, CORPS OF ENGINEERS
P. O. BOX 17300
FORT WORTH, TEXAS 76102-0300

REPLY TO
ATTENTION OF:

CESWF-PL-R

28 September 1988

MEMORANDUM FOR: Commander, Southwestern Division, ATTN: CESWD-PL

SUBJECT: Lake O' The Pines Master Plan for Resource Use, Design Memorandum No. 13

1. Submitted for review and approval are ten copies of subject design memorandum.

2. Coordination with other Federal, State, and local agencies for review and comment is occurring simultaneously with this transmittal. Request you comment within 45 days.

3. The principal issues addressed in this master plan are as follows:

a. Existing recreational use and estimates of future use and facility needs.

b. Description of project resources, carrying capacity and special considerations in the use of resources.

c. Zoning of project lands and water for specific uses and objectives for management of project resources.

d. Inventory and analyses of existing park areas and recreation facility development proposals.

4. All 11"X17" plates found in Chapters 1-5 and all photos are draft copies. The final master plan plates will be reproduced by photo process printing and be of a quality comparable to the park plates in Chapter 6.

FOR THE COMMANDER:

MICHAEL J. MOCEK, P.E.
Chief, Planning Division

Encl

RED RIVER BELOW DENISON DAM
CYPRESS CREEK, TEXAS
DESIGN MEMORANDUM NO 13
Master Plan for Resource Use
LAKE O' THE PINES

This Report has been prepared in the Planning Division of the Fort Worth District and has been coordinated with Operations, Real Estate, and Engineering Divisions. Approval is recommended.

Chief, Operations Division

Chief, Real Estate Division

Chief, Engineering Division

TABLE OF CONTENTS

RED RIVER BELOW DENISON DAM
CYPRESS CREEK, TEXAS
DESIGN MEMORANDUM NO. 13

MASTER PLAN FOR RESOURCE USE
FOR
LAKE O' THE PINES

TABLE OF CONTENTS

CHAPTER 4 - FACTORS INFLUENCING THE USE OF RESOURCES

CHAPTER 5 - PROJECT LAND AND WATER USE ZONING AND RESOURCE USE OBJECTIVES

CHAPTER 6 - RECREATIONAL DEVELOPMENT PLAN

CHAPTER 7 - DESIGN CRITERIA

CHAPTER 8 - NATURAL RESOURCE MANAGEMENT

CHAPTER 9 - SPECIAL PROBLEMS AND CONSTRAINTS

CHAPTER 10 - DISCUSSIONS AND CONCLUSION

APPENDIX

LIST OF FIGURES

LIST OF TABLES

LIST OF PLATES

introduction
Chapter 1

RED RIVER BELOW DENISON DAM
DESIGN MEMORANDUM NO. 13

MASTER PLAN FOR RESOURCE USE
FOR
LAKE O' THE PINES

CHAPTER 1
INTRODUCTION

1-01 PURPOSE

The updated Lake O' the Pines Master Plan for Resource Use, hereafter referred to as the "MPRU", replaces the Master Plan of 1975. The purpose of this updated MPRU is to provide a comprehensive guide to the sensitive, wise, and orderly development and management of the natural and manmade resources of the Lake O' the Pines project through the year 2005.

In keeping with Corps planning policy, the MPRU is a working document which contains information, analyses, and guidelines for the administration of all land and water areas of the project, including outgrants. The MPRU is both conceptual and flexible by design and is subject to revision as needs and conditions change.

This document is organized to reflect the general study process. **Chapter 1, Introduction,** describes master plan objectives, general purpose and existing use of the project. **Chapter 2, Regional Description and Analysis,** looks at regional patterns including estimates of future recreational use and facility needs. **Chapter 3, Project Resource Inventory and Analysis,** describes and maps resources with some discussion of present resource use. **Chapter 4, Factors Influencing the Use of Resources,** looks at factors such as present use patterns, public input concerning use of resources, carrying capacity of the project for specific activities and special considerations in the use of resources. **Chapter 5, Project Land and Water Use Zoning and Resource Use Objectives,** defines how the project land and water will be zoned for use and states objectives for management of project resources. **Chapter 6, Facility Development Plan,** inventories and analyses existing park areas and illustrates proposed recreation facilities. **Chapter 7, Design Criteria,** describes current standards for design, layout and construction of recreation facilities. **Chapter 8, Natural Resource Management,** prescribes soil, vegetative, fish and wildlife management for various areas. **Chapter 9, Special Problems and Constraints,** looks at unusual or special problems and contraints requiring special attention. **Chapter 10, Discussions and**

Conclusions, summarizes master plan proposals and recommendations. **Appendix A, Project Statistics**, lists project statistics, previous design memoranda, area and volume of reservoir. **Appendix B, Recreation Needs Analysis**, analyzes existing and future needs for recreation facilities. **Appendix C, Public Involvement and Correspondence**, summarizes public input and correspondence from organizations or governmental agencies. **Appendix D, Federal Aid in Fisheries Restoration Act**, describes existing resources and fisheries management by Texas Parks and Wildlife Department (TPWD).

1-02 SCOPE

The primary project purposes of flood control and water supply, as well as the operation and maintenance of structures associated with these purposes, are outside the scope of this study. The MPRU is, however, based on an understanding of the operation of the project. Accordingly, management recommendations and proposed improvements relative to public use and resource management are formulated to be in harmony with primary project purposes. The MPRU evaluates project resources in order to develop policies that allow development and management for their best use. Evaluation is focused on project lands and includes consideration of scenic, cultural, recreational, fish and wildlife, and manmade resources.

1-03 MASTER PLAN OBJECTIVES

The primary objectives of the master plan are to prescribe an overall land and water management plan, resource objectives, and associated design and management concepts, which:

a. Provide the best possible combination of responses to regional needs, resource capabilities and suitabilities, and expressed public interests and desires consistent with authorized project purposes;

b. Coordinate the master planning process with the public and interested local, state, and Federal agencies and exhibit consistency and compatibility with national objectives and other state and regional goals and programs;

c. Prepare an integrated plan which will promote the continued public utilization of all project resources up to a capacity which is consistent with Corps of Engineers policies, development and management constraints, and the natural and cultural environment;

d. Propose future recreation area plans that will provide for more efficient management and operation through the consolidation of certain existing areas, and the separation of day use and overnight facilities;

e. Provide management guidelines designed to optimize public use of the project, minimize environmental damage, and facilitate project operations and management;

f. Identify and discuss any unique or special problems that characterize and affect the development and management of the project.

1-04 APPLICATION OF PUBLIC LAWS

The following Federal laws provide for the development and management of Federal projects for various purposed according to the intent of the Congress:

a. Public Law 78-534 (The Flood Control Act of 1944), as amended by the Flood Control Acts of 1946, 1954, 1960 and 1962, authorized the Corps of Engineers to construct, maintain, and operate public park and recreational facilities at water resources development projects and to permit local interests to construct, maintain, and operate such facilities.

b. Public Law 85-624 (The Fish and Wildlife Coordination Act of 1958) States the general policy that fish and wildlife conservation shall receive equal consideration with other project purposes and will be coordinated with other project purposes features of water resources development projects.

c. Public Law 88-29, 28 May 1963, authorized the Secretary of the Interior to inventory and classify outdoor recreation needs and resources and to prepare a comprehensive outdoor recreation plan taking into consideration the plans of the various Federal agencies, State, and other political subdivisions. It also states that the Federal agencies undertaking recreational activities shall consult with the Secretary of the Interior concerning these activities and shall carry out such responsibilities in general conformance with the nationwide plan.

d. Public Law 89-655 (The National Historic Preservation Act of 1966) as ammended (PL-96-515) sets forth the Federal role in historic preservation and requires the Federal agency having jurisdiction over the proposed Federal undertaking on any historic district, site, building, structure, or subject included in the National Register, to coordinate with the Advisory Council on Historic Preservation concerning these matters.

e. Public Law 91-190 (The National Environmental Policy Act of 1966) as ammended (PL-515) sets forth a national policy for the protection and enhancement of the environment and requires that the environmental effects of each project be evaluated and presented in an environmental impact statement.

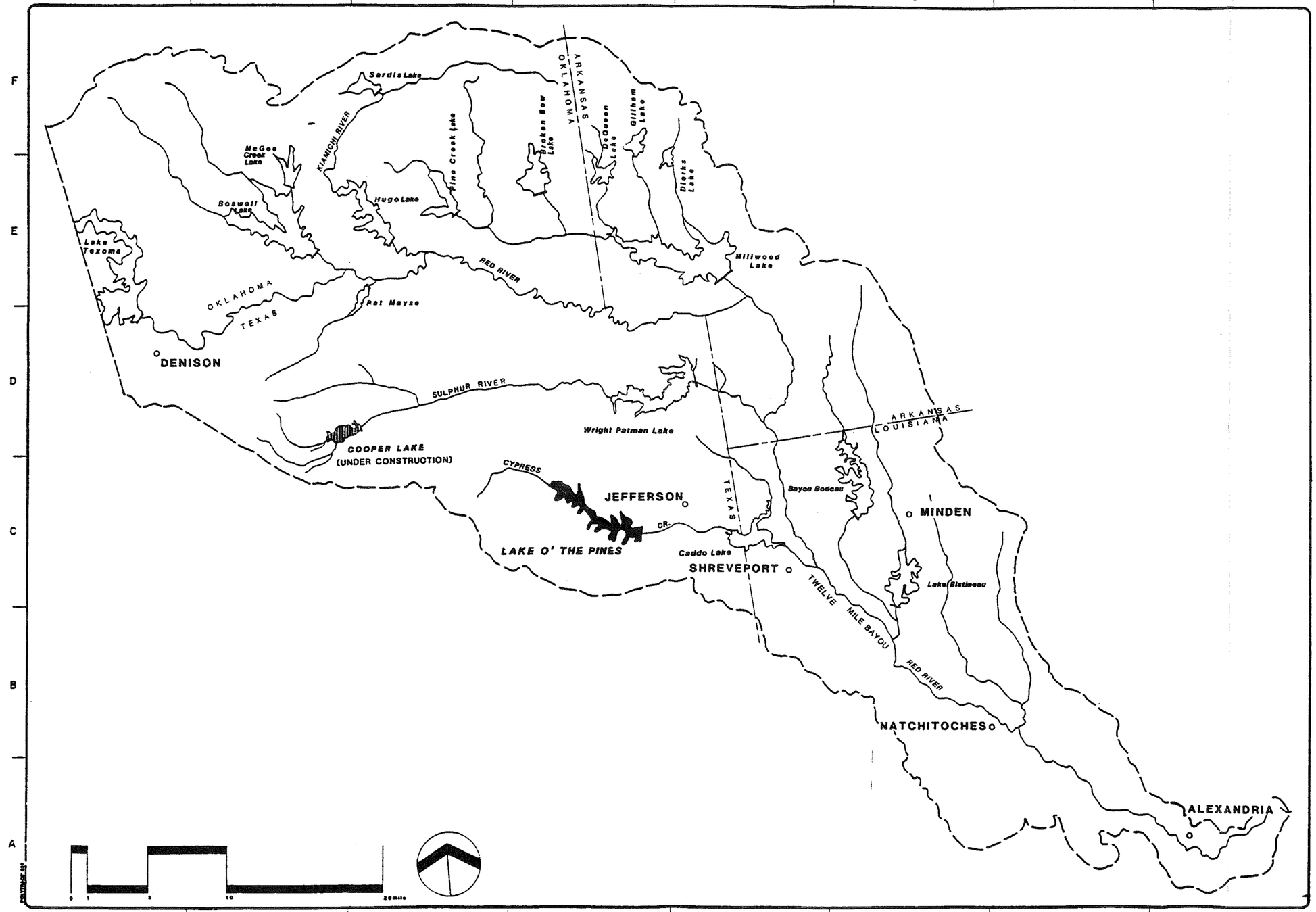
f. Public Law 91-611 (Rivers and Harbors and Flood Control Act of 1970) established the requirement (Section 122) for evaluating the economic, social, and environmental impacts of projects.

1-05 PROJECT AUTHORIZATION AND PURPOSE

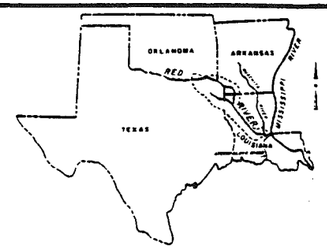
Ferrells Bridge Dam was constructed for the purpose of flood control and water supply storage. The Ferrells Bridge Reservoir, Texas, Project was authorized by the Flood Control Act of 24 July 1946, Public Law No. 526, 79th congress, 2nd Session. The reservoir was designated as Lake O' the Pines on 15 July 1958 (Public Law 85-522) 85th Congress.

This reservoir is part of the comprehensive plan for the control of floods on Red River below Denison Dam, Oklahoma - Texas. The drainage area of 850 square miles above the damsite is approximately 30 percent of the drainage area of Cypress Creek and approximately 3 percent of the drainage area of the Red River below Denison Dam, excluding the Ouachita-Black River Basin (see Plate 1-1). Since impoundment Lake O' the Pines has prevented flooding on Cypress Creek, Caddo Lake, and Twelve Mile Bayou. Stages also were lowered on Red River downstream from Shreveport, Louisiana. An additional benefit accruing from Lake O' the Pines is the utilization of water impounded therein to provide municipal and industrial water supplies to the cities of Daingerfield, Lone Star, and Hughes Springs, the rural systems of Mims Rural Water Cooperative and Holly Springs Rural Water Cooperative, and Southwestern Electric Power Company (Hallsville, Texas). The Northeast Texas Municipal Water District is the state agency created by the Texas legislature to administer the water supply features of the project.

The Lake O' the Pines project was transferred from the New Orleans District to the Fort Worth District in October 1979.



VICINITY MAP



LEGEND

- EXISTING LAKE
- UNDER CONSTRUCTION
- RIVER
- BASIN BOUNDRY

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

LAKE O' THE PINES
CYPRESS CREEK, TEXAS
LOWER RED RIVER
BASIN MAP

DRAWING NO. 1.1-1
SHEET NO. 1 OF 1

1-06 PROJECT OPERATIONS

a. Authorized Project Purposes. Flood control and water supply are the primary purposes of storage space at Lake O' the Pines. Regulation for downstream water quality is considered an incidental use of storage space. Figure 1-1 and Plate Sequence 1-2 identifies the pool storage area allocated for various uses.

b. Overall Water Regulation Plan. In the development of the water control plan for Lake O' the Pines, consideration was given to the following general requirements for reservoir operation:

1. Limitation of reservoir release to a maximum of 3,000 cfs for all floods up to and including the design flood;

2. Provision of storage space for water supply purposes in accordance with agreements with Northeast Texas Municipal Water District;

3. Provision of water level management to aid in the control of mosquito population;

4. Maintenance of a minimum release of 5 cfs for low water flow in Cypress Creek downstream from the dam; and

5. Provision of a recreation pool;

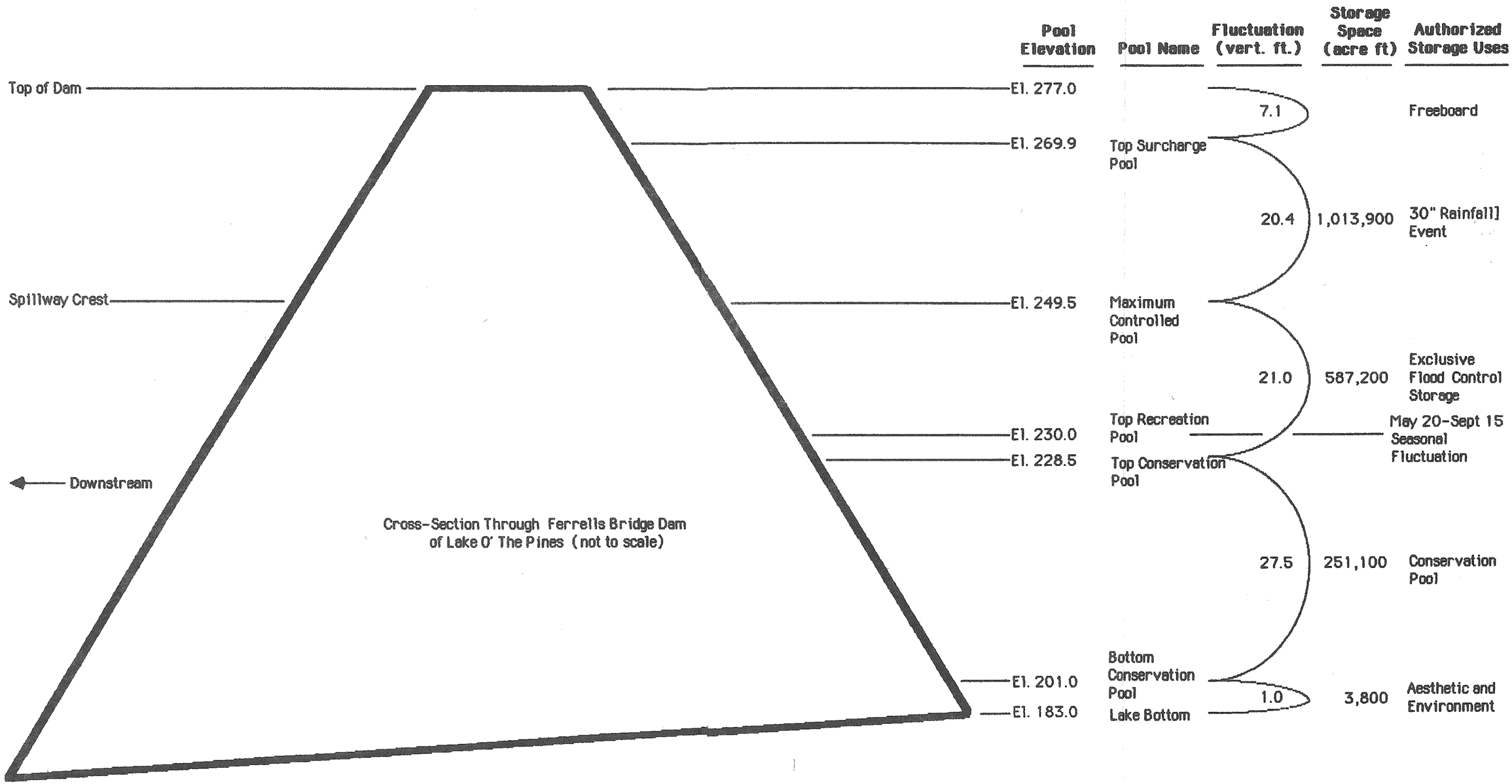
In 1980 the existing Plan of Regulation was modified to reduce the downstream flooding at Caddo Lake. Refer to Chapter 3-03 for details of the Lake O' the Pines water control schedule.

1-07 LAKE O' THE PINES

Ferrells Bridge Dam forms Lake O' the Pines. At its normal operating levels, the lake is approximately 18 miles long and 1 mile wide with water extending into 8 tributaries.

Plate Sequence 1-2 identifies the operating pool levels for Lake O' the Pines and authorized storage uses for pool ranges. The conservation pool (elevation 228.5 N.G.V.D.) has a capacity of 251,100 ac-ft, covers an area of 18,700 acres, and forms a lake about 18 miles long. At maximum flood control pool (elevation 249.5) waters detained for water supply and flood control purposes amount to 838,300 ac.-ft. This volume is equivalent to 18.5 inches of rainfall runoff from the watershed. The lake formed at elevation 249.50 will cover an area of 38,200 acres and extend about 30 miles upstream from the dam. The storage below elevation 249.50 feet National Geodetic Vertical Datum (N.G.V.D.) allocated to 50-years of sediment deposition is 3800 ac-ft. See Appendix A for areas and volume of selected reservoir elevations.

The flood pool, between the top of conservation pool and the spillway crest, has a fluctuation zone of 21 feet. The fluctuation in the lower portion of this pool is rapid during periods of heavy rainfall. The conservation pool, between the sediment storage pool and flood control pool, has a fluctuation zone of 27.5 feet. Fluctuations within the conservation pool depends upon the rate of withdrawals for water supply by the Water District as well as inflows and evaporation. The flood control pool is regulated by releasing a maximum of 3,000 cfs. Reservoir regulation provides a seasonal recession, as required, to aid in mosquito control and a firm water supply for the water district without lowering the pool below bottom of conservation pool level, 201 ft. N.G.V.D.

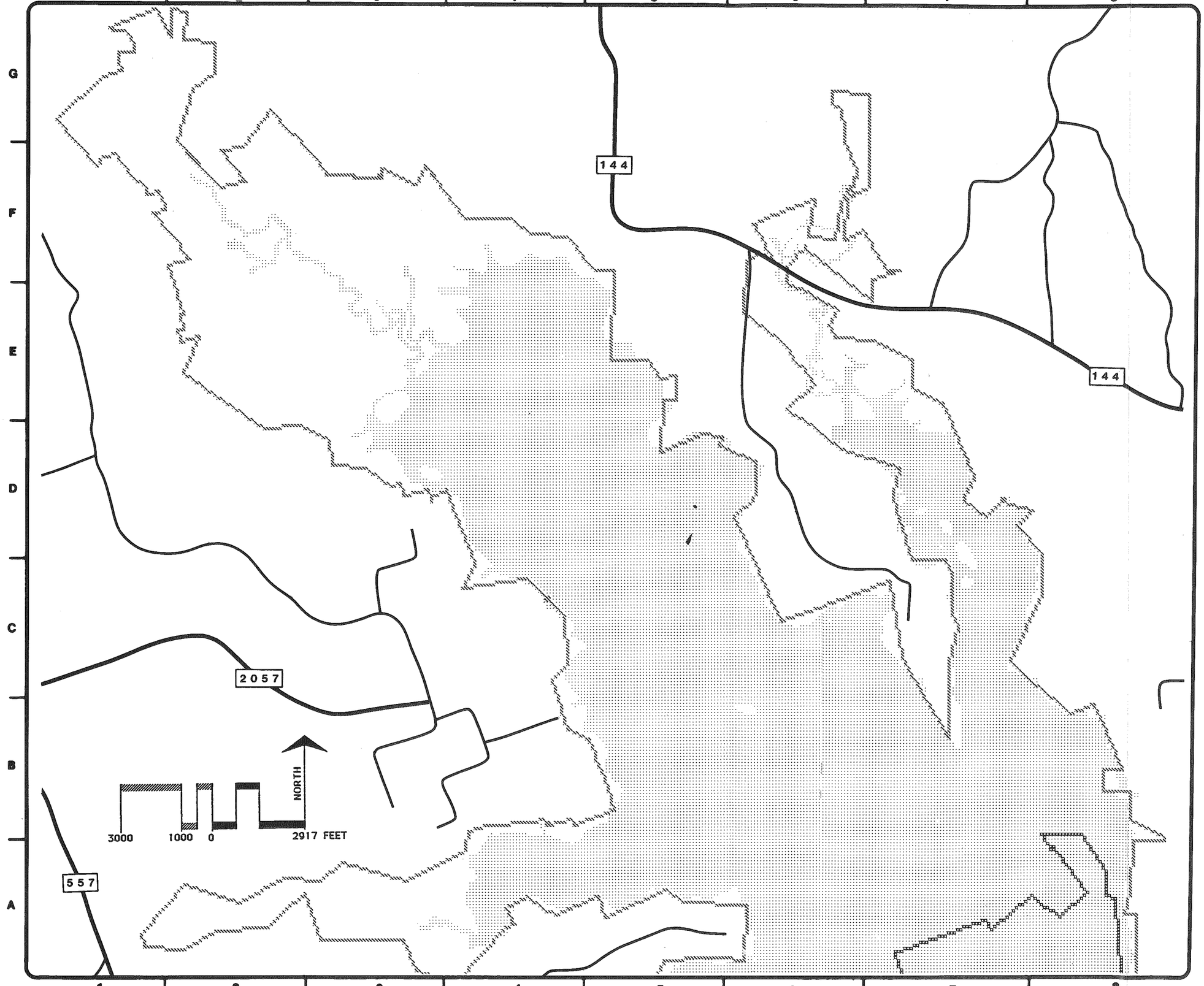


Cross-Section Through Ferrells Bridge Dam
of Lake O' The Pines (not to scale)

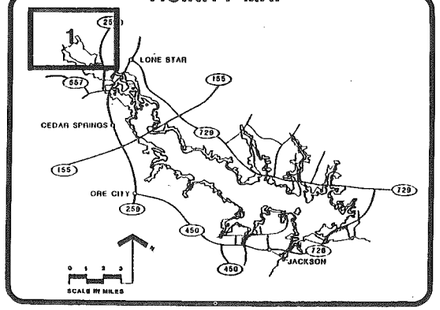
LAKE O' THE PINES

POOL ELEVATIONS AND AUTHORIZED STORAGE USES

Figure 1-1



VICINITY MAP



LEGEND

POOL LEVELS

- MAXIMUM CONTROLLED POOL ELEV. 249.5
- TOP RECREATION POOL ELEV. 230.0
- TOP CONSERVATION POOL ELEV. 228.5
- BOTTOM CONSERVATION POOL ELEV. 201.0

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROADS

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

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

LAKE O' THE PINES
CYPRESS RIVER, TEXAS
SELECTED POOL ELEVATIONS

INVITATION NO. | DATE:
CONTRACT NO. | SHEET NO. 1 OF 7 | SEQUENCE NO.
DRAWING NUMBER

LONE STAR

LONE STAR PARK

729

557

997

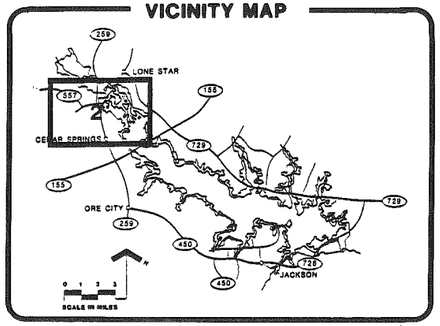
259

2796

NORTH

3000 1000 0 2917 FEET

VICINITY MAP



LEGEND

POOL LEVELS

- MAXIMUM CONTROLLED POOL ELEV. 249.5
- TOP RECREATION POOL ELEV. 230.0
- TOP CONSERVATION POOL ELEV. 228.5
- BOTTOM CONSERVATION POOL ELEV. 201.0

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROADS

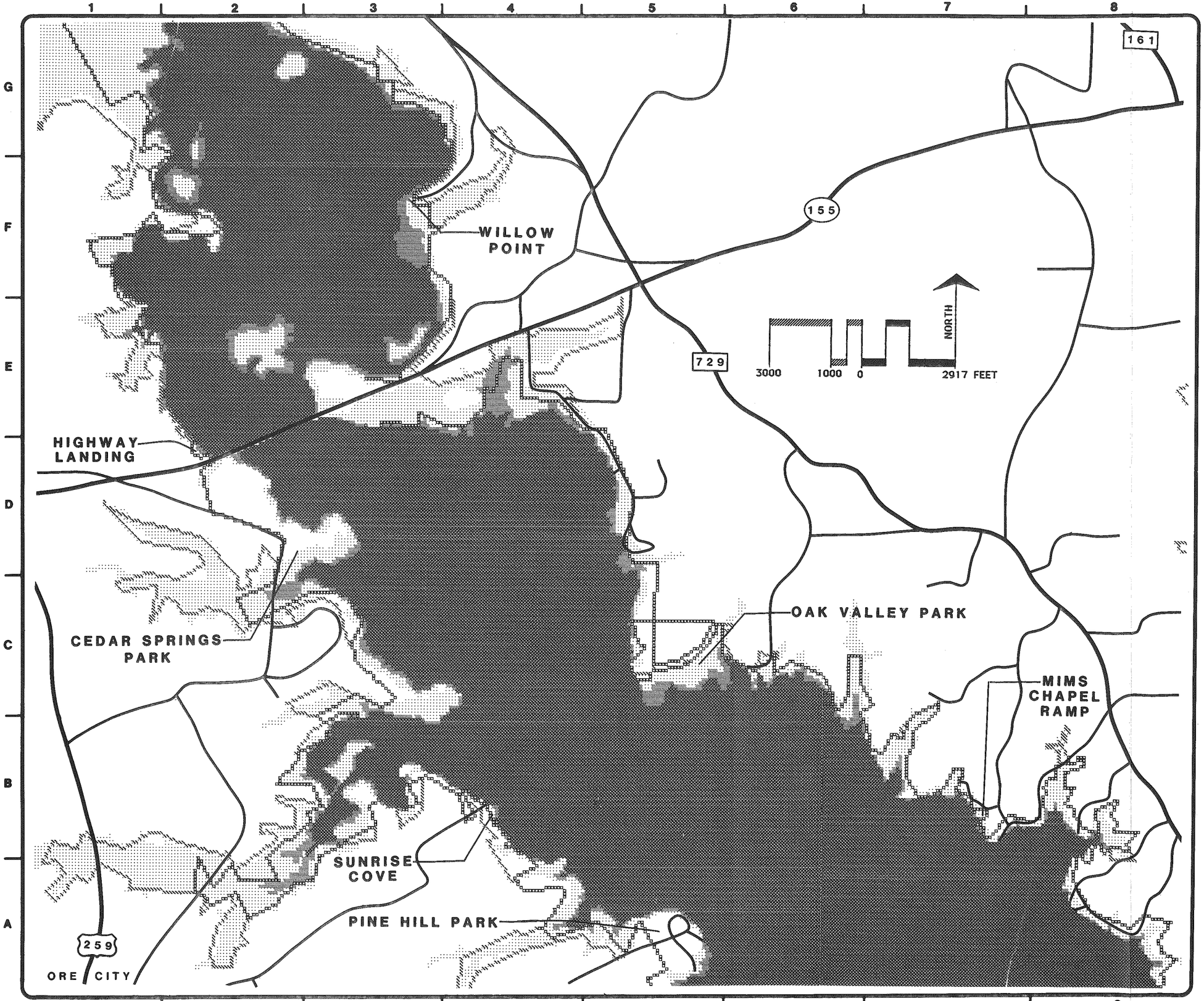
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

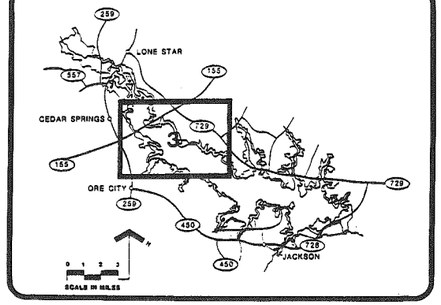
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

SELECTED POOL ELEVATIONS

INVITATION NO. | DATE:
CONTRACT NO. | SHEET NO. 2 OF 7 | SEQUENCE NO. 1-2
DRAWING NUMBER



VICINITY MAP



LEGEND

POOL LEVELS

- MAXIMUM CONTROLLED POOL ELEV. 249.5
- TOP RECREATION POOL ELEV. 230.0
- TOP CONSERVATION POOL ELEV. 228.5
- BOTTOM CONSERVATION POOL ELEV. 201.0

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROADS

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

LAKE O' THE PINES
CYPRESS RIVER, TEXAS

SELECTED POOL ELEVATIONS

DESIGNED BY:	
DRAWN BY:	
REVIEWED BY:	
INVITATION NO.	DATE:
CONTRACT NO.	SHEET NO. 3 OF 7
DRAWING NUMBER	SEQUENCE NO. 1-2

PINE HILL PARK

POP'S LANDING RAMP

ALLEY CREEK PARK

COPELAND CREEK PARK

WOODIE'S RAMP

450

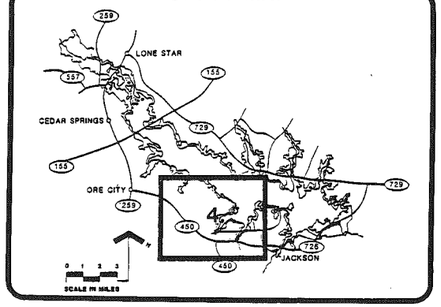
726

1968

NORTH

3000 1000 0 2917 FEET

VICINITY MAP



LEGEND

POOL LEVELS

- MAXIMUM CONTROLLED POOL ELEV. 249.5
- TOP RECREATION POOL ELEV. 230.0
- TOP CONSERVATION POOL ELEV. 228.5
- BOTTOM CONSERVATION POOL ELEV. 201.0

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROADS

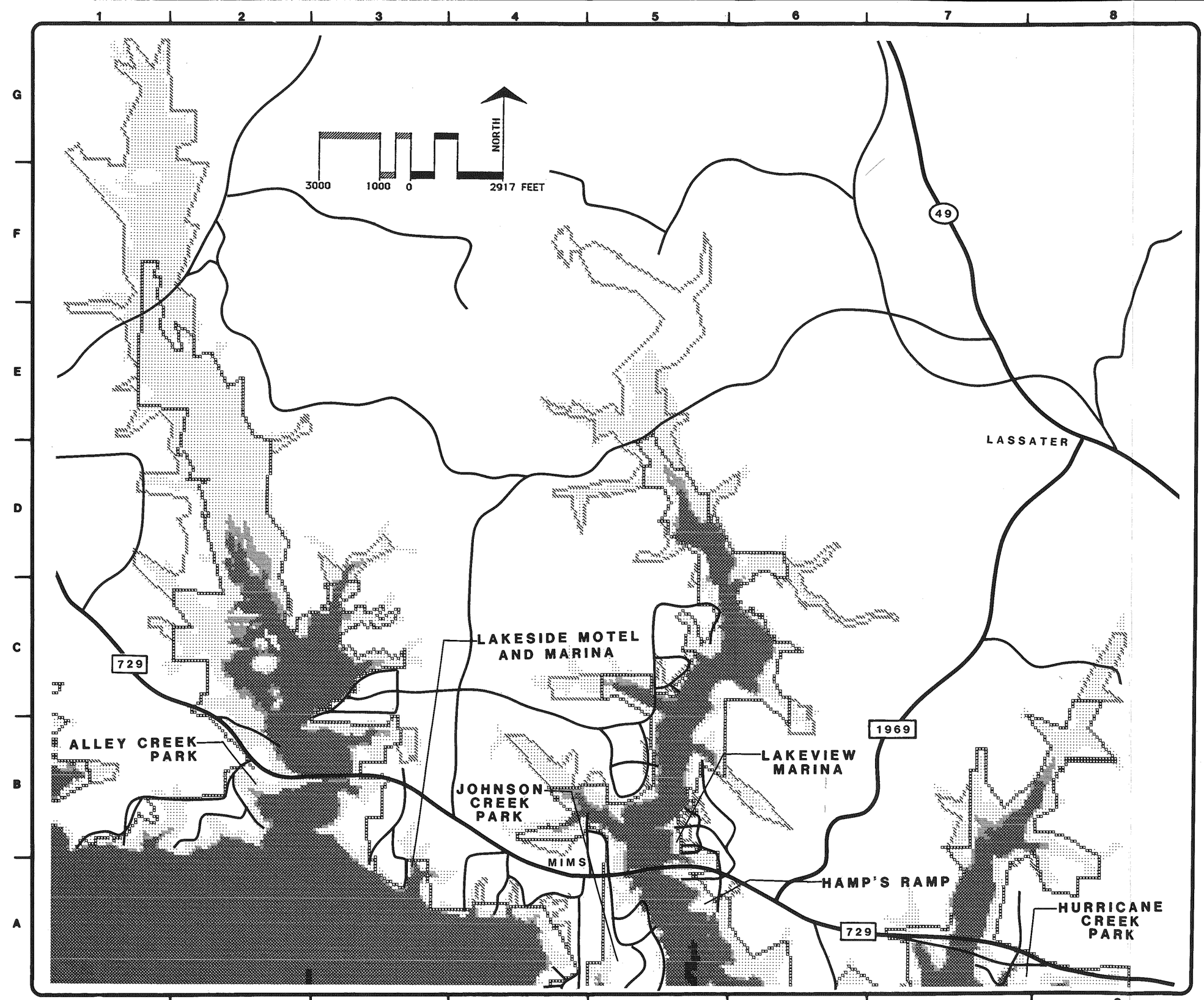
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

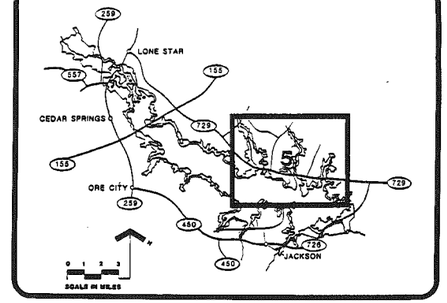
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

SELECTED POOL ELEVATIONS

INVITATION NO. | DATE:
CONTRACT NO. | SHEET NO. 4 OF 7 | SEQUENCE NO. 1-2
DRAWING NUMBER



VICINITY MAP



LEGEND

POOL LEVELS

- MAXIMUM CONTROLLED POOL ELEV. 249.5
- TOP RECREATION POOL ELEV. 230.0
- TOP CONSERVATION POOL ELEV. 228.5
- BOTTOM CONSERVATION POOL ELEV. 201.0

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROADS

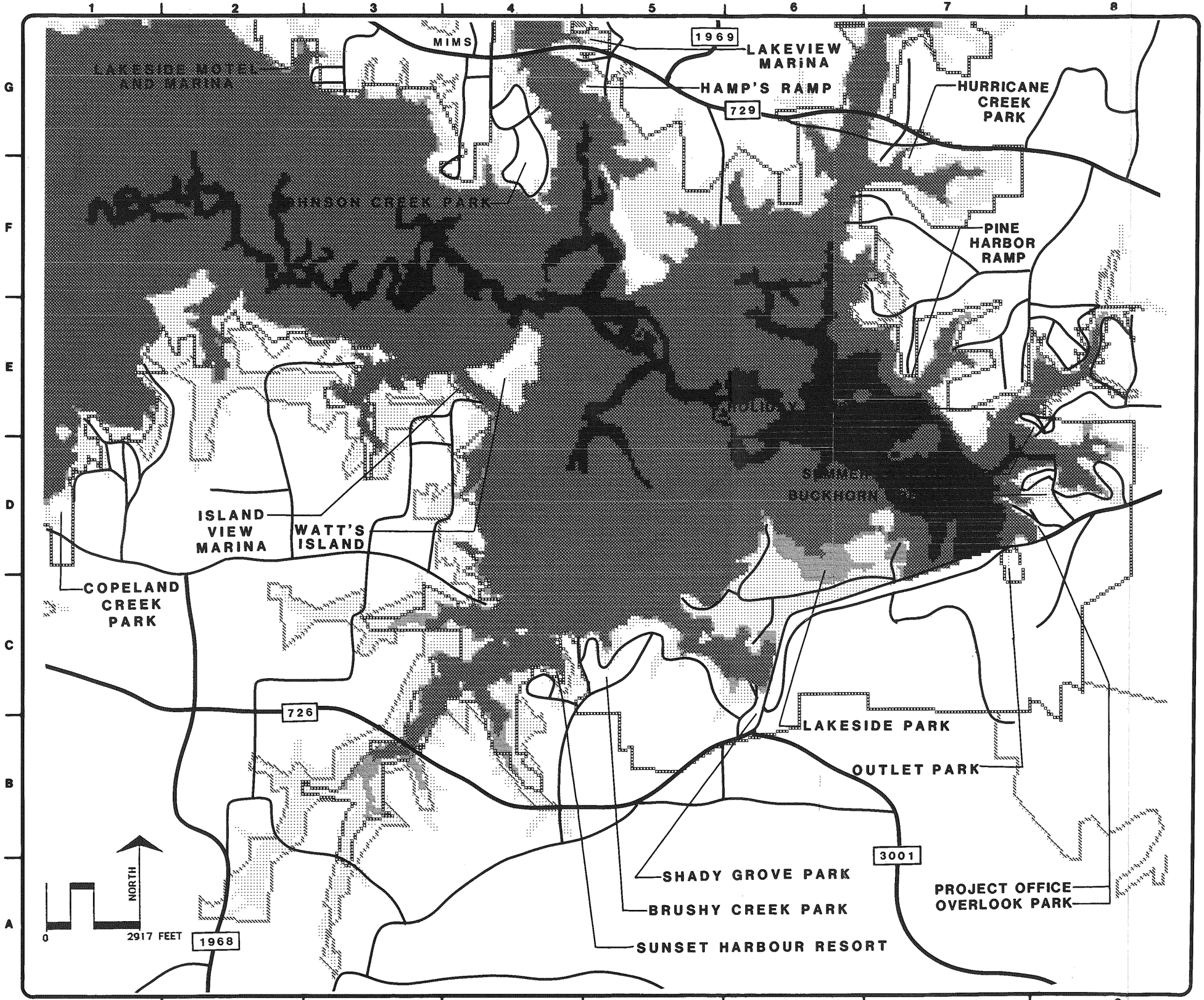
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

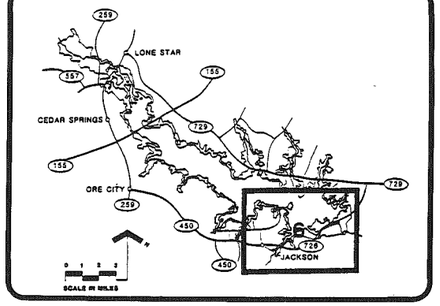
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

SELECTED POOL ELEVATIONS

INVITATION NO.
DATE:
CONTRACT NO.
DRAWING NUMBER
SHEET NO. 5 OF 7
SEQUENCE NO. 1-2



VICINITY MAP



LEGEND

POOL LEVELS

- MAXIMUM CONTROLLED POOL ELEV. 249.5
- TOP RECREATION POOL ELEV. 230.0
- TOP CONSERVATION POOL ELEV. 228.5
- BOTTOM CONSERVATION POOL ELEV. 201.0

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROADS

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

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

LAKE O' THE PINES
CYPRESS RIVER, TEXAS

SELECTED POOL ELEVATIONS

INVITATION NO.	DATE:	
CONTRACT NO.	SHEET NO. 6 OF 7	SEQUENCE NO. 1-2
DRAWING NUMBER		

PINE HARBOR RAMP

HOLIDAY HARBOR RAMP

726

729

SUMMER LAKE RESORT

BUCKHORN CREEK PARK

PROJECT OFFICE / OVERLOOK PARK

OUTLET PARK

3001

LAKESIDE PARK

SHADY GROVE PARK

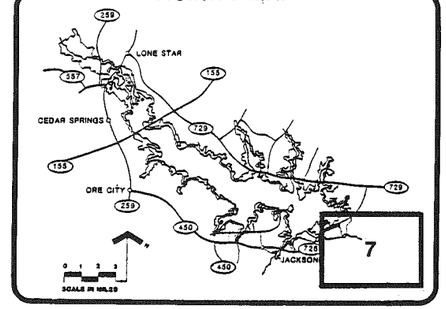
2208

3001

NORTH

3000 1000 0 2917 FEET

VICINITY MAP



LEGEND

POOL LEVELS

MAXIMUM CONTROLLED POOL ELEV. 249.5

TOP RECREATION POOL ELEV. 230.0

TOP CONSERVATION POOL ELEV. 228.5

BOTTOM CONSERVATION POOL ELEV. 201.0

FEE BOUNDARY

FLOWAGE EASEMENT BOUNDARY

PERMIT TO FLOOD BOUNDARY

ROADS

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

DESIGNED BY:

DRAWN BY:

REVIEWED BY:

LAKE O' THE PINES
CYPRESS RIVER, TEXAS

SELECTED POOL ELEVATIONS

INVITATION NO.

DATE:

CONTRACT NO.

SHEET NO. 7 OF 7

SEQUENCE NO. 1-2

DRAWING NUMBER

1-08 GENERAL PROJECT LOCATION AND SETTING

The Ferrells Bridge damsite is located in Marion County, Texas, on Cypress Creek at mile 81.2 above its mouth at the Red River and approximately 9 miles west of Jefferson, Texas. Major highway access is via Interstates 20 and 30 and State Highways 259 and 59 (refer to Figure 1-2).

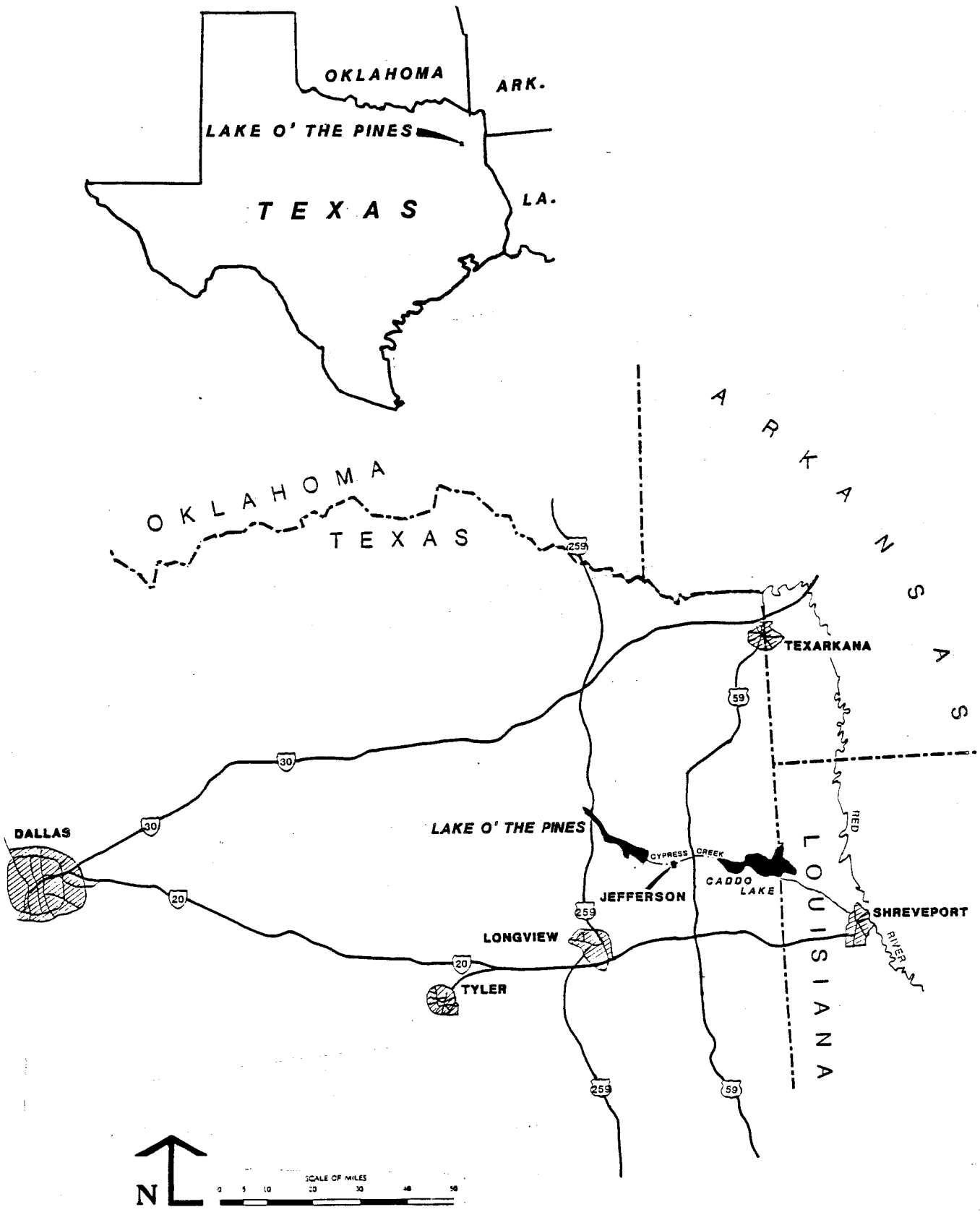
The lake area extends throughout portions of Marion, Harrison, Upshur, Morris, Camp and Titus counties, Texas. Topography of the area is generally rolling, hilly uplands with wide, flat flood plains and terraces. Some hills visible from the lake rise as much as 200 feet above the shoreline. The major forest type of the region is short-leaf and loblolly pine. Mixed pine and oak trees occupy shallow bottom land and hillsides, while pine is the major species occurring on hilltops and ridges. In bottoms along Cypress Creek and other streams, the major forest type is Oak-Gum-Cypress.

1-09 PROJECT LAND USE

The following land classification system and numbers of acres of each land use class were derived from the 1975 Lake O' the Pines Master Plan. These figures represent existing land use patterns at the project. The total project feesimple estate, including water and land areas is currently 29,030 acres. Total fee land above the average conservation pool (228.5 ft.) is about 10,330 acres. Total fee land below conservation pool (228.5) is about 18,700 acres. Present project land uses and associated acreage are approximately as follows:

LAND USE	ACREAGE
Forest Management	8,390
Natural Areas	527
Wildlife Management	8,390
Public Recreation Areas	870
Project Operations	20
Flowage Easement	16,063
Permit to Flood	125
TOTAL	34,385

Multiple use management practices for the various land use classifications require that some use areas overlap. Thus, the total of the above classifications does not equal the total project land area. The shoreline length at the 230 feet N.G.V.D. recreation pool elevation is approximately 144 miles.



LOCATION MAP

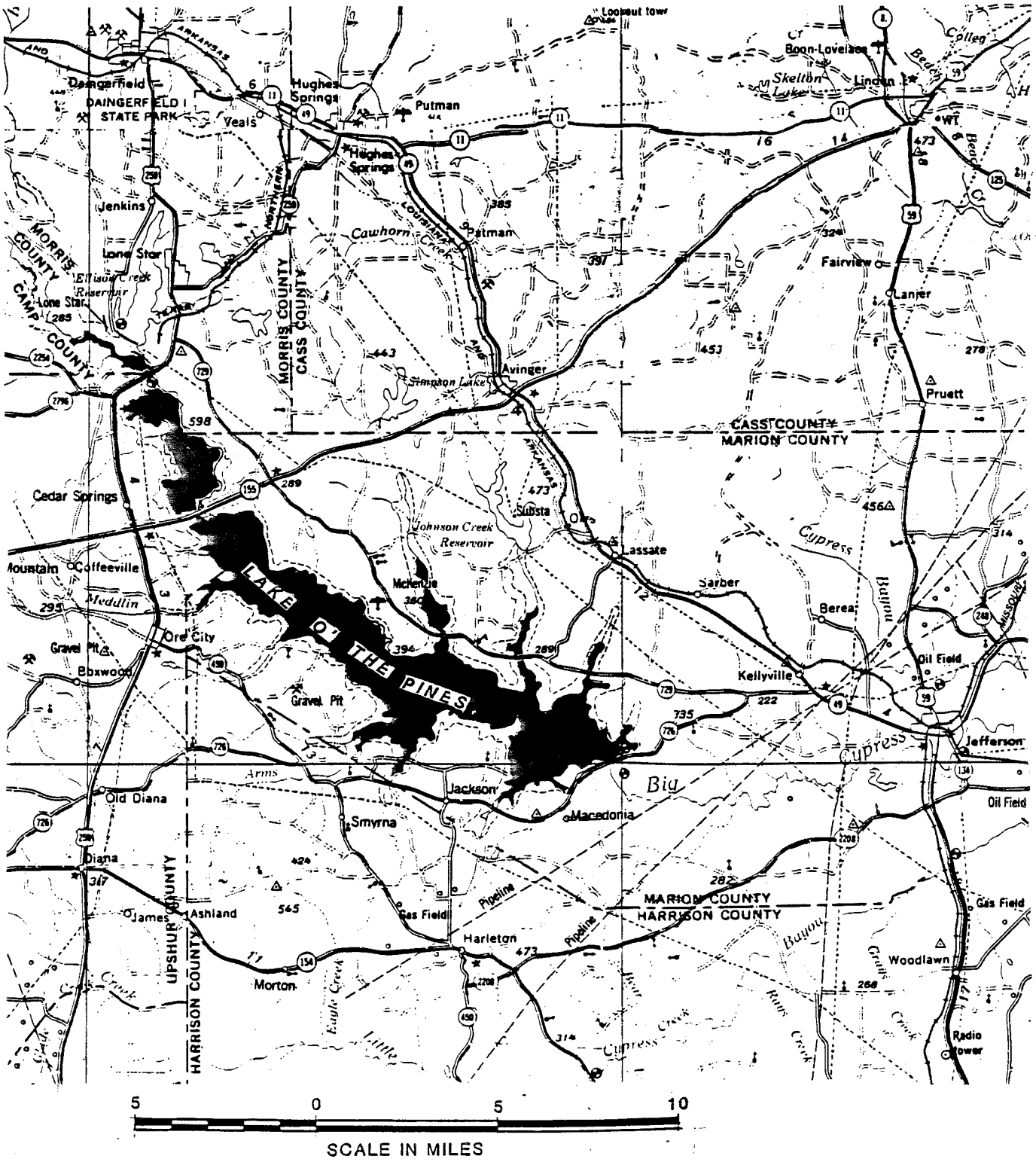
Figure 1-2

1-10 PROJECT FACILITIES AND STRUCTURES

a. Ferrells Bridge Dam. Ferrells Bridge Dam is constructed of earth placed in layers and compacted by rolling. The dam has a crest length of 10,600 feet, crown width of 30 feet, with a structural height of 77 feet above the valley floor. the dam's top elevation is at 277.0 feet N.G.V.D. The side slope of the dam varies from 1 vertical, 2.5 horizontal to 1 vertical, 3.5 horizontal. The upstream face of the dam is protected by limestone riprap and the downstream face is covered by grasses. Outlet works are located near the east end of the dam and include an approach channel, an intake and control structure, two conduits, a stilling basin, and an outlet channel. The spillway is located in the east abutment and consists of an approach channel, a 200 foot gravity-flow chute-type weir, a stilling basin and an outlet channel.

b. Project Operation Office and Maintenance Compound. The project office is located above the east end of the embankment and is accessible via Farm to Market Road 726. Constructed originally for use as a maintenance building, the structure was later remodeled into an office and storage workspace. A paved maintenance compound is surrounded by a chain link fence, with the office building, a steel maintenance building and shop building around the perimeter. The maintenance building and compound is used for storage of project materials and equipment. The former reservoir manager residence, located nearby has been converted into a storage building.

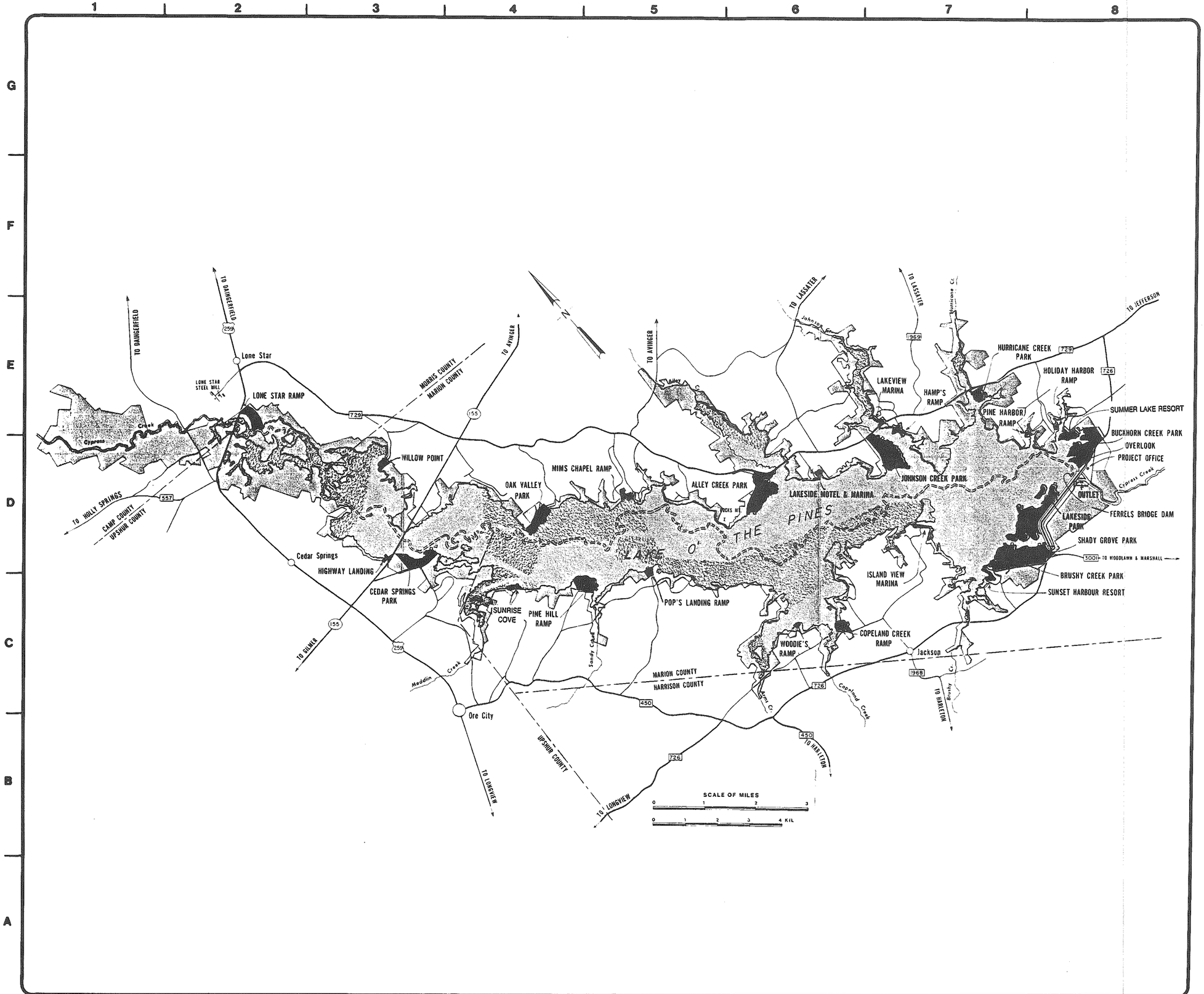
c. Project Roads and Access. Lake O' the Pines is accessible over U.S. Highway 259, Texas State Highway 155 and Farm to Market Roads 450, 557, 726,729, 1968 and 1969. Farm to Market road 726 crosses the creek on the crown of the dam, and, combined with Farm to Market Roads 450, 557, 1968, State Highway 155 and U.S. Highway 259, provides easy access to the north and south sides of the lake. U.S. Highway 259 and Texas State Highway 155 cross the lake about 17 and 14 miles northwest of the dam, respectively. Farm to Market Road 729 extends the north side of the lake between State Highways 59 and 155. Other access to the lake is by improved county roads. The locations of the reservoir, surrounding towns, and principal access roads are shown in Figure 1-3. Type and condition of access roads to parks will be discussed in Chapter 6.



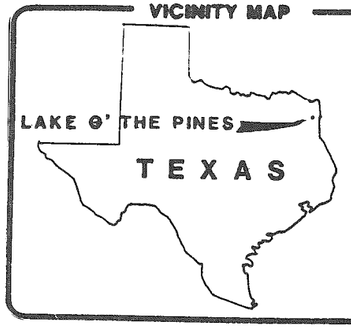
AREA SETTING

Figure 1-3

d. Public Use Facilities. The original selection of areas for various types of development was based on studies by the National Park Service and U.S. Army Corps of Engineers. Major consideration was given to the public-use requirements of the region and to the extent to which those needs could be fulfilled by the resources of the reservoir area. The selection of areas for public-use purposes was governed by area, terrain, scenic qualities, accessibility by roads, water frontage and depth, and many other factors. The plan was based on eventual development of the full recreational potential of the publicly owned lands and water areas and on granting permission for the recreation development of privately-owned lands that are located within flowage easement areas, because of their location, are or will be in demand for outdoor recreational purposes. Presently four fee camping, five day use, and five access areas are Corps managed. Four access areas are managed by Marion County and nine marinas are privately owned and operated. Refer to Plate Sequence 1-3 for location of existing recreation areas at Lake O' the Pines. Chapter 3-10 will detail number of existing facilities for each recreation area. Chapter 6 will map existing and proposed facilities for each of the existing recreation areas.



VICINITY MAP



LEGEND

MANAGING ENTITY	RECREATION USE OR FACILITY
MANAGED BY CORPS	
OUTLET PARK	RAMP
OVERLOOK PARK	PICNIC, RAMP
BUCKHORN CREEK PARK	CAMPING, RAMP
HURRICANE CREEK PARK	FREE CAMPING, RAMP
JOHNSON CREEK PARK	PICNIC. CAMPING, RAMP, BEACH
ALLEY CREEK PARK	PICNIC, CAMPING, RAMP, BEACH
MIMS CHAPEL PARK	RAMP
OAK VALLEY PARK	FREE CAMPING, RAMP
LONE STAR PARK	RAMP
CEDAR SPRINGS PARK	FREE CAMPING, RAMP
PINE HILL PARK	RAMP
COPELAND CREEK PARK	RAMP
BRUSHY CREEK PARK	PICNIC, CAMPING, RAMP, BEACH
SHADY GROVE PARK	PICNIC, RAMP
LAKESIDE PARK	PICNIC, RAMP
LEASE TO MARION COUNTY	
HOLIDAY HARBOR RAMP	RAMP
PINE HARBOR RAMP	RAMP
POPS LANDING RAMP	RAMP
WOODIES RAMP	RAMP
LEASE TO CONCESSIONAIRE	
SUMMER LAKE RESORT	MARINA, RAMP
HAMP'S RAMP	MARINA, RAMP
LAKEVIEW MARINA	MARINA, RAMP
LAKESIDE MOTEL &MARINA	MARINA, RAMP
WILLOW POINT	MARINA, RAMP
HIGHWAY LANDING	RAMP
SUNRISE COVE	RAMP
ISLAND VIEW MARINA	MARINA, RAMP
SUNSET HARBOUR	MARINA, RAMP

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

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

LAKE O' THE PINES
CYPRESS RIVER, TEXAS
EXISTING RECREATION AREAS

INVITATION NO. | DATE:
CONTRACT NO. | SHEET NO. 1 OF 1 | SEQUENCE NO. 1-3
DRAWING NUMBER

regional description and analysis
Chapter 2

CHAPTER 2
REGIONAL DESCRIPTION AND ANALYSIS

2-01 INTRODUCTION

This section provides a brief description of the physical, natural and cultural setting of the region in which Lake O' the Pines is located. It also analyzes the resource needs and desires of the people living in the region. The purpose of this section is to identify resource needs and desires that can be either partially or wholly satisfied at the project. The succeeding chapter of the master plan will relate this regional analysis to the project area and identify how project resources should be managed, used or developed to help fulfill regional needs.

2-02 REGIONAL GEOGRAPHIC SETTING

a. Location. Figure 1-2 illustrates the geographic location of the project within East Texas. As shown in more detail in Figure 1-3, the majority of Lake O' the Pines is situated in southwest Marion County with the upper end of the lake extending into Upshur, Morris and Camp Counties. Three small tributaries along the south side of the lake extend into Harrison County. The lake extends approximately 18 miles from the embankment to the upper end of the impoundment.

b. Regional Physiography. Most of Marion, Harrison, and Upshur Counties and the southern halves of Morris and Camp Counties are situated within the Timber Belt, also known as the Pineywoods and East Texas Forest Region. This region is characterized by gently rolling to hilly terrain averaging 200 to 500 feet in elevation. Numerous streams and large rivers drain pine and pine-hardwood forest, intermittent swamps and cultivated or pasture land. The river bottoms are wide and full of sloughs and bayous with motionless brown water. This region is the most mesophytic in Texas.

The northern halves of Morris and Camp Counties are situated in the Post Oak Savannah Region. This region includes plants found in the true prairie association as well as those found in the deciduous forest association. Topography is gently rolling to hilly averaging 500 - 600 feet above sea level. Most of the Post Oak Savannah is comprised of native or improved pastures with deciduous forests occurring primarily along streams and rivers (Manual of the Vascular Plants of Texas, Donovan Stewart Correll, 1970)

2-03 REGIONAL CLIMATE

This area receives relatively high rainfall with 35 to more than 50 inches per year. The monthly average rainfall tends to be evenly distributed throughout the year but small deficiencies or excesses are likely to occur within some months. Temperatures are usually relatively high in the summer months of July, August and September reaching sometimes over 100 degrees F, and relatively mild in December, January and February with few days below freezing. This area is relatively free from persistent winds and winters are generally mild. Warming winds originate primarily from the southeast during the late spring, summer and early fall and cooling winds originate from the northwest during late fall, winter and early spring (Manual of the Vascular Plants of Texas, Donovan Stewart Correll, 1970).

Many of the streams feeding the rivers are intermittent, drying up during the summer months. The rivers are constantly changing their courses, leaving bends of the river as oxbows except where reservoirs have been constructed. Reservoirs of the area, fed by ample east Texas rains, supply the area with more than adequate supplies for municipal, industrial, and recreational uses.

The maximum and minimum temperatures recorded in the area are 110 degrees F and 4 degrees F with an annual mean of 64.4 degrees F. Warm summer temperatures lead to a high demand by area residents for swimming, water-skiing, boating and other water dependent activities. it is expected that about 81 percent of the total annual visitation to Lake O' the Pines will occur during the summer months of June, July and August. During winter, temperatures remain cool with thin ice very rarely forming on the lake cove surface areas.

2-04 REGIONAL LAND OWNERSHIP AND USE

Forestry is and will probably remain the principal land use in this region since the soils of East Texas are better adapted to trees than to grass. Cattle-raisers must fertilize pastures heavily in order keep grass productivity high. Even with heavy inputs, two acres of prime land will only support one cow (Texas Wild, by Richard Phelan, 1976).

The ecologically diverse loblolly and shortleaf virgin forests of East Texas were cut down between 1819 and 1940. The majority of the forests of the area today result from intensive monoculture replanting programs using the fast growing loblolly pine. The favored area forestry procedure of today is called even-aged management. Generally once a forested area is clear cut, all the trees are removed, pine seedlings are planted, grasses are established or the area is left to natural succession. As a result, some lands are well vegetated with grasses or even aged

pine, some are overgrown with brambles and others are relatively barren and eroding (Texas Wild, by Richard Phelan, 1976).

Marion County totals 380 square miles. Approximately 98 percent is forest, agricultural land, or surface water and 1.2 percent is classified as urban, urban fringe, or rural settlements. Upshur County totals 584 square miles. Approximately 95 percent is forest or agricultural land and about 3.5 percent is classified as urban or urban fringe. Camp County totals 192 square miles. approximately 83 percent is forest or agricultural land and very little of the area is urbanized.

2-05 TRANSPORTATION AND ACCESS

Those traveling to Lake O' the Pines from surrounding states, counties, and cities most frequently use either I-20, I-30, State Highway 59, or State Highway 259. Interstate 30 and 20 run generally east and west while State Highways 59 and 259 run generally north and south. Overall, access to Lake O' the Pines by highway is very good.

2-06 SOCIO-ECONOMIC CHARACTERISTICS

Employment and income levels influence both overall demand for recreation and the types of recreation activities desired. Generally, increases in income can be correlated to increased use of public and private sector outdoor recreation facilities. Much of the increase in participation in high cost recreation activities and demand for expensive recreation equipment can be correlated to increases in spendable income.

The decline of forestry and agricultural products and oil prices has created increasingly higher unemployment in the region. The following sections discuss socio-economic characteristics that largely reflect that economic decline.

Camp County has historically relied upon agriculture and lumbering, but beginning about 1960 the economic base shifted toward light manufacturing. The recreational opportunities based on the proximity to several lakes and the rural lifestyle in the area apparently attracted in-migration of over 1,100 persons during the 1970's. The processing of poultry products and other businesses related to that industry employ the largest number of people in Camp County. The elementary and secondary school system is a large employer as it is in most counties. Significant numbers are employed in the garment industry and in furniture manufacturing.

The Marion County economy has historically included agriculture, oil, lumbering, and recreation. By 1985, the highest percentages of reported employment were in the services and trade sectors, which together accounted for over 46 percent of county

employment. The school system and manufacturing followed in employment percentages.

Upshur County has historically relied upon agriculture and light manufacturing. Commuting to manufacturing plants in neighboring counties has been common. By 1985, the highest percentages of employment were in the wholesale and retail trade, and services sectors, followed by employment in local government and manufacturing (Tx-Ark and East Texas Council of Governments).

2-07 REGIONAL RECREATION ANALYSIS

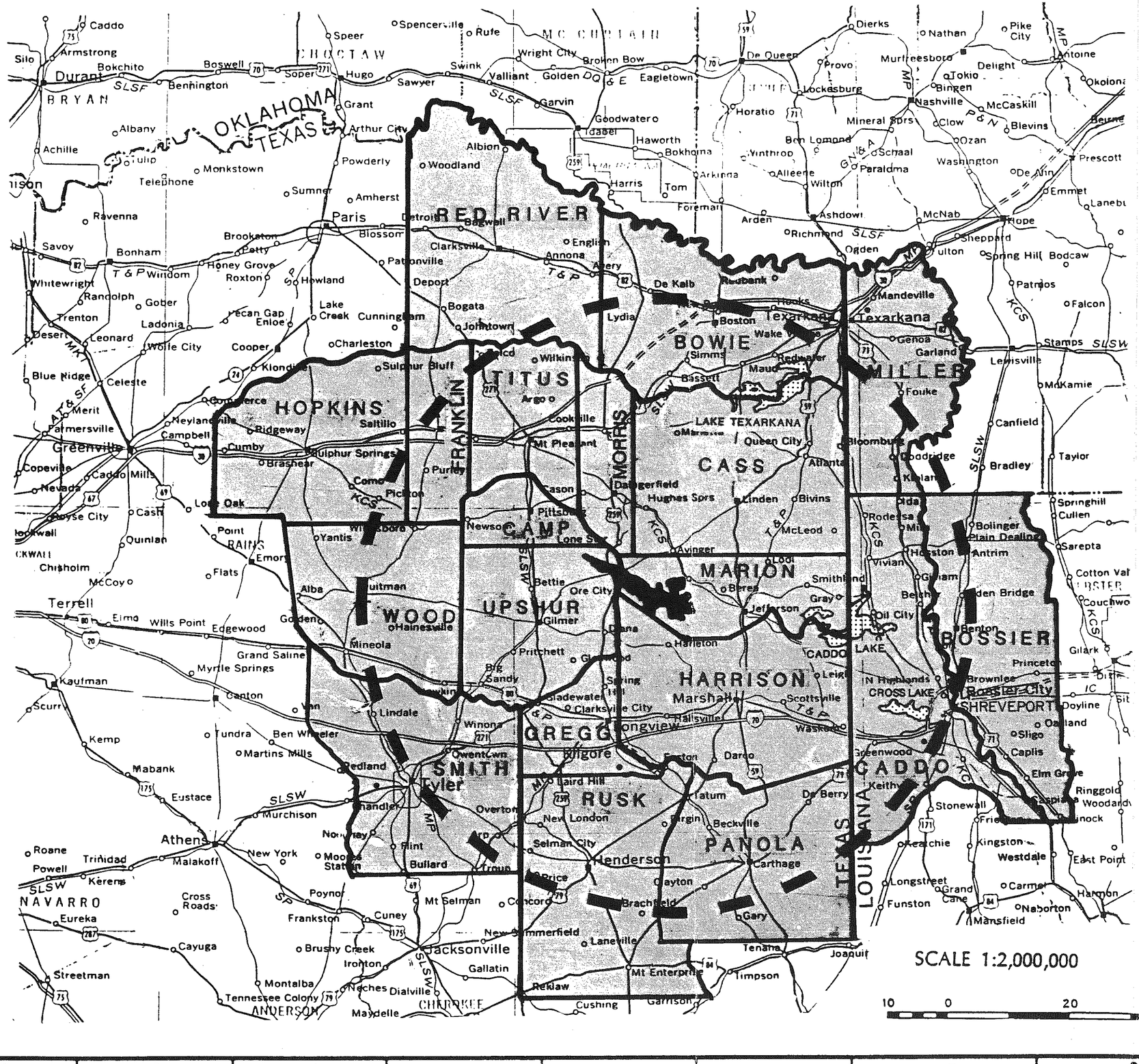
This section briefly summarizes the analysis of existing and future recreation use at Lake O' The Pines and the corresponding recreation facilities requirements. See Appendix B for more information about the analytical methodology and presentation of the findings in full detail.

Existing recreation use of the project was estimated on the basis of detailed visitor survey data, collected generally in 1986, and monthly vehicle counts at each of the 28 use areas at the project over the twelve month period from November 1986 to October 1987. The visitor surveys showed the average distribution of visitation between average weekday and average weekend day, among recreation activities, and by season (spring, summer, and combined autumn/winter), as well as other information (party size, length of stay for different purposes, and use of facilities). These survey data were combined with the total vehicle counts to compute average weekday and average weekend day visitation by season and recreation activity for each park.

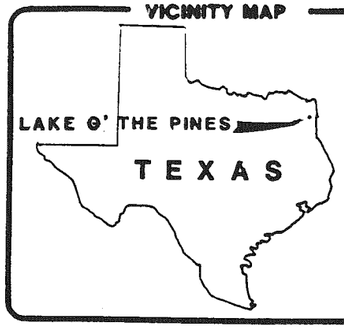
In the twelve-month 1986-87 period, Lake O' The Pines had about 1,409,000 visitors, of whom some 1,280,000 were there for day-use activities and 129,000 were campers. Sightseeing, boating, fishing and swimming were the most important day-use activities. The parks with the highest visitation for the year were Lakeside Park for day use and Johnson Creek Park for camping.

The 1985 Texas Outdoor Recreation Plan (TORP) projected future recreation demands by assuming that the participation rates for each activity will remain constant in the future for any given region, with actual participation therefore being solely a function of projected population. This approach was followed in this analysis.

The geographic distribution of origin of day-use and camping visitors, as provided by project personnel, was the basis for projecting the population of the source areas. The primary market area for the project is counties generally within a 50-mile radius of the project. This includes the Tyler, Longview-Marshall, Texarkana, and Shreveport Metropolitan Statistical Areas (MSA's)(see Plate Sequence 2-1)



VICINITY MAP



LEGEND

LAKE O' THE PINES

OTHER EXISTING LAKES

COUNTIES WITHIN THE PRIMARY MARKET AREA

50 MILE RADIUS

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

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

LAKE O' THE PINES
CYPRESS RIVER, TEXAS
PRIMARY MARKET AREA

INVITATION NO.
DATE:
CONTRACT NO.
DRAWING NUMBER
SHEET NO. 1 OF 1
SEQUENCE NO. 2-1

Population projections were based on the 1985 OBERS projections prepared by the U.S. Department of Commerce. Because of the relatively close time horizon of the projections (to the year 2005), they are in good agreement with population projections of the Texas Water Development Board (TWDB). By the year 2005, the primary market area population will grow from 1,078,000 in 1986 to 1,277,000, or 18 percent. In the same time the day use source area will grow in population by 19 percent compared to 1986, while the camping source area will grow by 17 percent.
The existing and future visitation data were converted into recreation facilities requirements on the basis of the turnover rate for each activity (in general terms, how many times a day a facility would be used), the optimum density of recreation use (mostly site-specific for each activity at each park), and the percent of visitors actually using the facilities that are provided at each park. Table 2-1 summarizes total recreation facilities needs at Lake O' The Pines for the years 1987, 1995, and 2005.

Due to its limitation the recreation needs analysis (Appendix B) has been augmented with direct public input. An important component of the Lake O' the Pines Master Plan study process was public involvement. On 17 November 1987 an input workshop was held for local groups. In January 447 public notices and questionnaires were mailed to individuals, groups, companies and state and federal agencies who had previously expressed an interest in Lake O' the Pines. Notices asking for public input were published in Tyler, Longview, and Jefferson newspapers. For details of the input process and a summary of comments from 20 people attending the input workshop and 40 respondents to the questionnaire, refer to Chapter 4, Public Input, and Appendix C.

Those facilities desired by the public which are consistent with water based recreation activities and are compatible with project resources are proposed in Chapter 6.

Table 2-1
Facility needs for 1987, 1995, 2005

FACILITY	EXISTING 1987	{----------NEEDS----------} 1987	1995	2005
Campsites	459	764	840	885
Parking Spaces (day-use)	1,325	1,633	1,812	1,914
Picnic Tables (day-use)	191	499	555	587
Boat Lanes	62	87	93	100
Water Surface Required for Water Skiing, Pleasure Boating, and Boat Fishing	15,600	6,000	6,700	7,000
Shore Fishing (shoreline feet)	150,000	91,400	101,500	107,200
Swimming (water acres)	14	6	7	7
Hiking Trails (trail feet)	5,000	24,000	26,500	28,000

2-08 REGIONAL WILDLIFE

The area is located in the northwest part of the East Texas Pineywoods. Typical vegetative cover types in the area are pine hardwood mixed stands, hardwood pine mixed stands, upland hardwood stands, bottomland hardwood stands, pine plantations, pasturelands and wetlands.

There are numerous resident species of mammals, reptiles, amphibians, and birds which inhabit the area. Many of the birds that can be found in this region are migrating through the area or spending the winter. A large number of these migrating and wintering birds concentrate along the Central Flyway which extends from Canada across the great plains to the Gulf of Mexico. Refer to Chapter 3-08 for a detailed description of wildlife resources at Lake O' the Pines.

project resource inventory and analysis
Chapter 3

CHAPTER 3
PROJECT RESOURCE INVENTORY AND ANALYSIS

3-01 INTRODUCTION

This section provides an inventory and analysis of the significant natural and cultural features of the project area, including climate, hydrology, geology, soils, water quality, wildlife resources, aquatic resources, recreational development, archeological and historical resources, and scenic and aesthetic resources. The information presented in this section was used to identify special resource opportunities of the project area, to determine the project's capability to help meet regional needs and desires identified in Chapter 2, and to identify factors that may influence and constrain existing and potential resource uses of the project area.

3-02 CLIMATE

Seasonal climatic variations strongly influence project visitor use pattern. The climate for Lake O' the Pines is characterized as warm, moist, humid and subtropical. It is an area of prevailing north and western air masses during late fall, winter and early spring and prevailing gulf air masses the rest of the year. Refer to Figure 3-1 for general climatological patterns in the vicinity of Lake O' the Pines.

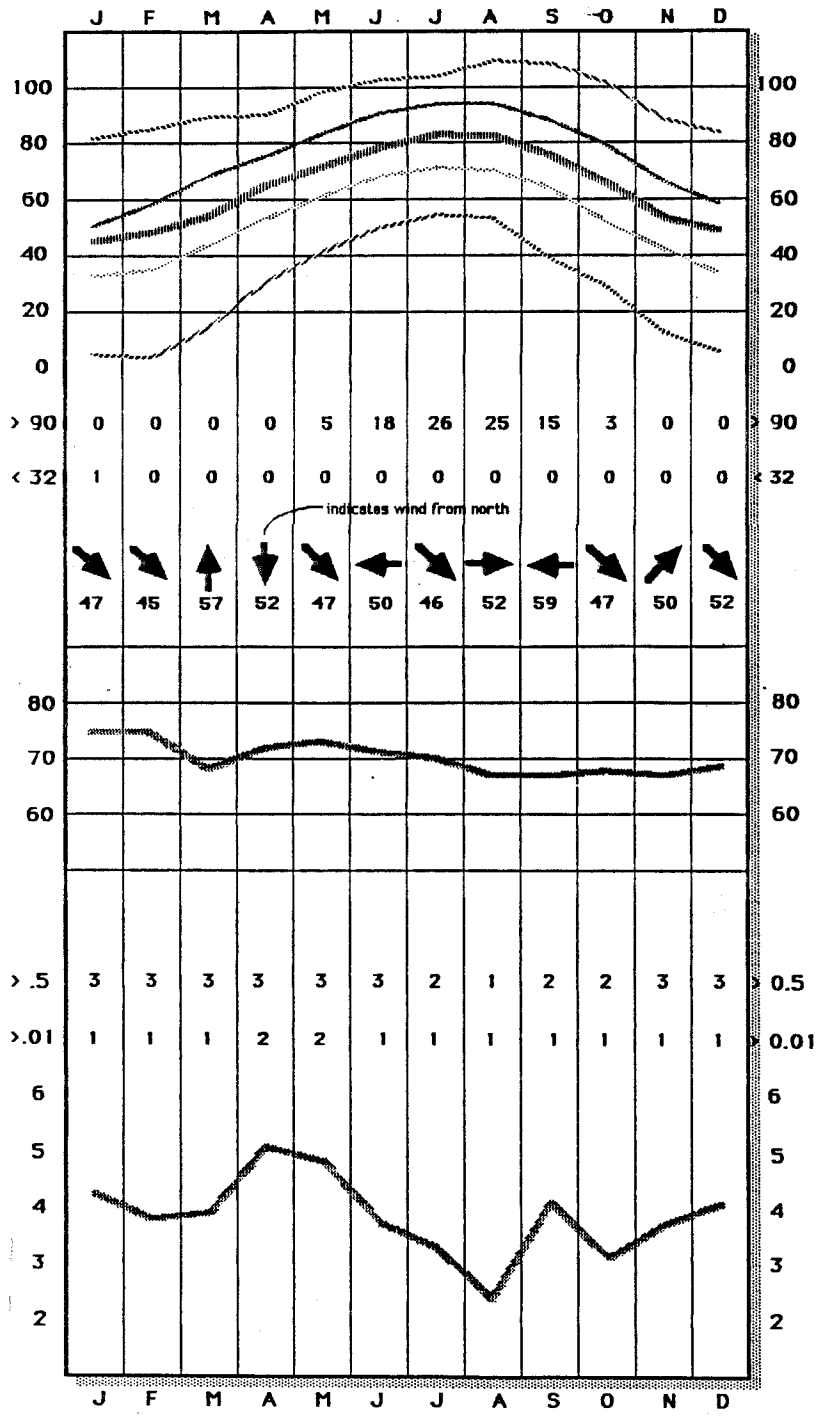
Since temperatures are usually relatively high (sometimes reaching 100 degrees F) during the summer months of July, August and September those park areas exposed to the southern breezes are cooler than those without exposure. Those parks and lands which are cooler during the summer tend to be those along the northern shorelines. Those parks and lands along the southern shorelines are generally well shaded by the canopy which tends to block southern breezes. During the winter months when northern winds prevail with temperatures occasionally drop into the teens the parks and lands along the north shores are generally more protected than the southern parks and lands.

The majority of the annual precipitation occurs during the months of April, May and June. Severe frontal-type storms are rare, but intense summer thunderstorms occur frequently, and occasionally deposit up to two inches of rain over broad areas.

During the hot summer months, in particular, there is high demand at Lake O' the Pines for water-related recreation activities, including sunbathing, boating, waterskiing and picnicking. On peak summer weekends the lake receives very heavy use for these activities. During the spring months boat and shoreline fishing is heaviest but continues strongly throughout the summer months.

CLIMATOLOGICAL DATA

Figure 3-1



TEMPERATURE

- maximum extreme
- maximum daily mean
- monthly mean
- minimum daily mean
- minimum extreme

maximum number of days above 90 degrees F

maximum nuber of days below 32 degrees F

MAXIMUM WIND VELOCITY AND DIRECTION

prevailing wind direction

max. wind speed mi/hr

%RELATIVE HUMIDITY

mean relative humidity

PRECIPITATION

number of days with precip. over 0.5 inches

number of days with precip. over 0.01 inches

mean precipitation in inches

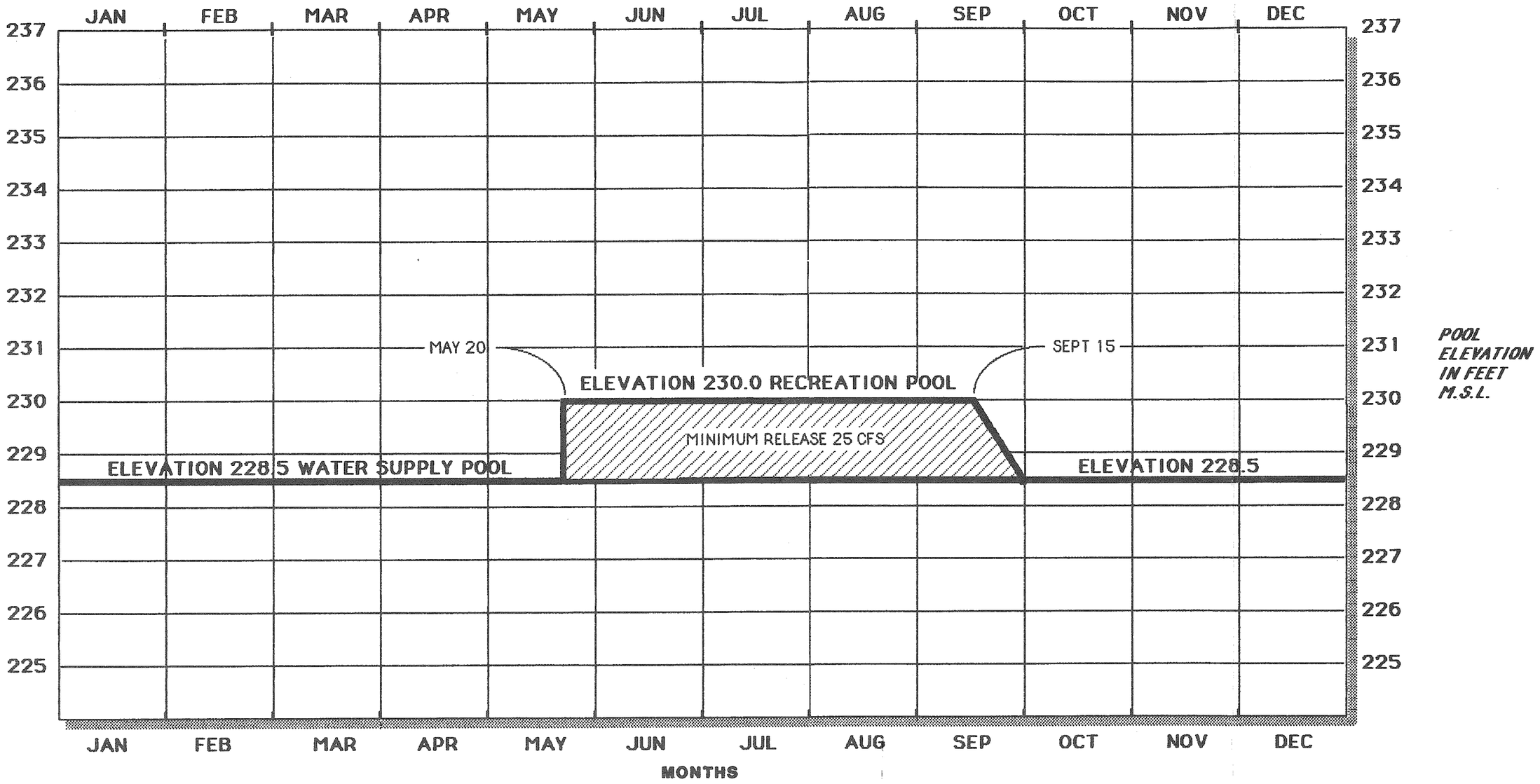
Temperature and Precipitation from 1951-80 Normals, Marshall, Texas.
Relative Humidity from Monthly Weather Review and Climatological Data National Summary through 1962.
Maximum Wind Velocity and Direction from 90 years of record, ending 1972, Shreveport, Texas.

3-03 HYDROLOGY

Water Control Schedule. In order to serve its authorized purposes, the reservoir is operated in accordance with its rule curve. The rule curve is the pool elevation which may not be exceeded at any time except for the storage of flood water inflows in excess of allowable releases. Pool elevations below the rule curve indicate that releases are not to exceed the lower water release except for mosquito control operation. The operating rule curve, Figure 3-2, to be used in the regulation of Lake O' the Pines, is fixed at 230.0 ft. N.G.V.D. between 20 May and 15 September and is lowered to 228.5 ft. N.G.V.D. between 1 October and 20 May. The period between 15 September and 1 October is generally a drawdown period. When the pool is between 228.5 and 230.0 feet m.s.l. a minimum flow of 25 cfs is released to provide low water flow in the downstream channel.

During 1 May through 31 October and when stages in the reservoir are below the rule curve, releases in excess of low water releases for mosquito control take precedence over the rule curve for reservoir regulation. At this time releases may be made in excess of the applicable minimum flow but not at a rate that lowers the lake level by more than 0.2 feet in any 10 day period. Should the pool level fall to the bottom of conservation pool elevation (201 feet N.G.V.D.) during the periods of low flow, the water supply withdrawals will cease. Whenever stages exceed the rule curve, the lower portion of the flood control storage is used for controlling releases such that when combined with controlled flows below the dam, they do not exceed the channel capacities of 3,000 cfs on the Big Cypress Creek near Jefferson and 7,000 cfs on the Big Cypress Creek near Karnack. Once the lake level exceeds 236.00 feet N.G.V.D., a release rate of 3,000 cfs is followed.

While this rule curve can be followed during most years and does provide conditions nearly ideal for the many purposes which the project must serve, there are times when inflows into the reservoir are such that the rule curve cannot be followed. In times of floods, the reservoir level must rise above the rule curve. During critical periods of major floods for which stages at Shreveport, Louisiana are predicted to peak at or above 32 feet gage height, special instructions will be issued and the release will be reduced to low water flow for a period of time necessary to minimize the duration of stages above 31 feet at Shreveport. In periods of drought, the reservoir must be drawn below the rule curve in order to provide flows downstream for water quality control.



LAKE O' THE PINES

OPERATING RULE CURVE

Figure 3-2

While the reservoir will reach these extremes only on rare occasions, it will depart from the rule curve to a lesser degree at more frequent intervals as the inflow varies from normal. Extreme fluctuations since operation at Lake O' The Pines began in 1961 are as follows:

LOW		HIGH	
Nov 1963	226.55	May 1966	245.50
Oct 1984	226.00	Jan 1988	238.94

Table 3-1 and Figure 3-2 present pool elevation frequency data for the Interim Plan of Regulation for Lake O' the Pines in tabular and graphical forms, respectively. The data indicate that there is a 50 percent chance of the elevation 231.2 feet N.G.V.D. being exceeded in any given year. Traditionally, elevation 231.2 feet N.G.V.D. would have been presented as being the two-year maximum water surface, i.e. over a very long time period one would expect this elevation to be exceeded on the average of once per two years.

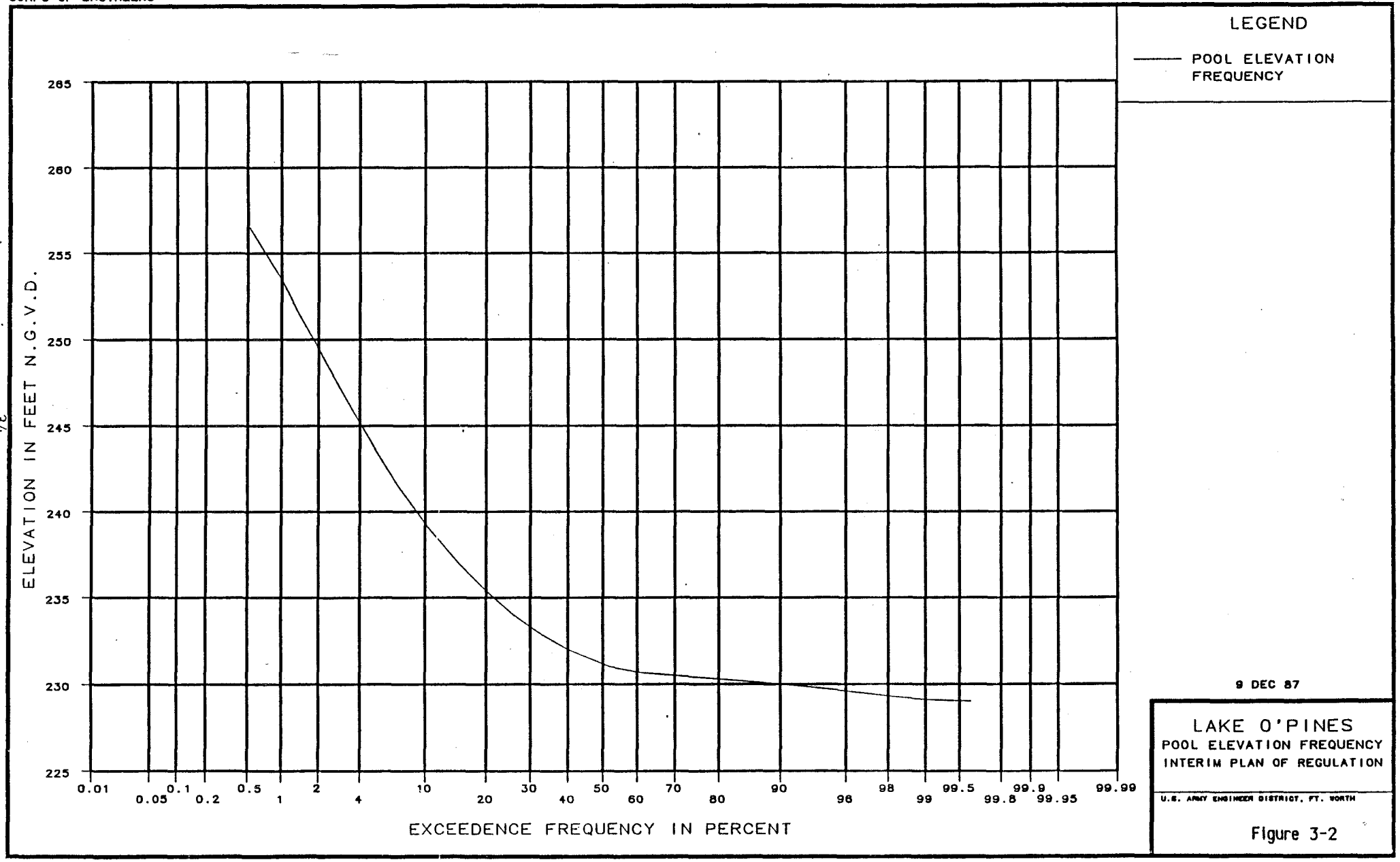
Table 3-1
Lake O' the Pines
Interim Plan of Regulation
Pool Elevation Frequency

Exceedance Frequency in Percent Per Year	Elevation	Traditional Exceedance Frequency in Years
50	231.2	2
20	235.4	5
10	239.3	10
2	249.5	50
1	253.5	100

Based on the pool elevation frequency data the following elevations have been set to quide future development. The minimum elevation for permanent concession buildings is 248.0, minimum elevation for portable concession buildings is 236.0, and the minimum elevation of structures for human habitation is 254.5.

CORPS OF ENGINEERS

U.S. ARMY



9 DEC 87

LAKE O'PINES
POOL ELEVATION FREQUENCY
INTERIM PLAN OF REGULATION

U.S. ARMY ENGINEER DISTRICT, FT. WORTH

Figure 3-2

3-04 GEOLOGY

a. Reservoir Physiography. Lake O' the Pines is situated in the West Gulf Coastal Plain section of the Coastal Plain physiographic province. This province is characteristically flat to rolling and slopes gently from the Ouachita Mountains on the north to the Gulf of Mexico to the south. The land surface has developed upon a sequence of sedimentary rock units which dip slightly more steeply toward the Gulf than the land surface, resulting in successively younger formations cropping out gulfward. The geologic age of these rock units ranges from Early Cretaceous to Quaternary (Recent Epoch). The various geologic formations and groups have distinctive soil, vegetation, and erosional characteristics which are the basis for further physiographic classification. Lake O' the Pines lies within the East Texas Timber Belt which consists of sandy, wooded, hilly, terrain developed on formations of Eocene (Early Tertiary) age. The lake is founded in the outcrop belt of the Queen City Formation. Outliers or remnants of the overlying Weches Formation form low hills called the Weches Ironstone Hills. They occur in upland areas in the upstream reaches and on the north side of the lake.

b. Reservoir Geology.

1. Stratigraphy. Lake O' the Pines lies entirely within the outcrop belt of the Queen City Formation. In the upstream end of the lake and on the north side of the lake, hills supported by the erosional resistant Weches Formation which overlies the Queen City Formation, occupy the upland areas. The higher hills are capped by sands of the Sparta Formation. The shoreline of the lake is predominantly Queen City sand on the north shore and predominantly Quaternary alluvium on the south side. Quaternary alluvium is exposed along the shoreline at Cedar Springs Park, Copeland Creek Ramp, and Pine Hill Ramp on the south side of the lake, and at Oak Valley park on the north side. Quaternary alluvium is also exposed in the upper reaches of major tributaries on both sides of the lake. Fluviatile terrace deposits occur at Highway 155 crossing on the north side of the lake. A description of the formations from oldest to youngest exposed in the lake area follows:

The Queen City Formation is composed of fine-grained quartz sand varying in color from light to brownish gray. It is locally carbonaceous, contains clay, and is slightly lignitic. Locally, it contains beds of glauconite, quartz green sand, and cross bedding. The thickness ranges from 100 to 400 feet.

The Weches Formation consists of glauconite and quartz sand with clay interbeds. The sand is grayish green to grayish olive green, thin bedded, locally cross-bedded, and weathers to a dark reddish brown. Locally, it forms limonitic and siderotic iron ore and clay iron stone concretions.

The Sparta sand which caps the Ironstone Hills north and northeast of the lake is composed of fine to medium-grained sand. The Formation is massive, slightly cohesive, due to its silt and clay content, locally cross-bedded and contains clay interbeds which are abundant in the upper part. The thickness is about 170 feet.

Fluviatile Terrace deposits consist of only one relatively small area on the north side of the lake at the Highway 155 crossing, a vestige of an older (Pleistocene) floodplain level. Materials consist of sand, silt, clay, and gravel. The thickness is about 50 feet.

Quaternary alluvium occupies the floodplain of Big Cypress Bayou and its tributaries. Most of the alluvium in the floodplain is covered by the lake. The alluvial material is of Recent age and typically consists of sand, silt, and clay.

2. **Structure.** Lake O' the Pines lies on the northwestern limb of the Sabine uplift, a relatively flat-topped structural high, centered near the Sabine River at the Texas-Louisiana boundary. The Sabine uplift breaks the characteristic gulfward dip of the Gulf Coastal Plain strata creating the Pittsburgh Syncline to the north of the uplift and Tyler Basin to the west. At Lake O' the Pines, strata dip at about 40 feet per mile to the northwest into the Pittsburgh Syncline. the axis of the syncline which is the eastward extension of the Tyler basin, lies about 15 miles northwest of the lake. No faulting has been delineated in the immediate vicinity of the lake.

3. **Ground Water.** The principal source of ground water in the lake area is the Cypress aquifer. The aquifer consists of four hydraulically connected units which, in ascending order are: the Wilcox Group, the Carrizo Sand, the Reklaw Formation, and the Queen City Sand. Cypress aquifer wells in the immediate vicinity of the lake tap the Queen City Sand at a depth of 200 to 300 feet. Other wells draw from the Wilcox portion of the aquifer at depths of 500 to 700 feet. The aquifer is underlain by the Midway Group composed of calcareous clay and limestone which yield no water. The maximum stratigraphic thickness of the aquifer is about 1,200 feet, but in the lake area the top of the Midway is reached at depths ranging from 781 feet in the upstream end of the lake to 1,012 feet near the dam. The altitude of aquifer water levels ranged from 225 to 235 in 1967 and are about the same at the present time.

One shallow large diameter well in the Queen City Sand provides drinking water for Oak Valley Park. All of the rest of Corps of Engineer parks are connected to public water supply systems.

The Weches Formation overlies the Queen City and occurs as scattered outliers, mainly to the northeast of the lake. The Weches is about 60 feet thick and locally yields small quantities of ground water to shallow domestic wells. The Sparta Sand overlies the Weches and caps some of the higher ridges in the same area. Seldom more than 50 feet thick, the Sparta also yields small quantities of ground water to shallow domestic wells.

4. Economic Geology.

(a) Oil and Gas. The only oil or gas fields known to partially impinge on the lake area are situated south of the lake, near the dam site in Marion and Harrison Counties, and on the north side of the lake between Johnson Creek and Mims Chapel ramp. The Whelan field covers a broad area which includes Harleton in Harrison County, extending to the south shore of the lake. Active discoveries in this field were made from 1956 to 1967. Smaller field discoveries within this area include the Oney, in 1971, the Ben-Gene, in 1969, the Trae, in 1973 and 1975, and the Davidson Chapel, in 1961. On the north side of the lake, the Lake Ferrell oil field, discovered in 1957, is situated near the lake shoreline between Johnson Creek and Mims Chapel ramp. These fields were all in production at the end of 1985.

(b) Iron Ore. Iron ore has been extensively mined from the upper half of the Weches Formation and used in the manufacture of oil-related tubular steel products at the Lone Star Steel plant situated immediately upstream from the lake. The open-pit mines were situated in southern Cass and Morris Counties.

(c) Lignite. Thin seams (15 inches) of lignite occur near Ellison Lake immediately upstream from Lake O' the Pines. However, no minable deposits are known in the lake area.

(d) Clay. Various types of clay occur over a broad area of east Texas, with brick clay occurring most commonly. Deposits of common brick and structural clays occur near the lake, but no mining operations exist.

(e) Sand. Sand is also a common occurrence in east Texas. Although extensive sand deposits are present near the lake, there are no mining operations in the area.

5. Soils. Soils developed on the upland areas on the Queen City Formation in the lake area are designated the Bowie-Cuthbert-Kirvin Soil Association, defined as undulating to rolling soils with loamy, sandy, or gravelly surface layers, and reddish mottled clayey or loamy subsoils. They are typically acid throughout and are low in plant nutrients.

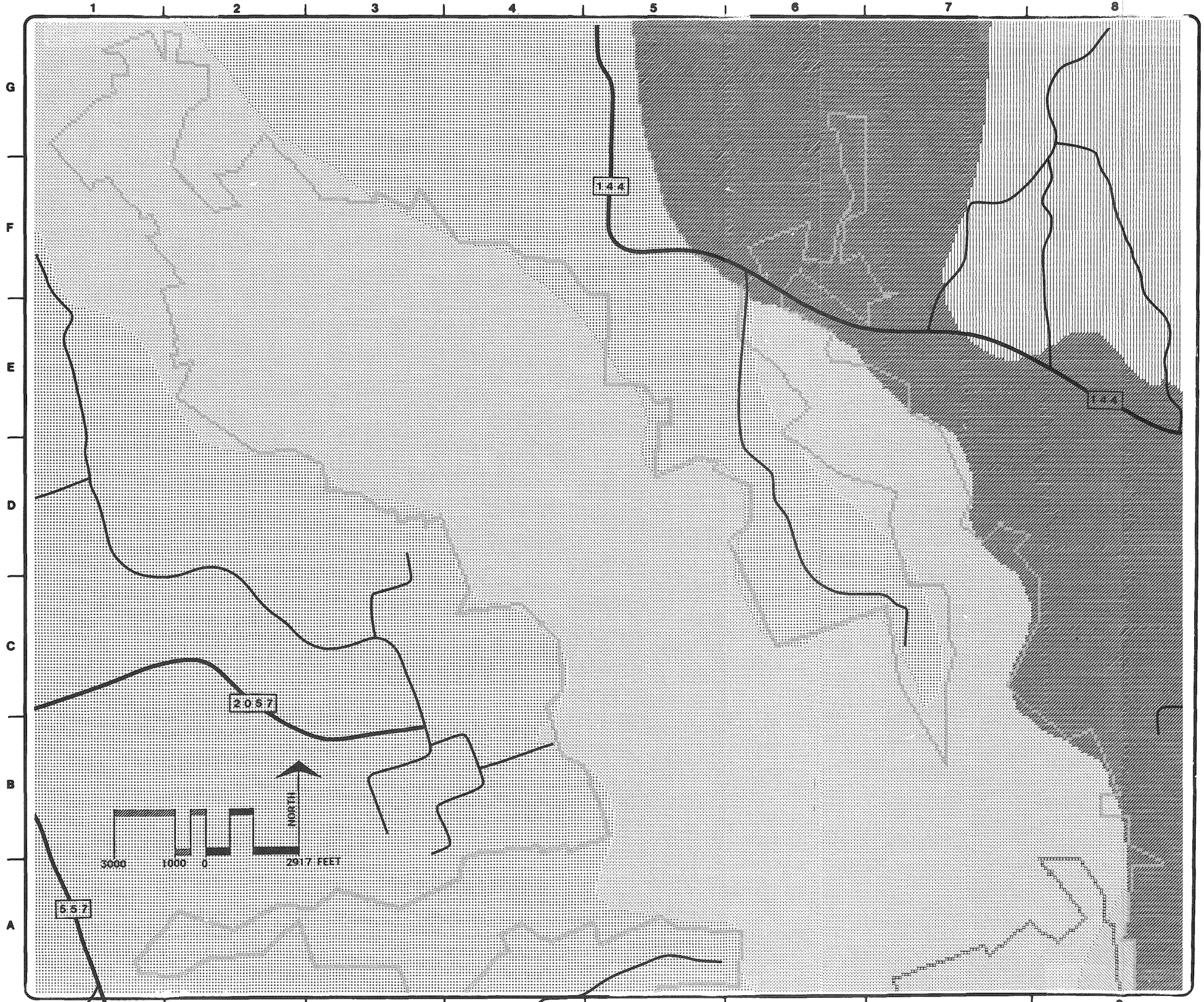
Soils developed in the upland areas on the Queen City Formation, Weches Formation, and Sparta Sand are designated the Cuthbert-Redsprings-Tenaha Association. Cuthbert soils are developed on the moderately sloping Queen city Formation, Redsprings soils on the Weches Formation, and Tenaha soils on the Sparta Sand.

3-05 SOILS

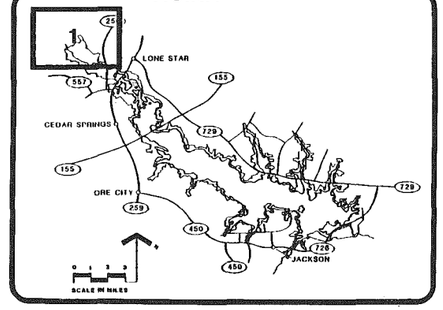
The Soil Conservation Service plans on publishing a modern soil survey by 1995 for Marion County, 1989 for Morris and Camp County and 1991 for Harrison County. A modern soil survey has been published for Upshur County. When available this set of modern soil surveys will be useful in assessing soil capabilities or limitations for specific project uses. Since detailed soil information is lacking for the majority of the project a general soil association map was compiled (Plate Sequence 3-1) using maps and descriptions supplied by the Soil Conservation Service. The soils have been grouped into soils of uplands, terraces and bottomlands. Each of the soil associations are described below.

a. Soils of Uplands.

1. **Bowie-Cuthbert Kirvin association.** Gently sloping to steep, well drained and moderately well drained loamy and gravelly soils on uplands. This is an area of slowly and moderately slowly permeable acid soils. Bowie soils have a brown friable, fine sandy loam surface layer about 6 inches thick. The subsurface layer, which extends to a depth of 12 inches, is brown fine sandy loam. The subsoil, to a depth of 72 inches, is sandy clay loam that is yellowish brown mottled with red in the upper part and light brownish gray in the lower part. Cuthbert soils have friable brown, fine sandy loam surface layers about 8 inches thick. The subsoil, which extends to a depth of 36 inches, is red clay with brownish mottles and gray shale fragments in the lower part. the underlying layer, to a depth of 60 inches, is reddish and yellowish fine sandy loam and grayish shale. Kirvin soils have friable brown, gravelly fine sandy loam surface layers about 10 inches thick. The upper part of the subsoil, to a depth of 42 inches, is red clay with brownish mottles. The lower part, to a depth of 57 inches, is mottled reddish, brownish, and grayish clay loam. The underlying layer, to a depth of 65 inches, is stratified shaly clay and sandy clay loam. Bowie soils make up about 32 percent of the association. Cuthbert soils 30 percent and Kirvin soils 15 percent. The remaining 23 percent is made up of soils that are sandy or in narrow loamy flood plains. Most of this association is used for pasture and woodland. Some areas are truck cropped.



VICINITY MAP



LEGEND

SOIL ASSOCIATIONS

UPLAND SOILS

- BOWIE-CUTHBERT-KIRVIN
- CUTHBERT-REDSPRINGS
- CUTHBERT-TENAHA
- DARCO-FUQUAY

TERRACE SOILS

- MOLLYVILLE-LATCH
- CHIPLEY-TUCKERMAN

BOTTOMLAND SOILS

- MATACHIE-IUKA
- NAHATCHE-THENAS

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROAD

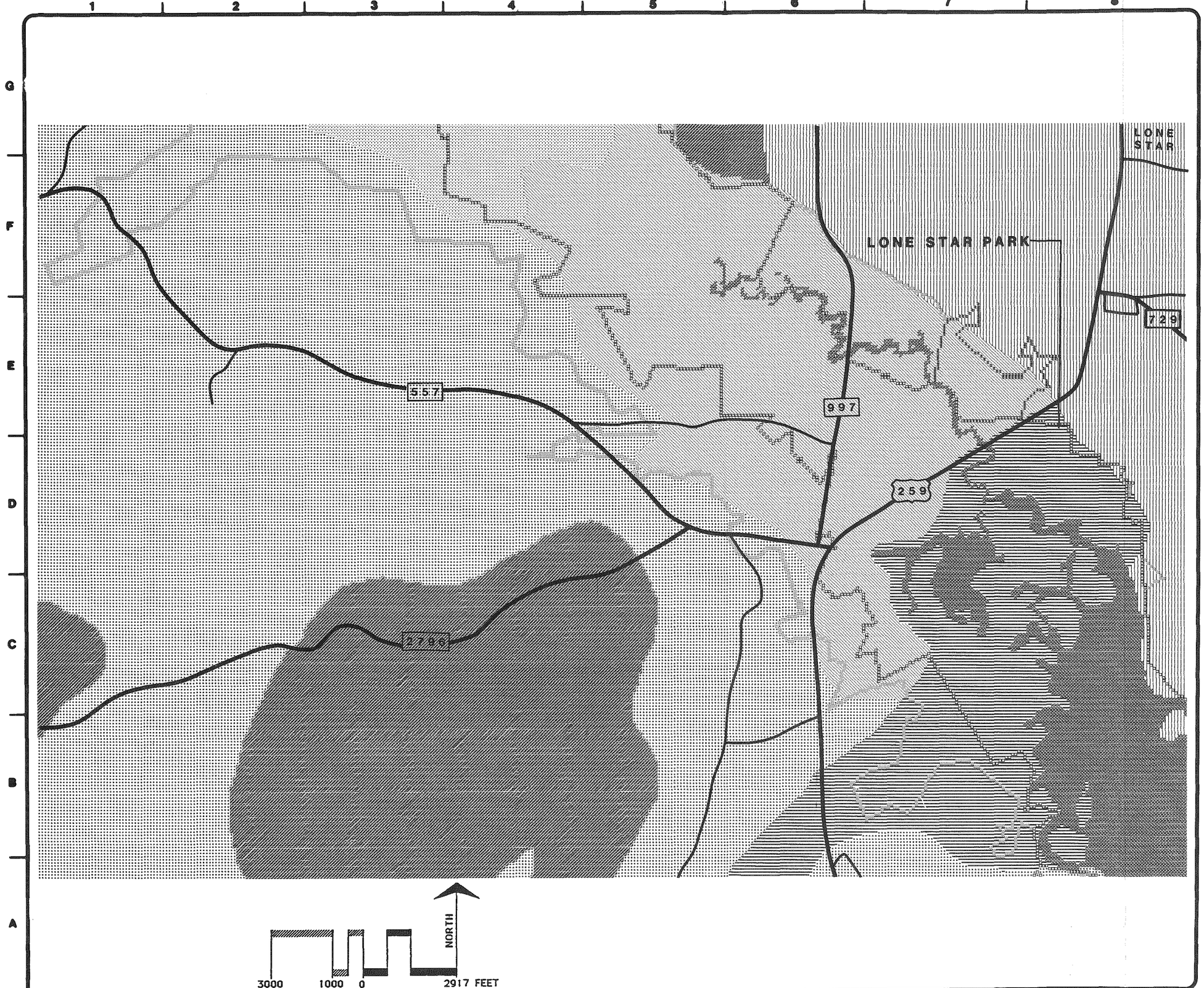
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

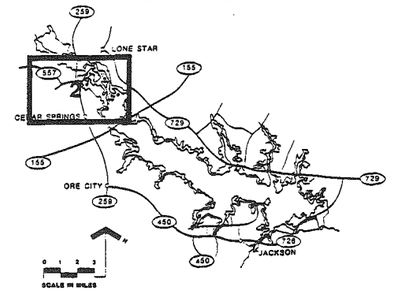
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

GENERAL SOIL MAP

INVITATION NO.	DATE:
CONTRACT NO.	SHEET NO. 1 OF 7
DRAWING NUMBER	SEQUENCE NO. 3-20-1



VICINITY MAP



LEGEND

SOIL ASSOCIATIONS

UPLAND SOILS

- BOWIE-CUTHBERT-KIRVIN
- CUTHBERT-REDSPRINGS
- CUTHBERT-TENAHA
- DARCO-FUQUAY

TERRACE SOILS

- MOLLYVILLE-LATCH
- CHIPLEY-TUCKERMAN

BOTTOMLAND SOILS

- MATACHIE-IUKA
- NAHATCHE-THENAS

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROAD

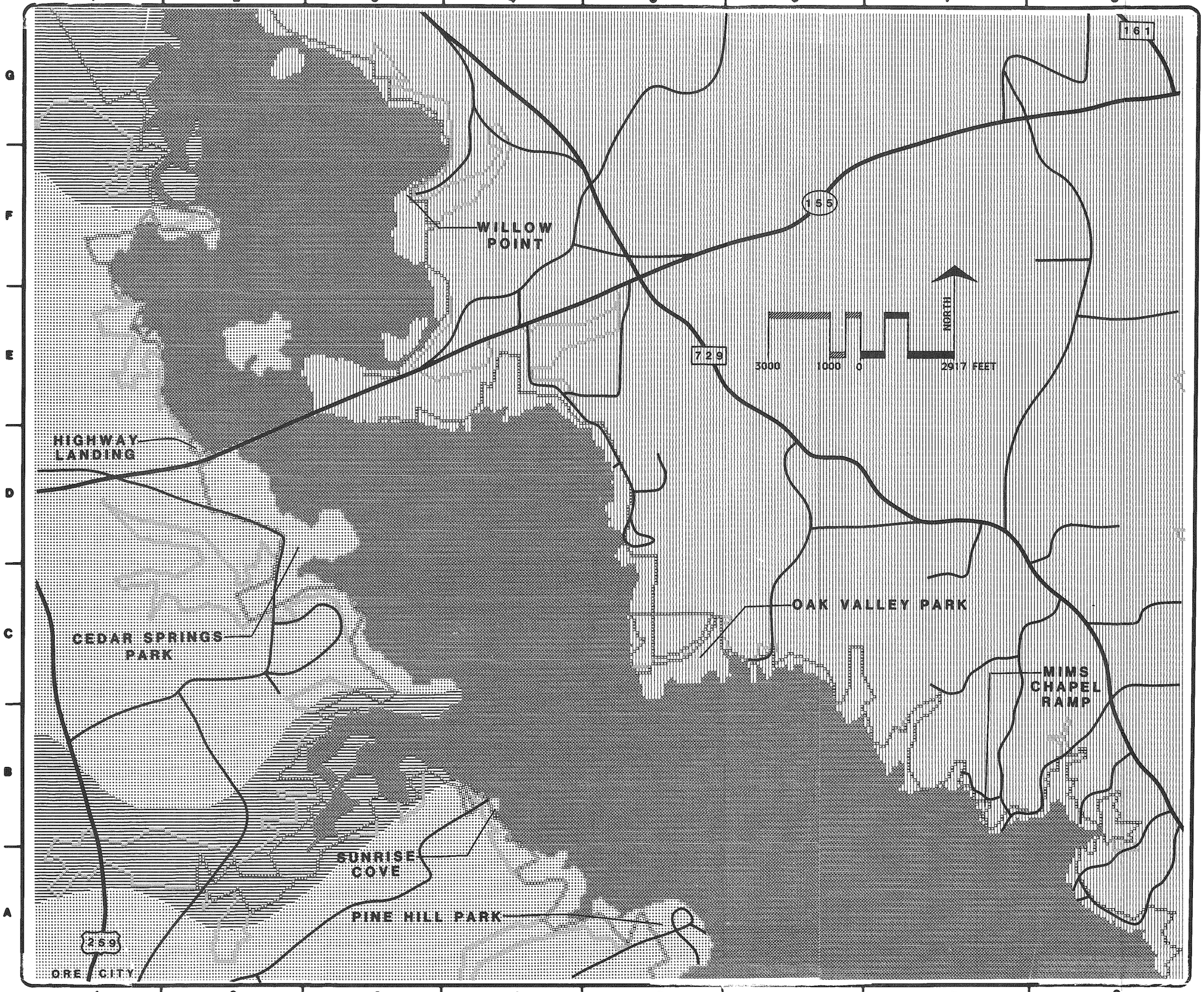
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

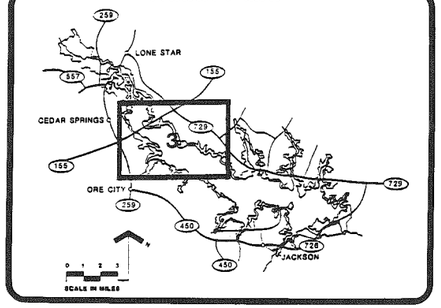
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

GENERAL SOIL MAP

INVITATION NO. | DATE:
CONTRACT NO. | SHEET NO. 2 of 7 | DRAWING NO. 3-1
DRAWING NUMBER



VICINITY MAP



LEGEND

SOIL ASSOCIATIONS

UPLAND SOILS

- BOWIE-CUTHBERT-KIRVIN
- CUTHBERT-REDSPRINGS
- CUTHBERT-TENAHA
- DARCO-FUQUAY

TERRACE SOILS

- MOLLYVILLE-LATCH
- CHIPLEY-TUCKERMAN

BOTTOMLAND SOILS

- MATACHIE-IUKA
- NAHATCHE-THENAS

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROAD

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

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

LAKE O' THE PINES
CYPRESS RIVER, TEXAS

GENERAL SOIL MAP

INVITATION NO.
DATE:
CONTRACT NO.
SHEET NO. 3 of 7
DRAWING NUMBER
NO. 3-1

PINE HILL PARK

POP'S LANDING RAMP

ALLEY CREEK PARK

COPELAND CREEK PARK

WOODIE'S RAMP

450

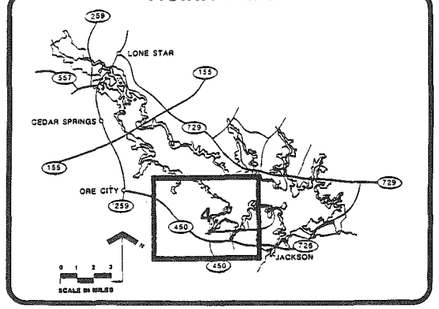
726

1968

3000 1000 0 2917 FEET

NORTH

VICINITY MAP



LEGEND

SOIL ASSOCIATIONS

UPLAND SOILS

- BOWIE-CUTHBERT-KIRVIN
- CUTHBERT-REDSPRINGS
- CUTHBERT-TENAHA
- DARCO-FUQUAY

TERRACE SOILS

- MOLLYVILLE-LATCH
- CHIPLEY-TUCKERMAN

BOTTOMLAND SOILS

- MATACHIE-IUKA
- NAHATCHE-THENAS

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROAD

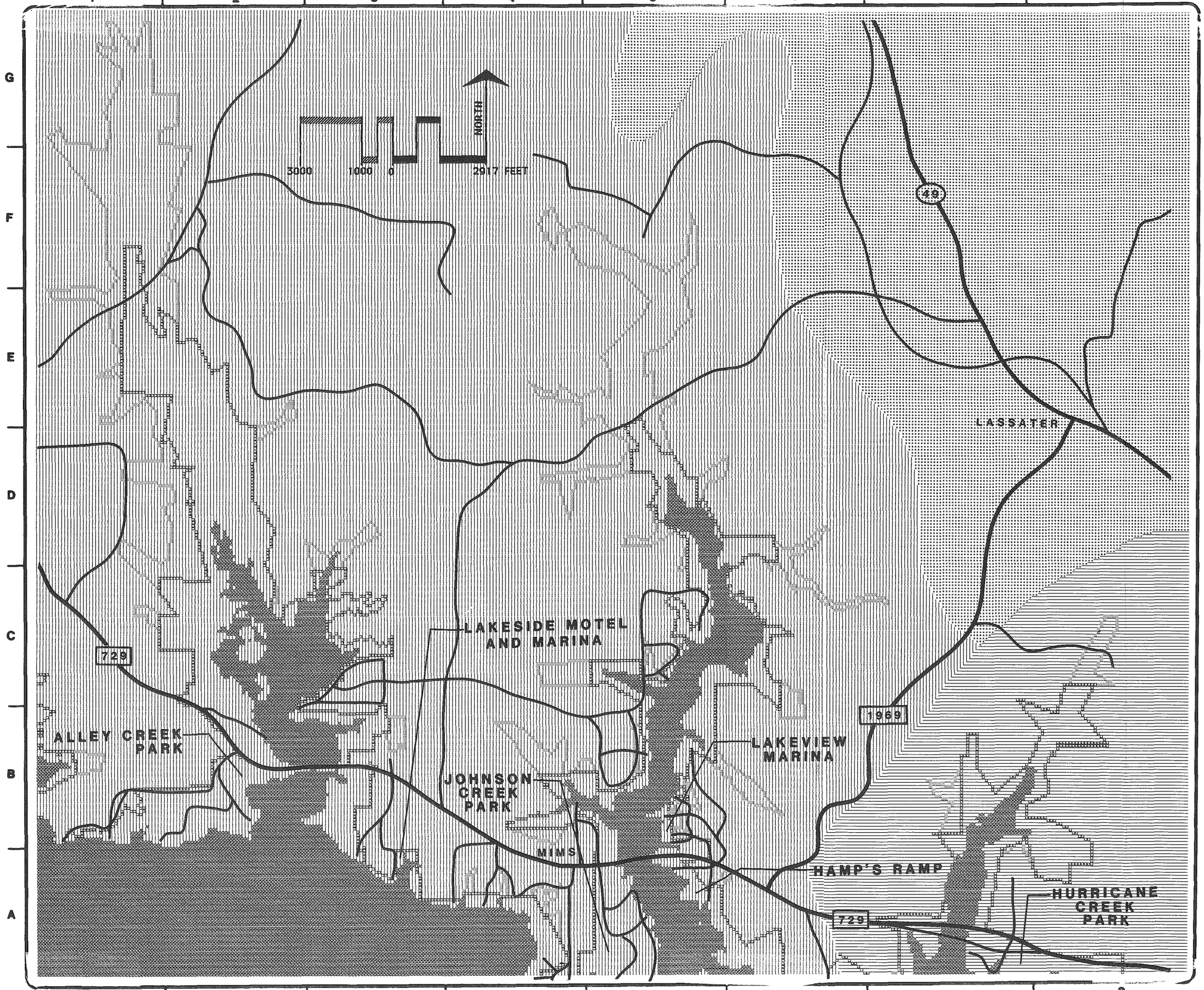
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

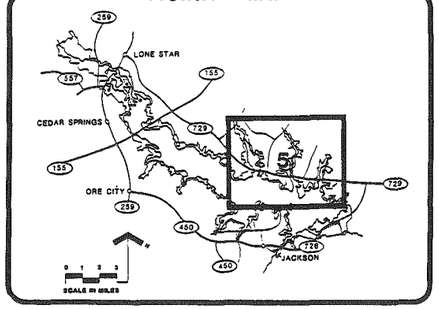
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

GENERAL SOIL MAP

INVITATION NO. | DATE:
CONTRACT NO. | SHEET NO. 4 OF 7 | SEQUENCE NO. 3-2-1
DRAWING NUMBER



VICINITY MAP



LEGEND

SOIL ASSOCIATIONS

UPLAND SOILS

- BOWIE-CUTHBERT-KIRVIN
- CUTHBERT-REDSPRINGS
- CUTHBERT-TENAHA
- DARCO-FUQUAY

TERRACE SOILS

- MOLLYVILLE-LATCH
- CHIPLEY-TUCKERMAN

BOTTOMLAND SOILS

- MATACHIE-IUKA
- NAHATCHE-THENAS

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROAD

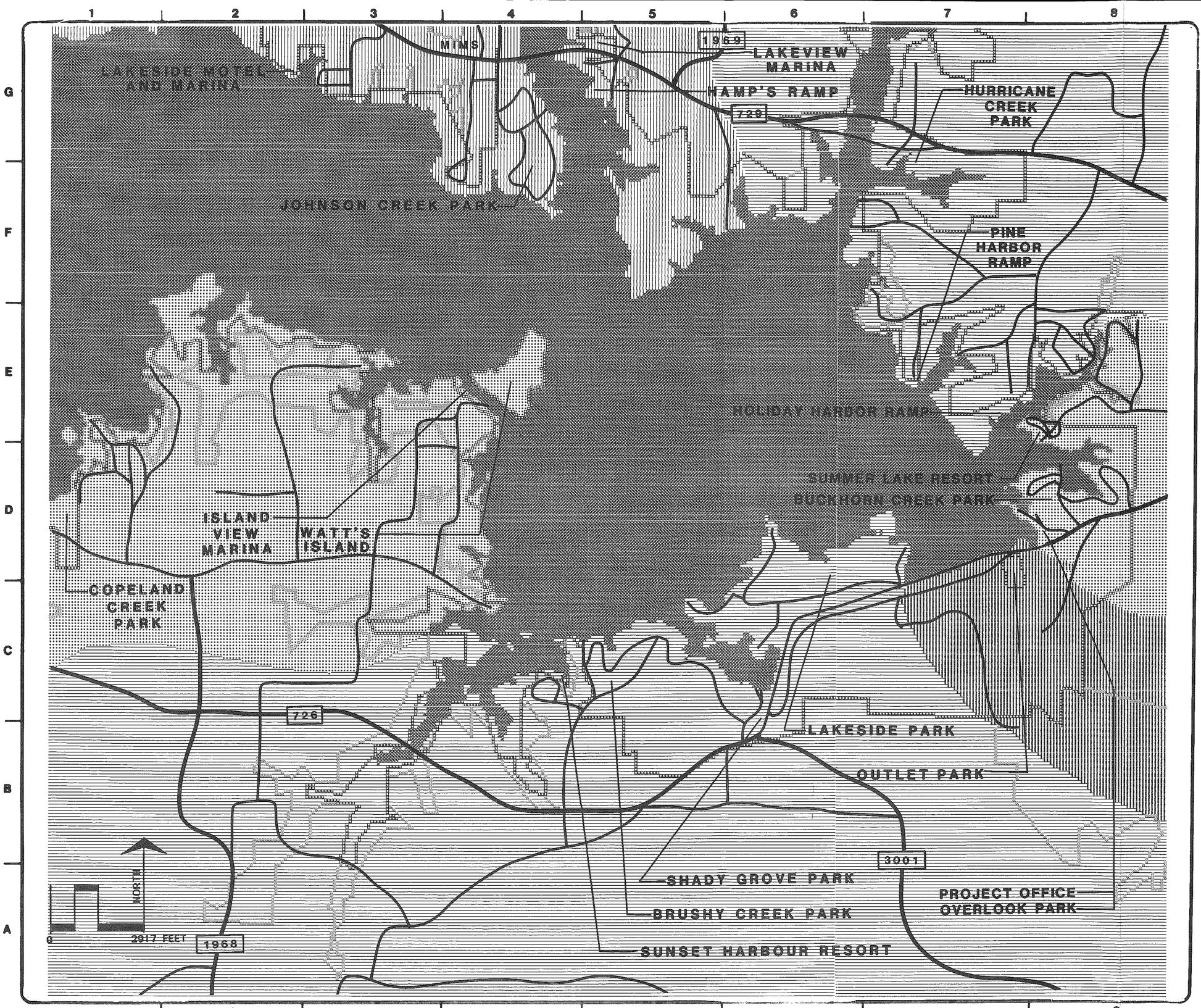
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

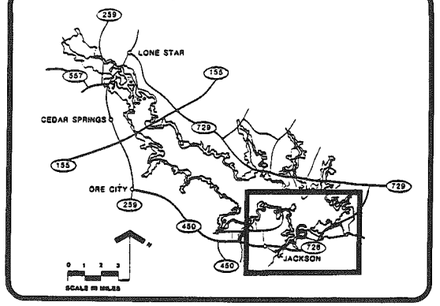
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

GENERAL SOIL MAP

INVITATION NO.
DATE:
CONTRACT NO.
SHEET NO. 5 OF 7
SEQUENCE NO. 3-1
DRAWING NUMBER



VICINITY MAP



LEGEND

SOIL ASSOCIATIONS

UPLAND SOILS

- BOWIE-CUTHBERT-KIRVIN
- CUTHBERT-REDSPRINGS
- CUTHBERT-TENAHA
- DARCO-FUQUAY

TERRACE SOILS

- MOLLYVILLE-LATCH
- CHIPLEY-TUCKERMAN

BOTTOMLAND SOILS

- MATACHIE-IUKA
- NAHATCHE-THENAS

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROAD

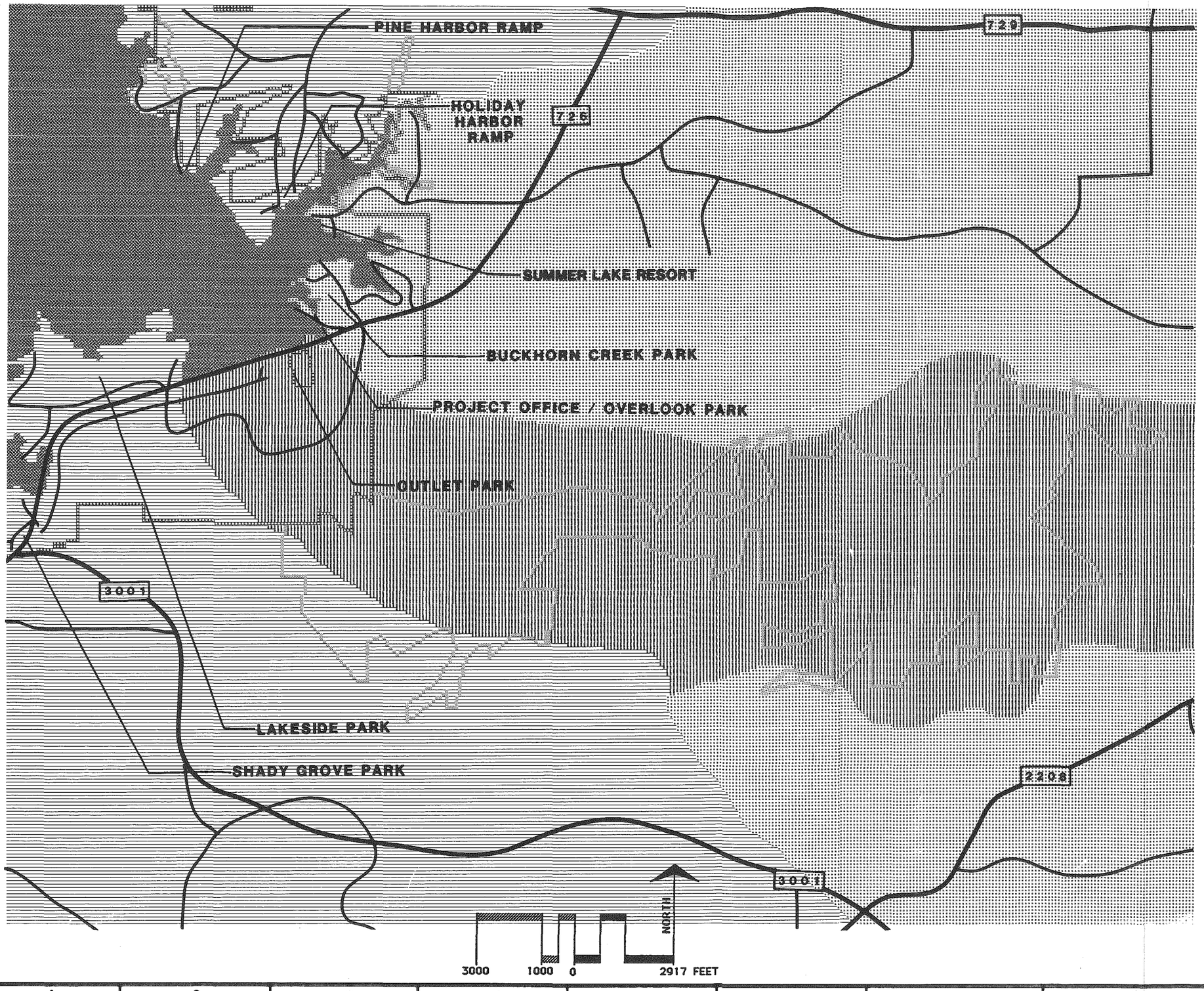
U. S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

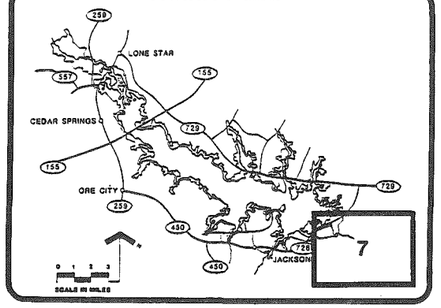
LAKE O' THE PINES
CYPRESS RIVER, TEXAS

GENERAL SOIL MAP

INVITATION NO.	DATE:
CONTRACT NO.	SHEET NO. 6 OF 7
DRAWING NUMBER	SEQUENCE NO. 3-1



VICINITY MAP



LEGEND

SOIL ASSOCIATIONS

UPLAND SOILS

- BOWIE-CUTHBERT-KIRVIN
- CUTHBERT-REDSPRINGS
- CUTHBERT-TENAHA
- DARCO-FUQUAY

TERRACE SOILS

- MOLLYVILLE-LATCH
- CHIPLEY-TUCKERMAN

BOTTOMLAND SOILS

- MATACHIE-IUKA
- NAHATCHE-THENAS

- FEE BOUNDARY
- FLOWAGE EASEMENT BOUNDARY
- PERMIT TO FLOOD BOUNDARY
- ROAD

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

DESIGNED BY:
DRAWN BY:
REVIEWED BY:

LAKE O' THE PINES
CYPRESS RIVER, TEXAS

GENERAL SOIL MAP

INVITATION NO. | DATE:
CONTRACT NO. | SHEET NO. 7 of 7 | DRAWING NO. 3-321
DRAWING NUMBER

2. Cuthbert-Redsprings association. Strongly sloping to steep, well drained, gravelly soils; on uplands. This is an area of moderately slowly permeable, hilly, acid soils. Cuthbert soils have a friable brownish gravelly fine sandy loam surface layer about 16 inches thick. The subsoil, to a depth of 38 inches, is yellowish red clay. The underlying material, to a depth of 60 inches, is yellowish brown, weathered glauconite. Cuthbert soils make up about 37 percent of the association and Redsprings soils make up about 30 percent. The remaining 33 percent is made up of soils that are less sloping or are sandy. Most of this association is used for woodland or wildlife habitat. A few areas are in pasture.

3. Cuthbert-Tenaha association. Well drained. Moderately slowly and moderately permeable,loamy and sandy soils with clayey and loamy subsoils. This is an area of gently rolling to hilly upland soils used mainly for woodland and pasture. Cuthbert soils make up about 60 percent of the association. They are sloping to moderately steep, well drained and moderately slowly permeable soils. They have a very dark gray and brown, strongly acid, fine sandy loam surface layer about 8 inches thick that contains pebbles and coarse fragments of ironstone. The next layer is a dark red and red, very strongly acid, clay about 22 inches thick. The next lower layer is stratified red, strong brown and grayish brown, extremely acid, soft sandstone and shale. Tenaha soils make up about 30 percent of the association. They are sloping to moderately steep, well drained and moderately permeable. Tenaha soils have a very dark grayish brown to light yellowish brown, medium acid, loamy fine sand surface layer 20-40 inches thick. The next layer is a red to yellowish red, very strongly acid, sandy clay loam about 13 inches thick. The next lower layer is soft sandstone. The remaining 10 percent of the association consist of soils that are deeper and are gently undulating.

4. Darco-Fuquay association. Somewhat excessively and well drained, moderately rapidly drained and moderately permeable sandy soils with loamy subsoils. This is an area of gently undulating to rolling soils used mainly for pasture and woodland with smaller acreage used for cropland. Darco soils make up about 55 percent of the association. They are gently sloping to strongly sloping, somewhat excessively drained and moderately rapidly permeable. These soils have a brown to yellowish brown, medium acid loamy fine sand surface layer 40 to 72 inches thick. The next layer is a red, very strongly acid, sandy clay loam. Fuquay soils make up about 25 percent of the association. They are gently sloping, well drained and moderately permeable. They have a grayish brown, strongly acid, loamy fine sand surface layer 20-40 inches thick. The next layer is a yellowish brown, strongly acid, sandy clay loam about 12 inches thick. The next lower layer is a mottled strong brown, yellowish red and gray strongly acid sandy clay loam several feet thick. The remaining 20 percent of the association is composed of loamy and clayey soils that are less permeable.

b. Soils of Terraces

1. Mollville-Latch unit. Nearly level, poorly drained and moderately well drained, loamy and sandy soils on stream terraces. This is an area of slowly and moderately permeable acid soils. Mollville soils have a friable dark grayish brown and grayish brown very fine sandy loam surface layer about 8 inches thick. The upper part of the subsoil, to a depth of 27 inches, is grayish brown sandy clay loam with brownish mottles, tongues, and streaks of grayish loam. The lower part of the subsoil, to a depth of 55 inches, is light brownish gray sandy clay loam with brownish and light gray mottles. Below this, to a depth of 67 inches, is light gray loamy fine sand. Latch soils have a loose dark grayish brown loamy fine sandy surface layer about 8 inches thick. Below this, to a depth of 52 inches, is brown and pale brown loamy fine sand. The subsoil, to a depth of 62 inches, is light brownish gray sandy clay loam with brownish and reddish mottles. Below this, to a depth of 80 inches, is light gray and very pale brown sand. Mollville soils make up about 36 percent of the association and latch soils make up about 32 percent. The remaining 32 percent is made up of soils that differ mainly in being either well drained, very slowly permeable or on flood plains. Most areas of this association are in woodland. Some areas are used for pasture.

2. Chipley-Tuckerman association. Moderately well and poorly drained, rapidly and slowly permeable soils. This is an area of nearly level to gently undulating moundy soils used for woodland and pasture. Chipley soils make up about 50 per cent of the association. They are nearly level to gently undulating, moderately well drained, rapidly permeable soils occupying mounds or low narrow ridges. They have a very dark gray to dark gray, strongly acid, sand or loamy sand surface about 6 inches thick. The next layer is a light yellowish brown to brownish yellow, strongly acid, fine sand or loamy sand mottled with light gray in the lower part. This layer is 39 to 49 inches thick. The next lower layer is a light gray, strongly acid, fine sand or loamy sand. Tuckeman soils make up about 40 percent of the association. They are nearly level, poorly drained, slowly permeable soils occupying intermound areas. They have a dark grayish brown, strongly acid, fine sandy loam surface layer about 10 inches thick. The next layer is a gray, strongly acid, sandy clay loam with yellowish brown mottles about 24 inches thick. The next lower layer is a gray, strongly acid, fine sandy loam to sandy clay loam. The remaining 10 percent of the association consists of soils that have dense clay subsoils.

c. Soils of Bottomlands

1. Mantachie-Luka association. Nearly level, somewhat poorly drained and moderately well drained, loamy soils; on flood plains. This is an area of moderately permeable, frequently flooded, acid soils. Mantachie soils have a friable brown, loam surface layer about 8 inches thick. The subsoil, to a depth of 65 inches, is clay loam that is dark grayish brown in the upper part and grayish brown in the lower part. Brownish and reddish mottles occur in most of this layer. Iuka soils have a friable dark grayish brown and brown fine sandy loam surface layer about 12 inches thick. Below this, to a depth of 60 inches, is fine sandy loam that is brown with brownish and grayish mottles in the upper part and mottled gray, brown, and yellow in the lower part. Mantachie soil makes up about 47 percent of the unit and Iuka soils make up about 35 percent. The remaining 18 percent of the association is made up of soils that differ mainly in being better drained or more clayey. Most of this association is used for woodland. Some areas have been cleared and are in pasture.

2. Nahatche-Thenas association. Somewhat poorly drained and moderately well drained, moderately permeable, loamy soils with loamy and clayey subsoils. This is an area of loamy alluvial soils that form flood plains around drains. Most of the soils are frequently flooded and are used mainly for woodland and pastureland. Nahatche soils make up about 53 percent of the association. They have a brown loamy surface layer and a medium acid to alkaline, brownish gray clay loam lower layer. Thenas soils make up about 27 percent of the association. These soils have a dark brown fine sandy loam surface layer and a brownish sandy clay loam lower layer that contains gray mottles and is medium acid. About 20 percent of the association consists of similar soils of minor extent that differ mainly in being more clayey.

3-06 Water Quality

The Texas Water Commission (TWC) published Texas Surface Water Quality Standards (drafted as a proposed rule pending further review and approval) in October 1987 for the protection of the State watercourses. In this publication, Lake O' the Pines (Segment No. 0403) was deemed desirable for domestic water supply, contact recreation, and non-contact recreation. TWC has also designated the lake as a "high quality aquatic habitat". Water quality standards for the protection of these uses within the lake are listed below.

chlorides, average (not to exceed)	80 mg/l
sulfates, average (not to exceed)	50 mg/l
total dissolved solids, average (not to exceed)	300 mg/l
pH, allowable range	6.0-8.5 S.U.
fecal coliforms, log average (not to exceed)	200 #/100 ml
temperature in degrees F (C) max.(not to exceed)	94 (33.9)
dissolved oxygen, minimum (not less than)	5.0 mg/l

During a 1976 National Eutrophication Survey conducted by the Environmental Protection Agency (EPA), Lake O' the Pines was classed as a highly eutrophic lake (a nutrient-rich lake with a high potential for developing nuisance algal conditions) based on an EPA trophic index of 298. However, it should be noted that most lakes in Texas are eutrophic (below the trophic index of 420) and 44 percent are highly eutrophic (indices below 300). Lake O' the Pines was ranked 22nd of 39 Texas lakes in order of the higher quality first. Table 3-2 lists the 39 lakes and displays their corresponding indices. Eutrophic lakes contain relatively high concentrations of nutrients (phosphorus and nitrogen compounds). These nutrients promote excessive growth of algae during the late summer. In severe cases, algae die-off near the end of the summer can deplete dissolved oxygen and subsequently cause fish kills. Excessive algal blooms have occurred within Lake O' the Pines and have caused occasional taste and odor problems in the municipal water supply. However, no fish kills have been recently reported within the lake.

TABLE 3-2

NES EUTROPHICATION INDICES FOR TEXAS LAKES

Rank	Lake Name	Index Number
1	Canyon Lake	445
2	Lake Meredith	441
3	Eagle Mountain Lake	430
4	Chimp Lake	423
5	Amistad	402
6	Brownwood Lake	394
7	Bastrop Lake	393
8	White River Reservoir	390
9	Possum Kingdom Reservoir	387
10	Travis Lake	384
11	Lake Belton	384
12	Stillhouse Hollow Lake	372
13	Diversion Lake	372
14	Calaveras Lake	362
15	Whitney Lake	357
16	Medina Lake	342
17	Sam Rayburn Reservoir	322
18	E V Spence Reservoir	321
19	Twin Buttes Reservoir	311
20	Lake Colorado City	310
21	Palestine Lake	302
22	**Lake O' the Pines**	**298**
23	Caddo Lake	297
24	Ft Phantom Hill Lake	296
25	Lake Buchanan	261
26	Stamford Lake	259
27	Lavon Lake	258
28	Tawakoni Lake	253
29	Lyndon B. Johnson Lake	238
30	Texoma Lake	217
31	Somerville Lake	208
32	San Angelo Reservoir	200
33	Wright Patman Lake	176
34	Garza Little Elm Reservoir	173
35	Trinidad	169
36	Braunig Lake	159
37	Corpus Christi Lake	155
38	Houston Lake	139
39	Livingston Lake	91

Lake O' the Pines receives wastewater effluents from 17 permitted discharges within the contributing watershed of the Big Cypress Basin. A list of these point source discharges are shown on Table 3-3. Eleven of the permitted discharges are effluents from sewage treatment plants. The other discharges are from industrial sources. Major municipal dischargers include Mount Pleasant, Lone Star, and Pittsburgh. Many of the industrial effluents are comprised of spent cooling water discharges. Lone Star Steel Company is one of the major industrial dischargers. In addition to discharge outfalls, Lone Star Steel Company has wastewater holding ponds adjacent to Lake O' the Pines. These ponds principally hold stormwater runoff from the plant and are suspected of occasionally releasing metals and other contaminants into the lake. However, aside from this concern, no significant water quality impacts associated with point source discharges are known to have occurred.

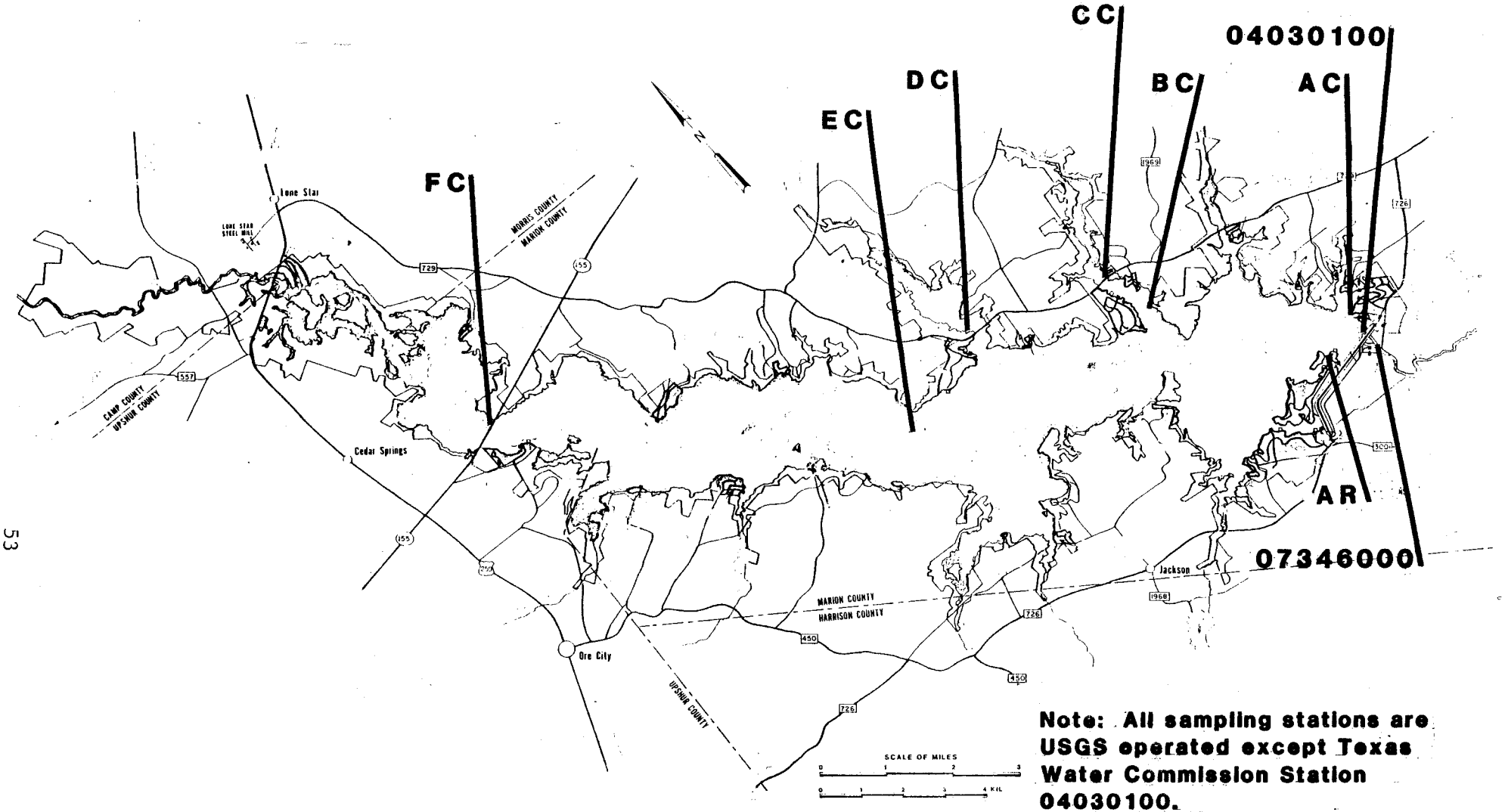
Most of the non-point source pollution is attributed to silvaculture surrounding Lake O' the Pines. Decaying leaves and other organic debris enter the lake through direct runoff and tributaries. Subsequently, a large portion of these materials break down for algae uptake and growth. Tannins and lignins from wooded areas also affect lake coloration. However, the water treatment plant of Northeast Texas Municipal Water District effectively removes potential color problems with granulated activated carbon treatment. Strip mining for coal is usually an important contributor to pollution problems. Although strip mining is conducted in areas upstream of Ellison Creek Reservoir, a series of small impoundments (particularly Barnes Creek Reservoir) retain much of the runoff from mining activities.

The water quality for Lake O' the Pines was assessed from data extracted from the STORET system. The STORET system is a computerized data base developed with analytical results of collected samples at various sampling stations across the nation. Sampling stations within Texas are operated by the U.S. Geological Survey (USGS) and the Texas Water Commission (TWC). Data collected from STORET from 1976 to 1984 indicate that the water quality of Lake O' the Pines is relatively good. Figure 3-3 shows the location of TWC and USGS stations for this data, and Table 3-4 compares the lake water quality with Texas Surface Water Quality Standards. Since the lake is principally used for recreation, propagation of aquatic life, and a domestic raw water supply; several water quality parameters are discussed below with respect to water use.

TABLE 3-3
List of Wastewater Permittees Discharging into the Contributing Watershed of Lake O' the Pines

Stream Segment No./Description	Permittee	Plant Name	State Permit No.
0403-Lake O' The Pines*	City of Lone Star	OTFL 001 (STP)	012411
	Ore City	OTFL 001 (STP)	010241
	Southwestern Elec. Power Co.	Wilkes S.E.S.	001331
	Sunset Harbor Resort, Inc.	OTFL (STP)	011260
	Slimco, Inc.	Crestwood STP	012563
0404-Big Cypress Creek Upstream of Lake O' The Pines **	Conoco, Inc.	Mt. Pleasant Term.	002917
	Gillford-Hill & Co., Inc.	Barfield Enterprise	001146
	Lone Star Logistics	Truck Wash Station	002938
	Lone Star Steel Co.	OTFLS 001-005	000348
	City of Mt.Pleasant	SE Plant (001) NE Plant (002) SW Plant (003)	010575 010575 010575
	City of Omaha	OTFL 001 (STP)	010239
	City of Pittsburgh	Sparks Br. (001) Dry Cr. (002)	010250 010250
	T&N Lone Star Warehouse Co.	T&N STP	013326
	Trey Corporation of Vivian	Mt. Pleasant Ref.	000378

Source: Texas Water Commission, March 1988.
* Includes almost all of the lake except for a small portion of US Highway 259.
** Big Cypress Creek from US Highway 259 to Lake Bob Sandlin dam.



Note: All sampling stations are USGS operated except Texas Water Commission Station 04030100.

LAKE O' THE PINES

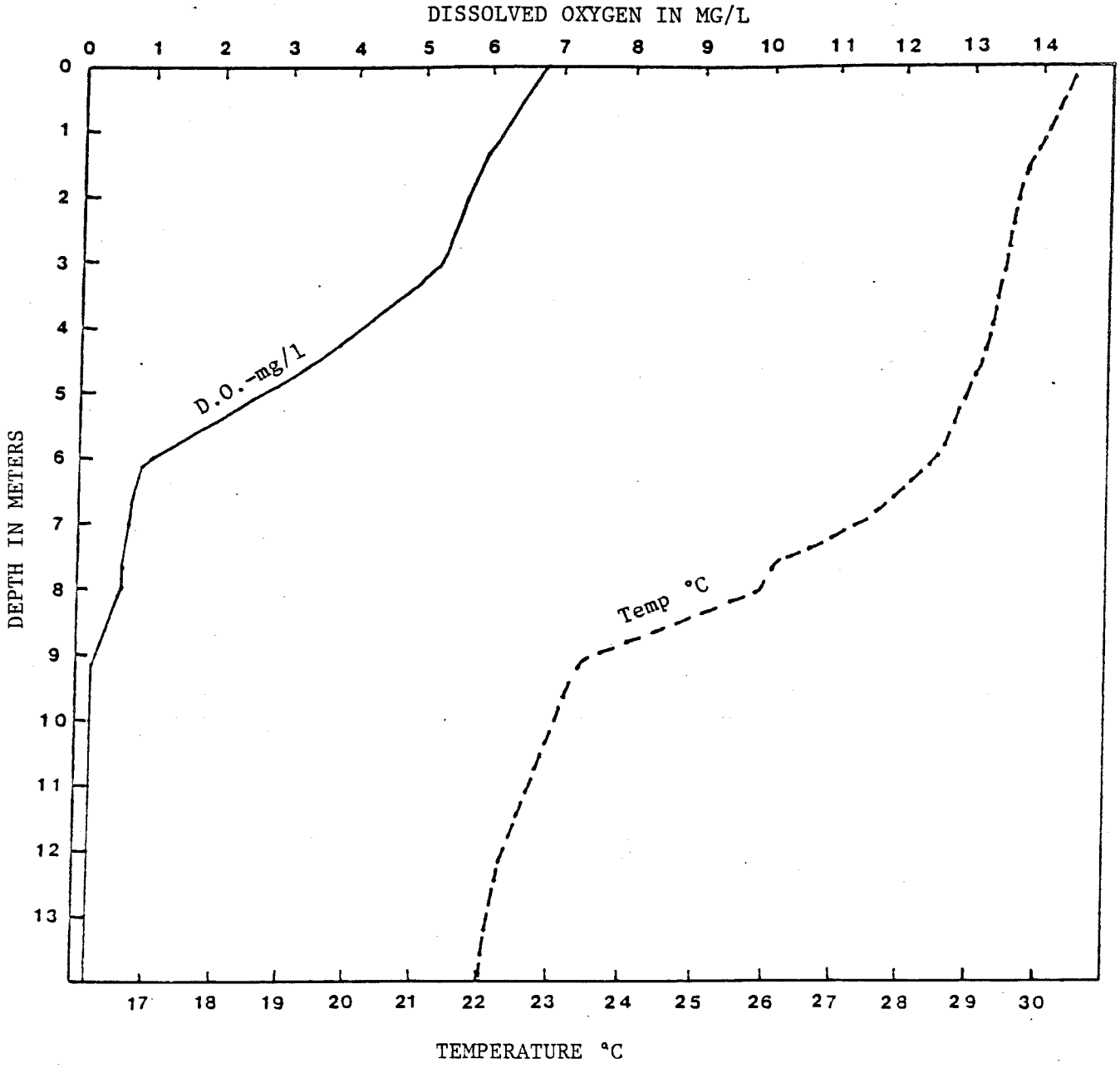
ROUTINE WATER SAMPLING STATIONS

Figure 3-3

a. Alkalinity and pH. The approved Texas Surface Water Quality Standard for pH for Lake O' the Pines is 6.0-8.5, which is the same as the stream segment immediately upstream and downstream of the lake. This pH range assures that the raw waters will be treatable and noncorrosive for domestic use and protects aquatic life. From USGS routine sampling stations in Table 3-4, the overall pH for the lake ranges from 5.4 to 8.8 which does not comply with surface standards. Approximately 8 percent of the pH readings were lower than the acceptable pH range. There is no state surface water standard for alkalinity, but alkalinity buffers the water against low pH (or acid) conditions. As depicted in Table 3-4, the alkalinity is relatively low. As a result of these low alkaline conditions, Northeast Texas Municipal Water District has on occasion had some problems with pH regulation within the water treatment plant, but have corrected these problems by adding chemicals. Furthermore, there have not been any significant impacts to aquatic life or recreation resources as result of the few pH extremes occurring in Lake O' the Pines.

b. Temperature. The approved Texas Standard for maximum surface water temperature for Lake O' the Pines is 93 degrees F (33.9 degrees C) as shown in Table 3-4. This standard was primarily formulated to protect existing aquatic life resident in the watercourse. All sampling stations, except Station EC, recorded maximum temperatures below 33.9 degrees C. Only one sample at station EC exceeded the standard. Although portions of the lake may exceed the temperature limit, fish can migrate to other areas where deeper and cooler waters exist. Therefore, the present thermal conditions should not impact aquatic life.

c. Dissolved Oxygen. Aquatic life depends heavily on the dissolved oxygen concentration within a lake environment. It is for this reason, as well as maintaining aesthetic conditions, that it is necessary to note. The approved Texas State standard for minimum dissolved oxygen (DO) in surface waters of Lake O' the Pines is 5.00 mg/l. Dissolved oxygen concentrations within the hypolimnion (bottom portion) of the lake have been below 5.00 mg/l during the summer months; however, this condition is typical of large manmade lakes in Texas. Lake O' the Pines has had dissolved oxygen concentrations below the standard at all lake stations in the bottom portions of the lake and has had 5 of the 8 lake stations with dissolved oxygen concentrations lower than the standard at one-foot depths (see Table 3-4) during the summer months. However, the overall lake at one-foot depth averages approximately 6.5 mg/l of dissolved oxygen. These DO concentrations have not significantly affected fish populations within the lake (and no known fish kills have been attributed to low DO concentrations). A profile of temperatures and dissolved oxygen data recorded from the Lake O' the Pines in August 1983 is presented in Figure 3-5.



TEMPERATURE AND DISSOLVED
OXYGEN PROFILE
LAKE O' THE PINES - AUGUST 10, 1983

Figure 3-3

Table 3-4

WATER QUALITY OF LAKE O' THE PINES
October 24, 1973 to April 4, 1985

	Max Temp ° C	Min[a] D.O. mg/1	Avg Fecal Coliform #/100 ml	Avg Secchi Disc meters	Avg TDS mg/1	Avg Hard-ness mg/2[b]	Avg Chloride mg/1	Avg Sulfate mg/1	Avg Alka-linity mg/1[b]	pH Range SU
Surface Stds[c]	<33.9	>5.0	<200[d]	--	<300	--	<80	<50	--	6.0-8.5
Station Data										
04030100	31.2	7.0	5.0	2.23	132	795	26	25	15	5.4-8.2
AC	31.5	3.0	9.0	1.86	90	33	17	22	24	5.5-8.1
AR	31.5	4.9	--	--	1020	81	152	31	224	5.6-8.2
BC	31.5	5.6	--	1.85	90	36	69	51	53	5.5-8.7
CC	31.5	4.5	--	1.78	75	31	13	16	21	5.6-8.1
DC	32.0	4.6	--	1.74	71	29	12	16	20	5.6-8.2
EC	37.3	5.0	3.0	1.71	92	34	18	22	27	5.5-8.8
FC	32.5	4.5	13.0	1.18	114	47	22	31	28	6.0-8.2
Overall Lake[e]	37.3	3.0	5.0	1.77	101	40	24	27	29	5.4-8.8

[a] From samples taken at 1-foot depth

[b] mg/1 as C_aCO_3

[c] Texas Department of Water Resources. Texas Surface Water Quality Standards, April, 1981.

[d] Log mean of not less than 5 samples collected over not more than 30 days

[e] Overall maximum, minimum, or average (sample-weighted) values depending on parameter

d. Fecal Coliforms. For primary contact recreation (swimming and bathing) fecal coliform bacteria, though not an ideal indicator, are considered the best indicator of pathogenic bacteria within surface waters. The fecal coliform concentration within Lake O' the Pines has averaged less than 13.0 organisms/100 ml (see Table 3-4) and appears to be well below the surface water quality standard (log mean 200 organisms/ 100 ml) for the protection of bathers and swimmers. Therefore, it is not anticipated that pathogens would be a problem for contact and noncontact recreation activities within the lake.

e. Secchi Disc. Secchi disc readings are important to note for swimming and diving areas within a lake. EPA 1973 water clarity criteria for swimming areas require the visibility of the Secchi disc at 4 feet (1.22 meters) depth or at the lake bottom in learn-to-swim areas. The overall Secchi disc reading for Lake O' the Pines has averaged approximately 5.8 feet (1.77 meters). Therefore, if swimming and diving areas are cleared of hazardous debris, the lake should be acceptable for swimmer safety.

f. Total Dissolved Solids. Excessive total dissolved solids are relatively indicative of salinity and impair waters for agricultural and domestic uses. Measurements within the lake have averaged approximately 101 mg/l which is well below the State surface water standard annual average value of 300 mg/l.

g. Hardness. Water hardness, though not a hazardous health agent, is another important item for consideration for municipal water supply. Hard water consumes a soap before a lather will form and creates scale in boilers, water heaters, and hot water pipes. Average measurements of total hardness of Lake O' the Pines (see Table 3-4) at various lake stations have ranged from 40 to 795 mg/l as CaCO3. The overall lake averages 40 mg/l as CaCO3 which lies within the range (0-60 mg/l) termed as "soft" by Texas Department of Health. Thus, no hardness problems are expected to occur.

h. Chlorides. Chlorides, like total dissolved solids, are indicative of salinity and contribute a "mineral" taste to waters. The approved Texas State Standard for chlorides in surface waters for Lake O' the Pines is an average of 80 mg/l. Overall lake average has been well under the standard with 24 mg/l, and only one lake station depicted in Table 3-4 has had an average above the standard.

i. Sulfates. Excessive sulfates have laxative effects and are frequently combined with sodium (which causes hypertension and aggravates cardiac conditions). The approved Texas State Standard for sulfates in surface waters for Lake O' the Pines is an average of 50 mg/l. The overall lake has a sulfate average of 27 mg/l. Among the eight lake stations sampled, only one station average exceeded the standard with 51 mg/l. Therefore, the lake is also relatively acceptable with respect to sulfate concentrations.

j. Pesticides, PCB's, and Metals. The average concentrations of these contaminants in routine water samples have generally been low. However, TWC is currently conducting a special water quality study at Lake O' the Pines to determine the source of several toxic pollutants that were found elevated in lake bottom sediment samples taken in the vicinity of the Lone Star Steel facility and to determine impacts, if any, on aquatic life within the reservoir. In some of the individual sediment samples tested thus far, cadmium, lead, zinc, volatile solids, and oil and grease concentrations have exceeded their respective statewide 90 percentile values (personal communication with Mr. Tom Weber of TWC, March 1988).

k. Downstream Flows and Dissolved Oxygen. The quantity and quality of flows released from Lake O' the Pines are important to sustain downstream aquatic life and supply downstream users. Release water is drawn at a relatively low elevation within the lake. Average annual release flows for water years 1985 and 1986 are 508 cfs and 427 cfs, respectively. Minimum releases for the same two water years are 13 cfs and 21 cfs, respectively (data from USGS Station 07346000). Based on sampling data taken from August 26, 1981 through August 27, 1985, at USGS Station) 07346000 (location shown in Figure 3-4), release water quality generally complies with Texas Surface Water Standards for Big Cypress Creek below Lake O' the Pines (Stream Segment 0402). Dissolved oxygen content, which is important to support aquatic life, is generally the lowest in the late summer. The lowest DO concentration recorded at USGS Station 07346000 was 4.6 mg/l taken on August 26, 1981. Of the ten samples taken at the station, this was the only DO concentration to fall below the minimum standard of 5.0 mg/l.

3-07 PROJECT VEGETATION

Lake O' the Pines lies within the Pineywoods vegetational area of eastern Texas. To more specifically describe the forest and other dominant vegetation types found at Lake O' the Pines a comprehensive analysis and mapping study was conducted using SPOT satellite imagery, black and white aerial photos and USGS maps. Since SPOT data was collected when the lake was at elevation 229.03, the vegetative mapping (see Plate Sequence 3-2) and the number of acres of each vegetative type is based on fee lands above elevation 229.03. From this study, seven distinct cover types have been identified as follows: pine, pine-hardwood, upland hardwoods, bottomland hardwoods, open field/cut grasses, wetlands, and water weeds/lotus. The location of the seven vegetation types for the Lake O' the Pines project are presented on Plate Sequence 3-2. The forest cover types of North America, as classified by the society of American Foresters, was used as a guide in mapping the vegetation types at Lake O' the Pines. Grouping of several types was necessary to facilitate cost/effective map preparation.

a. Pine (2399 acres). The pine type exists in either natural or planted stands and were identified as forests in which pine comprises 80 percent or more of the tree species. Some pine stands are old fields which were allowed to reseed naturally or else were planted shortly after Federal acquisition. Loblolly pine and/or shortleaf pine predominates except in a few stands which were planted in slash pine. In natural stands, shortleaf pine predominates on dry sites, although considerable mixing occurs. Associated hardwoods and understory species mostly make up the upland-hardwood type on the higher, drier sites and toward those of the bottomland-hardwood type on the lower, poorly drained sites.

b. Pine-Hardwood (2688 acres). Pine hardwood types are forests in which pine comprises more than 50 percent and less than 80 percent of the tree species. The loblolly-shortleaf pine relationship is the same as that described for the pine type, depending on the site.

c. Upland Hardwood (2666 acres). The upland hardwood type is found on both rich mesic uplands and drier ridges characterized by relatively poor soils. Common tree species include post oak, white oak, blackjack oak, black hickory, mockernut hickory, shortleaf pine, and loblolly pine. Pine is a very minor component probably having been cut prior to Federal ownership. Commonly associated understory and ground cover plants include yaupon, wax myrtle, American beautyberry, poison oak, poison ivy, greenbriar, hawthorn, spanglegrass, switchgrass, and tickclover.