Appendix Table of Contents

Pittsburg Water Conservation and Emergency Demand Management Plan.
Prepared for the City of Pittsburg**.**

Pecan Gap Comprehensive Plan.
Prepared for the City of Pecan Gap by Hayter Engineering, Inc., Paris, Texas, 1996.

Mount Vernon Master Plan.
Prepared for the City of Mt. Vernon.

Gafford Chapel Water Supply Corporation Determining Water Use and Future Demand.
Prepared for the Gafford Chapel Water Supply Corporation by Hayter Engineering, Inc, Paris, Texas, 1999.

Shirley Water Supply Corporation Engineering Report on Water Improvements.
Prepared for the Shirley Water Supply Corporation by Augeier, Martin & Associates.

Sulphur Springs Surface Water Treatment Assessment Study.
Prepared for the City of Sulphur Springs by Black & Veach, 1991.

Deport Comprehensive Plan.
Prepared for the City of Deport by Hayter Engineering, Inc., Paris, Texas, May, 1992.

Lamar County Water Supply District Master Plan.
Prepared for the LCWSD by Hayter Engineering, Inc., Paris, Texas, 1991.

Petty Emergency Water Demand Plan.
Prepared for the City of Petty

Detroit Comprehensive Plan.
Prepared for the City of Detroit by Hayter Engineering, Inc. Paris, Texas, March, 1992.

410 Water Supply Corporation Master Plan.
Prepared for the 410 WSC by Hayter Engineering, Inc., Paris, Texas, 1999.

City of Mt. Pleasant Water System Study.
Prepared for the City of Mt. Pleasant by Bucher, Willis, & Ratliff.

City of Mt. Pleasant Water Treatment Plant Study.
Prepared for the City of Mt. Pleasant by W.T. Ballard, P.E.

City of Talco Comprehensive Plan.
Prepared for the City of Talco, 1999.

Tri Water Supply Corporation Master Plan.
Prepared for the Tri Water Supply Corporation, 1999.

City of Caddo Mills Community Development Plan, Vol II.
Prepared for the City of Caddo Mills by Tim F. Glendening & Associates.

Evaluation of Available Water Supply on Cowleach Fork.
Prepared by Freese & Nichols, 1999.

Lone Oak Water System Study.
Prepared for the City of Lone Oak by Hayter Engineering, Inc., Paris, Texas, 1992.

Avery Comprehensive Plan.
Prepared for the City of Avery by Hayter Engineering, Inc., Paris, Texas, October, 1993.

Celeste Comprehensive Plan.
Prepared for the City of Celeste by Hayter Engineering, Inc., Paris, Texas , 1991.

Clarksville Comprehensive Plan.
Prepared for the City of Clarksville by Taylor Consulting Associates, Inc. & R.I.M. Enterprises, Inc., 1992.

Commerce Comprehensive Plan.
Prepared for the City of Commerce by J. T. Dunkin & Associates, Inc., 1994.

Edgewood Comprehensive Plan.
Prepared for the City of Edgewood by Hayter Engineering, Inc., Paris, Texas, October, 1995.

Neylandville Comprehensive Plan.
Prepared for the City of Neylandville by Hayter Engineering, Inc., Paris, Texas, March, 1997.

Wolfe City Water System Study.
Prepared for the City of Wolfe City by Hayter Engineering, Inc., Paris, Texas, April, 1991.

Point Water System Analysis.
Prepared for the City of Point by Hayter Engineering, Inc., Paris, Texas, March, 1992.

Alba Comprehensive Plan.
Prepared for the City of Alba.

Golden Water Supply Corporation Water Conservation and Emergency Water Demand Management Plan.

Prepared for the Golden Water Supply Corporation by Hayter Engineering, Inc., Paris, Texas, December, 1998.

DeKalb Water Conservation and Emergency Demand Management Plan.
Prepared for the City of DeKalb by Hayter Engineering, Inc., Paris, Texas, July, 1999.

Charleston Water Supply Corporation Master Plan.
Prepared for the Charleston Water Supply Corporation by Hayter Engineering, Inc., Paris, Texas, 1994.

Commerce Water Reuse Plan.
Prepared for the City of Commerce by Hayter Engineering, Inc., Paris, Texas, September, 1992.

Commerce Water Study.
Prepared for the City of Commerce by Hayter Engineering, Inc., Paris, Texas, 1993.

Como Comprehensive Master Plan.
Prepared for the City of Como by Hayter Engineering, Inc., Paris, Texas, 1994.

Cooper Comprehensive Plan.
Prepared for the City of Cooper by Hayter Engineering, Inc, Paris, Texas, 1998.

Water Distribution System Analysis for the City of Reno.
Prepared for the City of Reno by Hayter Engineering, Inc., Paris, Texas 1994.

City of Paris Water System Study.
Prepared for the City of Paris by Bucher, Willis, & Ratliff, April, 1991.

Feasibility Report for Water Treatment and Transmission Facilities – Delta County Municipal Utility District.
Prepared for the Delta County Municipal Utility District by Hayter Engineering, Inc., Paris, Texas September, 1995.

Preliminary Engineering Report.
Prepared for the North Hunt Water Supply Corporation by D. W. Johnston & Associates, Rockwall, Texas, 1994.

Water Treatment and Supply Study.
Prepared for the City of Greenville by City Staff, February, 1991.

Commerce Water Conservation and Drought Contingency Plan.
Prepared for the City of Commerce, 1991.

Water System Analysis and Plan.
Prepared for the City of Clarksville.

Water Conservation and Drought Contingency Plan.
Prepared for the City of Sulphur Springs, July, 1999.

Miller Grove Water Supply Corporation Summary Engineering Report.
Prepared for Miller Grove Water Supply Corporation

Drought Management and Contingency Plan.
Prepared for Cypress Springs Water Supply Corporation, April, 1999.

City of Redwater Water System Analysis.
Prepared for the City of Redwater by NRS Consulting Engineers.

Preliminary Study of Sources of Additional Water Supply, Volume 1 – Report and Volume II – appendices, North Texas Municipal Water District.
Prepared for the North Texas Municipal Water District by Freese and Nichols, Inc., Forth Worth, Texas, May, 1996.

Comprehensive Plan for the City of Sulphur Springs, Texas.
Prepared by Kindle, Stone, & Associates, Inc.

Evaluation of the Long Range Alternatives for Water Treatment, City of White Oak, Texas.
Prepared for the City of White Oak, Texas by Dunn Engineering Company, Longview, Texas, November 1997.

Feasibility Study, Lake O' The Pines South Side Regional Water Supply System.
Prepared for the Northeast Texas Municipal Water District, City of Longview, Bi-County Water Supply Corporation, Diana Water Supply Corporation, City of East Mountain, Glenwood Water Supply Corporation, Gum Springs Water Supply Corporation, City of Hallsville, Harleton Water Supply Corporation, City of Ore City, Tryon Road Water Supply Corporation, and West Harrison Water Supply Corporation by KSA Engineers, Inc., East Texas Engineers, Inc., and NRS Consulting Engineers, Longview, Texas, December 1998.

Feasibility Study for Water Supply from Lake O' The Pines, City of Longview.
Prepared for the City of Longview, Texas by KSA Engineers, Inc., Longview, Texas, March 1995.

Master Plan, Golden Water Supply Corporation.
Prepared for Golden Water Supply Corporation by Hayter Engineering, Inc., Paris, Texas, April 1998.

Preliminary Engineering Report for the City of East Mountain Water System Improvements.
Prepared for the City of East Mountain, Texas by NRS Consulting Engineers, Longview, Texas, December 1993.

Preliminary Engineering Report for Diana Water Supply Corporation Water System Improvements.
Prepared for Diana Water Supply Corporation by KSA Engineers, Inc., Longview, Texas, October, 1993.

Preliminary Engineering Report for Fouke Water Supply Corporation Water System Improvements.
Prepared for Fouke Water Supply Corporation by NRS Consulting Engineers, Longview, Texas, October 1996.

Preliminary Engineering Report for Lake Fork Water Supply Corporation Water System Improvements.
Prepared for Lake Fork Water Supply Corporation by NRS Consulting Engineers, Longview, Texas, November 1993.

Raw Water Demand Projections, City of Longview and Longview Customers.
Prepared for the City of Longview, Texas by HDR Engineering, Inc., Austin, Texas, October 1991.

1996 System Appraisal & Value Analysis Related to City of Marshall Annexation.
Prepared for Leigh Water Supply Corporation by NRS Consulting Engineers, Longview, Texas, August 1996.

Ten Year Water System Improvements Plan, West Gregg Water Supply Corporation.
Prepared for the West Gregg Water Supply Corporation by KSA Engineers, Inc., Longview, Texas, August 1997.

Water and Sewer System Preliminary Engineering Report, City of Linden, Texas.
Prepared for the City of Linden, Texas by NRS Consulting Engineers, Texarkana, Arkansas, Revised October 1998.

Water Conservation and Emergency Water Demand Management Plan, Golden Water Supply Corporation.
Prepared for Golden Water Supply Corporation by Hayter Engineering, Inc., Paris, Texas, July 1999.

Water Conservation Plan and Drought Contingency Plan, Diana Water Supply Corporation.
Prepared for Diana Water Supply Corporation by KSA Engineers, Inc., Longview, Texas, April 1992.

Water Distribution System Analysis, City of Longview, Texas.
Prepared for the City of Longview, Texas by KSA Engineers, Inc., Longview, Texas, April 1998.

Water Supply Report, City of Gilmer, Texas.
Prepared for the City of Gilmer, Texas by NRS Consulting Engineers, Texarkana, Arkansas, January 1999.

Water System Study, Glenwood Water Supply Corporation.
Prepared for the Glenwood Water Supply Corporation by East Texas Engineers, Inc., Longview, Texas, April 1994.

Water System Study, Gum Springs Water Supply Corporation.
Prepared for Gum Springs Water Supply Corporation by East Texas Engineers, Inc., Longview, Texas, December 1997.

Water System Study, Harleton Water Supply Corporation.
Prepared for Harleton Water Supply Corporation by NRS Consulting Engineers, Longview, Texas, March 1993.

Able Springs Water Conservation and Drought Management Plan.
Prepared for Able Springs Water Supply Corporation

Report on Feasibility of Substitution of Reclaimed Water for Potable Water and/or Freshwater .

Prepared by Scott Drake, Director of Public Works for City of Willis Point, Van Zandt County.

Report on Water Production Capacity .

Prepared by Kirk R. Bynum, The Brannon Corporation for South Tawakoni Water Supply Corporation, Van Zandt County.

Preliminary Engineering Report .

Prepared by Daniel & Brown Inc. for Ben Wheeler Water Supply Corporation, Van Zandt & Smith Counties.

Report on the Estimated Cost of Supplying Water to Sulphur Springs.

Prepared by Wisenbaker Fix & Associates for Franklin county Water District, Mount Vernon, Texas, 1968.

Water Supply and Treatment Facilities.

Prepared by Henningson Durham and Richards for the City of Sulphur Springs, Texas, 1963.

Report on Langford Creek Lake.

Prepared by Wisenbaker Fix & Associates for the City of Clarksville, Texas, 1958.

Preliminary Report on Paris Dam and Reservoir, Sanders Creek, Lamar County, Texas.

Prepared by Forrest and Cotton Inc. for the City of Paris, 1960.

Cooper Reservoir Water Supply Study.

Prepared by Black & Veatch for the City of Sulphur Springs, Texas, 1988.

Water Supply Study.

Prepared by Henningson Durham and Richardson for the City of Longview, 1974.

Gregg County Water Quality Management Implementation Plan.

Prepared by B.L. Nelson & Associates for the Middle Sabine River Basin, 1972.

Report on Longivew Municipal Lake on Tiawichi Creek and Cherokee Bayou, Sabine River Basin, Rusk County, Texas.

Prepared by Forrest and Cotton, Inc. for presentation at the public hearing on Application 2774, Texas Water Rights Commission, Austin, Texas, 1970.

Water Supply Study.

Prepared by Kindle Stone and Associates Inc. for the City of Marshall, 1979.

Projected Water Needs for Marshall and Harrison County, Texas, as Related to Available Water Supplies.

Prepared by Lockwood, Andrews and Newman Inc.

Comprehensive Plan for Water and Sewer.
Prepared by B.L. Nelson & Associates for Gregg County, 1960.

Water Quality Management Implementation Plan, Middle Sabine River Basin.
Prepared by B.L. Nelson & Associates for Gregg County, 1972.

Preliminary Report on the Kilgore Dam Reservoir Wilds Creek.
Prepared by Forrest and Cotton, Inc, for Rush, Gregg, and Smith Counties, Texas, 1960.

An Analysis of the Significant Factors Concerning the Construction of a Lake In Franklin County, Texas.
Prepared for Franklin County, Texas.

Comprehensive Water and Sewer Plan: Lamar County, Texas.
Prepared by Hayter Engineering, Inc., 1967.

A Public Water Supply Protection Strategy.
Prepared by Brad L. Cross, geologist; David P. Terry, environmental scientist; David D. Beard, engineer technician for Maloy Water Supply Corporation, 1992.

Comprehensive Area-Wide Water and Sewer Plan.
Prepared by Vance W. King for Delta County, 1968.

Intensive survey of Rock Creek, Hopkins County: Hydrology, Field Measurements, Water Chemistry, Benthal Oxygen demand, Fecal Coliforms.
Prepared by Richard Orman Respress for Hopkins County, 1980.

Comprehensive Plan for Water and Sewer.
Prepared by B.L. Nelson & Associates for Hopkins County, 1970.

Engineering Report on Development of a Supply of Water.
Prepared by Knowlton-Ratliff-English-Collins for the City of Mount Pleasant, Texas from the proposed Titus County Reservoir on Big Cypress Creek, Texas, 1971.

A Public Water Supply Protection Strategy.
Prepared by John Jasek for the Rosewood Water Supply corporation, 1998.

The Country Club Estates; a Public Water Supply Protection Strategy.
Prepared by Brad L. Cross, David P. Terry, and Kenneth D. May, 1997.

Comprehensive Plan for Water and Sewer.
Prepared by B.L. Nelson & Associates for Upshur County.

Plan Summary Report for the Cypress Creek Basin WaterQuality Management Plan.
Prepared by Northeast Texas Municipal Water District for Texas Department of Water Resources, 1978.

Water Quality Management Plan for the Cypress Basin.
Prepared by Northeast Texas Municipal Water District, 1975.

Plan Summary Report for the Cypress Creek Basin Water Quality Management Plan.
Prepared by Northeast Texas Municipal Water District for Texas Department of Water Resources, 1981.

Water Quality Management Plant for the Cypress Basin.
Prepared by Northeast Texas Municipal Water District, 1975.

Engineering Report.
Prepared by Wyatt C. Hendrick Consulting Engineer for the Northeast Texas Municipal Water District, Daingerfield, Texas, 1962.

Report on Lower Blundell Creek Dam and Reservoir on Blundell Creek, Cypress Creek Basin, Titus County, Texas.
Prepared by Forrest and Cotton, Inc., 1970.

Update of the Master Plan.
Prepared by Espey Huston & Associates for the Sabine River and Tributaries in Texas, 1985.

Lake Fork Dam and Reservoir on Lake Fork Creek, Sabine River Basin, Wood, Rains, and Hopkins Counties, Texas.
Prepared by URS/Forrest and Cotton, Inc., 1974.

Water System Study
Ten Year Master Plan for East Mountain, Texas
Prepared by NRS Consulting Engineers, Longview, Texas 1999.

RED RIVER AUTHORITY REPORTS

An Assessment of the Biological Integrity of the Eastern Red River Basin in Texas.

Prepared by the Red River Authority, Wichita Falls, Texas, April, 1998.

This paper gives insight to the biological health of streams located in the eastern Red River Basin in Texas. Results show good overall biological health of the selected streams in the region with some moderate impairment.

Red River Basin Chloride Control Project.

Prepared by the Red River Authority of Texas, Wichita Fall, Texas, January 1997.

This report discusses the goals of the chloride control project and summarizes the environmental issues involved.

Regional Assessment of Water Quality, Red River Basin of Texas: Biennial Report.

Prepared by Red River Authority of Texas, 1994.

Regional Assessment of Water Quality, Red River Basin of Texas.

Prepared by the Red River Authority of Texas and HDR Engineering, Inc. in cooperation with the Texas Water Commission, 1992.

Plan Summary Report for the Red River Study Area Water Quality Management Plan.

Prepared by the Red River Authority for the Texas Department of Water Resources, 1981.

SABINE RIVER AUTHORITY REPORTS

Yield Study, Toledo Bend Reservoir.
Prepared for SRA Texas and Louisiana by Brown & Root, July, 1991.

Trans-Texas Water Program Southeast Area Phase I Report.
Prepared by Brown & Root in association with Freese & Nichols, Inc., March 1994.

Trans-Texas Water Program Planning Information Update.
Prepared by Brown & Root in association with Freese & Nichols, Inc., April, 1996.

Update of the Master Plan for the Sabine River and Tributaries in Texas.
Prepared for SRA Texas by Espey, Hutson, & Associates and Tudor Engineering Company, March,1985.

Lake Fork Reservoir Yield Determination.
Prepared for SRA Texas by Espey, Hutson, & Associates, April, 1985.

Lake Tawakoni Yield Determination.
Prepared for SRA Texas by Espey, Hutson, & Associates, April, 1985.

Update of Master Plan for the Sabine River and Tributaries in Texas, Hydrology Appendix.
Prepared for SRA Texas by Espey, Hutson, & Associates, 1985.

Upper Sabine Basin Regional Water Supply Plan.
Prepared for SRA Texas by Freese & Nichols, 1988.

Reconnaissance Study for the Lake Tawakonoi Regional Water Supply System.
Prepared for SRA Texas by Freese & Nichols, November, 1989.

Master Plan of the Sabine River and Tributaries in Texas.
Prepared by Forrest & Cotton, January, 1955.

Supplement to the Master Plan of the Sabine River and Tributaries in Texas.
Prepared by Forrest & Cotton, November, 1962.

Report on Lake Tawakoni Yield Study.
Prepared for SRA Texas by Forrest & Cotton, March, 1977.

Report on Potential Water Supply From Sabine River Basin.
Prepared for North Texas Municipal Water District by Forrest & Cotton, August, 1979.

Water Supply Study, Addendum No. 1.
Prepared for the City of Marshall, Texas by Kindle, Stone, & Associates, Inc., January, 1981.

Longview Water Supply Study.

Prepared for the City of Longview, Texas by Kindle, Stone, & Associates, Inc., May, 1982.

Preliminary Feasibility Study, Little Cypress Reservoir.

Prepared for the Cities of Shreveport, Longview, Marshall, Kilgore, Gilmore, and Hallsville by Kindle, Stone, & Associates, Inc., July, 1982.

Big Sandy Reservoir Study.

Prepared for the SRA Texas by Kindle, Stone, & Associates, Inc., October, 1984.

Preplanning Studies for the Upper Sabine Reservoir Projects (Mineola, Lake Fork, and Big Sandy).

Prepared by Sabine River Authority of Texas, July 1, 1972.

1996 Regional Assessment of Water Quality – Sabine River Basin, Texas, Vol. I-III.

Prepared by Sabine River Authority of Texas, October, 1992.

1992 Regional Assessment of Water Quality-Sabine River Basin, Texas.

Prepared by Sabine River Authority of Texas, October, 1996.

Upper Sabine Water Supply Study.

Prepared for the SRA Texas, and twelve cities and four private entities interested in obtaining water from the upper Sabine River watershed) by URS Engineers, May, 1983.

Report on Comprehensive Basin Study: Sabine River and Tributaries, Texas and Louisiana.

Prepared by U.S. Army, Corps of Engineers, Fort Worth District, February, 1981.

Sabine River and Tributaries, Texas and Louisiana.

Prepared by U.S. Army Corps or Engineers, Fort Worth District, February, 1981.

Problems Relating to the Proposed Waters Bluff Reservoir and other Surface Water Supply Projects in Texas in Texas, Sabine River Authority.

Prepared by the Sabine River Authority, Orange, Texas, December, 1996.

This report discusses issues related to the proposed Waters Bluff Reservoir in Wood, Upshur, and Smith counties as well other surface water projects in Texas.

Comprehensive Sabine Watershed Management Plan – Draft.

Prepared for the Sabine River Authority by Freese and Nichols, Inc., Forth Worth, Texas, April, 1999.

This report presents the 50-year regional water management plan for the Sabine River Basin. Included in this report are descriptions of current population, water use, and water supply estimates for the Sabine basin, as well as potential sources for additional supply.

Feasibility Study for the Lake Tawakoni Regional Water Supply Systsem.

Prepared by Freese and Nichols, Inc. for the Sabine River Authority of Texas in conjunction with the Texas Water Development Board, 1991.

Feasibility Study for the Lake Tawakoni Regional Water Supply System.
Prepared by Freese and Nichols, Inc., 1991.

Preliminary Feasibility Study: Interbasin Water Transfer from the Sabine River to the San Jacinto River Authority Service Area.
Prepared by Ronnie M. Lemmons and John Lee Rutledge, Freese and Nichols, Inc., 1989.

Feasibility Study Interbasin Transfer, Sabine to San Jacinto.
Prepared by Wayne Smith & Associates, 1988.

Problems Relating to the Proposed Waters Bluff Reservoir and the Texas Water Plan.
Prepared by the Sabine River Authority of Texas, 1987.

Preliminary Feasibility Study: Waters Bluff Dam and Reservoir, Sabine River, Texas.
Prepared by Espey Huston and Associates, 1986.

Water Quality Management Program Data Summary and Evaluation Report January, December, 1976.
Prepared by the Sabine River Authority of Texas for Lake Fork Creek, 1977.

Water Quality Management Program Data Summary and Evaluation Report January, 1975 – December, 1979.
Prepared by the Sabine River Authority of Texas, Technical Division for Lake Fork, 1977.

Plan Summary Report for the Sabine Basin Water Quality Management Plan.
Prepared by the Sabine River Authority of Texas for the Texas Department of Water Resources, 1981.

Water Quality Study.
Prepared by Forrest and Cotton, Inc. for the Sabine River Authority of Texas, 1966.

Master Plan of the Sabine River and Tributaries in Texas: Report on Supplement.
Prepared by Forrest and Cotton, Inc., 1962.

Proposed Toledo Bend Dam on the Sabine River of Texas and Louisiana: Preliminary Report.
Prepared by Forrest and Cotton, Inc., 1955.

Master Plan of the Sabine River and Tributaries in Texas.
Prepared by Forrest and Cotton, Inc., 1955.

Pertinent Data for Reservoirs Required by 1980.
Prepared by the Sabine River Authority of Texas.

Regional Assessment of Water Quality.
Prepared by the Sabine River Authority of Texas.

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION REPORTS

Texas Clean Rivers Long Term Action Plan.

Prepared by the Texas Natural Resource Conservation Commission, 1991.

Provides a brief overview of the Clean Rivers Program strategies of the program statewide.

The Statewide Watershed Management Approach for Texas.

Prepared by the Texas Natural Resource Conservation Commission, March, 1997.

Provides background information and guidance for integrating and coordinating key program functions through a watershed management approach.

Clean Water for Texas – Solving Water Quality Problems.

Prepared by the Texas Natural Resource Conservation Commission, August, 1997.

Discusses water quality impairments, their causes, and strategies for addressing impairments. Explanation of the watershed management approach..

Aquatic Life Use and Dissolved Oxygen Concentrations During Low-Flow, High-Stress Summer Conditions, 1995-1996.

Prepared by the Texas Natural Resource Conservation Commission, February, 1998.

Summary of a study designed to provide information on actual life use and dissolved oxygen concentrations in different sized streams in the Cypress Creek Basin.

A Survey of Mercury Concentrations in the Cypress Creek and Super Sabine River Basins of Northeast Texas.

Prepared by the Texas Natural Resource Conservation Commission, December, 1996.

Discusses mercury and its properties, lists mercury concentrations in northeast Texas waters, and describes the process of the study and its results.

A Public Water Supply Protection Strategy.

Prepared by Brad L. Cross, David P. Terry, and Valerie Billings and the Texas Water Commission for the City of Atlanta, 1990.

A Public Water Supply Protection Strategy.

Prepared by Brad L. Cross, geologist; David P. Terry, environmental scientist; David M. Prescott, engineering specialist for the Gum Springs Water Supply Corporation, 1994.

A Public Water Supply Protection Strategy.

Prepared by Brad L. Cross, geologist; David P. Terry, hydorlogist; Mabel Lin, Engineering assistant for the Liberty City Water Supply corporation, 1994.

Water Quality Management Plan.

Prepared by the Texas Water Quality Board for the Red Basin, 1975.

A Public Water Supply Protection Strategy.

Prepared by John Jasek for the Lake Fork Water Supply Corporation, 1998.

A Public Water Supply Protection Strategy.

Prepared by John Jasek for the Foulke Water Supply Corporation, 1998.

A Public Water Supply Protection Strategy.

Prepared by Brad L. Cross, geologist; David P. Terry, environmental scientist; David M. Prescott, engineering specialist for the New Hope Water Supply Corporation, 1994.

Interim Water Quality Plan for Como Texas in Hopkins County in Sabine River Basin.

Prepared by Texas Water Quality Board, 1971.

Water Quality Management Plan.

Prepared by the Texas Water Quality Board for the Red Basin, 1975.

Summary Report: Regional Assessments of Water Quality Pursuant to the Texas Clean Rivers Act (Senate Bill 818).

Prepared by the Texas Water Commission in partnership with Red River Authority of Texas, 1992.

Excerpted Statewide Materials: Summary Report: Regional Assessments of Water Quality Pursuant to the Texas Clean Rivers Act (Senate Bill 818).

Prepared by the Texas Water Commission in partnership with Red River Authority of Texas, 1992.

Regional Assessment of Water Quality, Cypress Basin of Texas: Regional Assessment Report September 1, 1993 through August 31, 1994.

Prepared by HDR Engineering in association with Paul Price Associats, Inc. prepared in cooperation with the Texas Natural Resource Conservation Commission under the authorization of the Clean Rivers Act for the Titus County Fresh Water Supply district No. 1, 1994.

TEXAS WATER DEVELOPMENT BOARD REPORTS

Aquifers of Texas.

Prepared by Texas Water Development Board, November, 1995.

This report discusses major and minor aquifers in Texas. Discussion includes a description of the aquifer, its water quality, and changes in the aquifer over time.

Volumetric Survey of Lake Cypress Springs.

Prepared by the Franklin County Water District by the Texas Water Development Board, July 30, 1998.

This report summarizes a hydro graphic survey of Lake Cypress Springs. The purpose of the survey was to determine the capacity of the lake at the conservation pool level. Survey results are presented.

Memorandum Report – Updated Water Project Opinion of Cost.

Prepared for the Texas Water Development Board by Freese and Nichols, Inc., Fort Worth, Texas, June 3, 1996.

This report presents estimated costs to develop numerous water supply and water transmission projects across the state.

Ground-Water Resources of the Nacatoch Aquifer.

Prepared for the Texas Water Development Board by John B. Ashworth, April,1988.

This report presents information of the Nacatoch Aquifer which occurs in a narrow band in northeast Texas. Region D Counties include Hunt, Hopkins, Franklin, Titus, Red River, Rains and Bowie Counties. Records of wells and location maps are presented as well as a general discussion of the aquifer itself.

Occurrence, Availability, and Chemical Quality of Ground Water in the Blossom Sand Aquifer.

Prepared for the Texas Water Development Board by Celeste McLaurin, August, 1988.

Study of groundwater in the Blossom Sand. Discusses geographic setting, geology as related to groundwater, the occurrence of groundwater, utilization and development of the Blossom Sand, and availability of water in the aquifer.

Ground-Water Resources of Camp, Franklin, Morris, and Titus Counties, Texas.

Prepared for the Texas Water Development Board by M.E. Broom, W.H. Alexander, Jr., B. N. Myers, July, 1965.

A description of the economic development and water use and a summary of the groundwater resources in Camp Franklin, Morris and Titus Counties.

Water-Level and Water-Quality from Observation Wells in Northeast Texas.

Prepared for the Texas Water Development Board by Howard D. Taylor, February, 1976.

Presents quantitative and qualitative information on groundwater resources in 20 northeast Texas counties, including Hunt, Lamar, Red River and Delta Counties of Region D. Location maps and records of selected wells are included. Region D aquifers include the Woodbine, Nacatoch and Blossom Sand.

Occurrence, Availability, and Chemical Quality of Ground Water in the Cretaceous Aquifers of North-Central Texas.

Prepared for the Texas Water Development Board by Phillip L. Nordstrom, April, 1982.

Evaluation of Water Resources in Part of North-Central Texas.

Prepared for the Texas Water Development Board, by Bernard Baker, Gail Duffin, Robert Flores, Tad Lynch, January, 1990.

This study presents a discussion of the groundwater resources in 23 counties of north central Texas. Surface water supplies are discussed. Population projections and supply/demand evaluation through year 2010.Counties in Region D including Hunt, Delta, Lamar, and Red River. Region D aquifers included are the Woodbine, Nacatoch and Blossom Sand.

Investigation of Alleged Ground-Water Contamination new Kilgore, Gregg County, Texas.

Prepared for the Texas Water Development Board, by H. D. Holloway, April, 1964.

Water Resources of Gregg County, Texas.

Prepared for the Texas Water Development Board by W. L. Broadhurst, September, 1945.

Base-Flow Studies, Little Cypress Creek, Upshur, Gregg, and Harrison Counties, Texas, Quantity and Quality, January and June, 1964.

Prepared for the Texas Water Development Board by J. T. Smith, J. H. Montgomery, J. F. Blakey, August, 1966.

This report discusses the base-flow investigation of Little Cypress Creek, made by the U.S. Geological Survey. It begins by describing the watershed features, then the geohydrology character of the streamflow and, water uses in the creek, and concludes by comparing the two studies.

Ground-Water Resources of Gregg and Upshur Counties, Texas.

Prepared for the Texas Water Development Board by M. E. Broom, October, 1969.

Discusses groundwater resources in Gregg and Upshur Counties, including the Carrizo-Wilcox and Queen City aquifers. Concludes that substantially increased supplies above 1996 pumpage levels are available – however, high chloride levels in parts of Upshur and Gregg may be a problem in the Carrizo-Wilcox, and iron content may impede development of the Queen City. Contains location maps and records of selected wells.

Evaluation of Ground-Water Resources in the Vicinity of Henderson, Jacksonville, Kilgore, Lufkin, Nacogdoches, Rush, and Tyler in East Texas.

Prepared for the Texas Water Development Board by Richard D. Preston, Stephen W. Moore, February, 1991.

Presents a discussion of a study to identify and evaluate present and potential groundwater problems within Angelina, Cherokee, Gregg, Nacadoches, Rush and Smith Counties. Includes research on geohydrology, climate, geographic setting, groundwater problems, projected water demands and the availability of ground and surface water in the study area.

Water Resources of Harrison County, Texas.

Prepared for the Texas Water Development Board by W. L. Broadhurst, September, 1943.

Ground-Water Resources of Harrison County, Texas.

Prepared for the Texas Water Development Board by M. E. Broom, B. N. Myers, August, 1966.

Discusses the quantity, quality and availability of groundwater in Harrison county. It also speculates the availability of groundwater for future development. Includes the Wilcox Group, the Carrizo Sand, The Reklaw formation and the Queen City Sand.

Ground Water in the Greenville Area, Hunt County, Texas.

Prepared for the Texas Water Development Board by N. A. Rose, June, 1945.

Water Resources of Marion County, Texas.

Prepared for the Texas Water Development Board by W. L. Broadhurst.

Ground-Water Resources of Rains and Van Zandt Counties, Texas.

Prepared for the Texas Water Development Board by D. E. White, April, 1973.

Study of quantity, quality and availability of groundwater in Rains and Van Zandt Counties. Includes the Carrizo-Wilcox present in both counties, and the Queen City Sand, present in Van Zandt County.

Availability and Quality of Ground Water in Smith County, Texas.

Prepared for the Texas Water Development Board by J. W. Dillard, May, 1963.

A description of the groundwater resources of Smith County, including the Carrizo-Wilcox, Queen City and Sparta aquifers. Location maps and records of selected wells are included.

Results of Pumping Test of Municipal Wells at Tyler, Texas.

Prepared for the Texas Water Development Board by W. L. Broadhurst, October, 1944.

City of Hawkins, Wood County, Texas.

Prepared for the Texas Water Development Board by S. C. Burnitt, March, 1963.

Ground-Water Resources of Wood County, Texas.

Prepared for the Texas Water Development Board by M. E. Broom, August, 1968.

Study of the geology in Wood County, focusing on water bearing formations including the Wilcox Group, the Carrizo Sand, the Queen City Sand and the Sparta Sand. The report also addresses the chemical quality and availability of groundwater for future development in each formation. Recrods of wells and springs in Wood County are included.

Ground-Water Resources of Cass and Marrion Counties, Texas Report 135.

Prepared by the Texas Water Development Board, October, 1971.

A discussion of the groundwater resources of Cass and Marion Counties in Region D. Aquifers include the "Cypress aquifer", which is composed of the Wilcox Group, Carrizo Sand, Reklaw formation and the Queen City Sand. Concludes that substantially increased *quantities of water can be withdrawn with proper well development. Location maps and records of selected wells are included.*

Suspended-Sediment Load of Texas Streams Compilation Report 1975-1982 Report 306.

Prepared by the Texas Water Development Board, July 1998.

Presents the results of suspended-sediment load measurements at permanent observation points from 1975 thought 1982, and references earlier publications for pre-1975 data.

Groundwater Conditions in Texas, 1980-1985, Report 309.

Prepared by the Texas Water Development Board, October 1988.

A summary description of characteristics, pumpage, and water levels in the various aquifers of Texas including the Woodbine, Carrizo-Wilcox, Queen City, Sparta, Nacatoch and Blossom Sand in Region D.

Water Quality Records for Selected Reservoirs in Texas – 1976-77 Water Years Report 271.

Prepared by the Texas Department of Water Resources, September 1982.

Tabulates results of water quality surveys in certain Texas reservoirs, including Wright Patman Lake and Lake O' the Pines in Region D, and references sources for earlier similar data.

Ground-Water Publication Abstracts, 1991.

Edited by Janie Payne, Geologist for the Texas Water Development Board, March 1992.

Includes the abstracts of various groundwater investigations conducted by the TWDB during 1991. Included reports were prepared by Ground Water Section geologists primarily from data collected by staff technicians.

Erosion and Sedimentation by Water in Texas.

Prepared for the Texas Water Development Board by John H. Greiner, Jr., Geologist U.S. Soil Conservation Service.

Presents the results of a study conducted by the Soil Conservation Service, Forest Service, and Economic Research Service – U.S. Department of Agriculture, concerning the average annual rates of soil erosion and sedimentation within the State of Texas. Provides estimates of the amounts of grass sheet and rill erosion and gully and streambank erosion occurring on an average annual basis above 300 yield points.

An Analysis of Bottomland Hardwood Areas at Three Proposed Reservoir Sites in Northeast Texas.

Prepared by the Texas Water Development Board, 1997.

Water Requirements in Texas and Proposed Projects in Lower Red River Basin, Sulphur River Basin and Cypress Creek.

Prepared by the Texas Water Development Board, 1967.

U. S. ENVIRONMENTAL PROTECTION AGENCY

Report on Caddo Lake, Caddo Parish, Louisiana Marion and Harrison County, Texas.
Prepared by the U.S. Environmental Protection Agency, 1977.

Report on Lake Tawakoni, Hunt, Rain, and Van Zandt Counties, Texas.
Prepared by the U.S. Environmental Protection Agency, 1977.

Report on Wright Patman (Texarkana) Reservoir, Bowie and CassCounties, Texas.
Prepared by the U.S. Environmental Protection Agency, 1977.

USGS REPORTS

Ground Water in the Greenville Area, Hunt County, Texas.

Prepared by Nicholas Anthony Rose in cooperation between the Geological Survey, U.S. Department of the Interior, and the Texas State Board of Water Engineering, 1963.

Surface Water Supplies in Gregg County, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1943.

Water Supply near Woodall, in southwestern Corner of Harrison County, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1942.

Harrison County, Texas Water Resources.

Prepared by W.L. Broadhurst and S.D. Breeding for the Texas Board of Water Engineers, 1943.

Surface Water of Harrison County, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1943.

Ground Water Resources of Harrison County, Texas.

Prepared by M.E. Broom and B.N. Myers and the U.S. Geological Survey in cooperation with the Texas Water Development Board and the Harrison county Commissioners Court, 1966.

Surface Water Supply of Marion County, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1943.

Surface Water Supply of Cass County, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1943.

Surface WaterSupply of Camp, Franklin, and Titus Counties, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1945.

Surface Water Supply of Rains County, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1943.

Surface Water Supply of Hopkins county, Texas.

Prepared by the U.S. Geological Survey. Water Resources Division (Tex.), 1943.

CORPS OF ENGINEERS REPORTS

Caddo Lake Enlargement, Louisiana and Texas: Summary of Results.
Prepared by U.S. Corps of Engineers, 1985.

Survey Report on Sanders, Big Pine and Collier Creeks, Texas.
Prepared by U.S. Corps of Engineers, 1961.

OTHER REPORTS

Study of Potential Sources of Additional Surface Water Supply in the Red River Basin and the Cypress Creek Basin.

Prepared by Freese and Nichols, 1979.

Water Supply and Water Quality Control Study, Pat Mayse Reservoir, Sanders Creek, Texas: Study of Needs and Value of Storage for Municipal and Industrial Water Supply and Water Quality Control.

Prepared by U.S. Public Health Service, 1965.

An Ecological Assessment of Big Cypress Creek, Lake O' Pines, and Ellison Creek Reservoir, Lone Star, Texas.

Prepared by Glenn C. Millner and Alan C. Nye, 1990.

Water Storage Reservoir near Longview, Texas.

Prepared by Freese and Nichols for Tennessee Eastman Corporation, Texas Division Longview, Texas, 1950.

Comprehensive Development Plan: Waterworks, Sanitary Sewerage, Drainage.

Prepared by Henningson, Durham and Richardson, Inc., for Ark-Tex Council of Governments, 1970.

Water Quality Management Plan.

Prepared by the Texas Water Quality Board for the Red Basin, 1975.

Work Plan for Watershed Protection, Flood Prevention and Nonagricultural Water Management, Landford Creek Watershed, Red River County, Texas.

Prepared by Red River County Soil Conservation District with assistance by U.S. Department of Agriculture, Soil Conservation Service, 1958.

Work Plan for Watershed Protection, Flood Prevention, and Agricultural Water Management: Logan-Slough Creek Watershed, Lamar County, Texas.

Prepared by the U.S. Soil Conservation Service, 1963.

Table 1: Population Projections by County and Basin

COUNTY NAME	BASIN NAME		pop2000	pop2010	pop2020	pop2030	pop2040	pop2050
BOWIE	RED	12,809	12,433	13,509	14,590	15,668	16,764	17,858
	SULPHUR	72,164	79,316	86,292	93,263	100,237	107,193	114,151
CAMP	CYPRESS	10,692	10,849	13,668	14,488	15,307	16,127	16,946
CASS	SULPHUR	3,975	4,189	4,503	4,845	5,189	5,556	5,922
	CYPRESS	26,750	27,996	29,906	31,789	33,669	35,526	37,385
DELTA	SULPHUR	5,014	6,091	6,127	6,148	6,148	6,148	6,148
FRANKLIN	SULPHUR	5,387	5,685	6,604	7,513	8,535	9,101	9,704
	CYPRESS	3,255	3,463	4,047	4,625	5,273	5,634	6,020
	SABINE	82	94	109	125	142	151	161
GREGG	SABINE	109,798	112,504	123,250	134,039	144,760	155,399	166,017
	CYPRESS	1,711	1,485	1,782	2,036	2,359	2,763	3,188
HARRISON	SABINE	39,372	39,799	43,758	46,581	49,794	53,185	56,467
	CYPRESS	21,077	21,415	23,547	25,065	26,793	28,619	30,383
HOPKINS	SULPHUR	23,900	24,651	27,335	30,010	32,682	35,365	38,046
	CYPRESS	299	315	347	382	417	455	491
	SABINE	6,814	7,029	7,785	8,546	9,311	10,061	10,816
HUNT	SULPHUR	13,011	13,409	14,907	16,411	17,932	19,469	20,988
	SABINE	55,783	58,709	65,464	72,213	78,943	85,657	92,388
	TRINITY	382	401	443	486	531	576	621
LAMAR	RED	22,590	23,935	26,594	28,516	30,449	32,263	34,116
	SULPHUR	23,066	23,601	25,271	26,951	28,634	30,309	31,979
MARION	CYPRESS	10,405	10,964	11,671	12,378	13,085	13,792	14,499
MORRIS	CYPRESS	12,232	13,112	13,278	13,351	13,382	13,375	13,369
	SULPHUR	1,253	1,334	1,381	1,412	1,431	1,438	1,443
RAINS	SABINE	7,457	7,765	9,033	10,300	11,567	12,834	14,101
RED RIVER	SULPHUR	11,774	11,814	11,822	11,818	11,807	11,796	11,765
	RED	2,888	2,947	2,970	2,989	3,033	3,093	3,172
SMITH	SABINE	23,377	24,357	27,517	30,678	33,838	36,999	40,159
TITUS	CYPRESS	20,989	21,131	23,261	25,377	27,515	29,642	31,781
	SULPHUR	5,275	5,443	6,032	6,635	7,216	7,807	8,387
UPSHUR	SABINE	12,229	11,788	13,050	13,602	14,644	15,834	16,708
	CYPRESS	22,291	21,427	23,683	24,634	26,458	28,545	30,034
VAN ZANDT	SABINE	23,090	24,329	27,982	31,637	35,292	38,947	42,599
	NECHES	10,821	11,406	13,120	14,833	16,545	18,257	19,973
	TRINITY	8,156	8,617	9,912	11,206	12,501	13,796	15,089
WOOD	SABINE	31,392	31,394	35,410	39,426	43,442	47,458	51,476
	CYPRESS	1,920	1,908	2,152	2,396	2,640	2,884	3,127
TOTAL		**663,480**	**687,105**	**757,522**	**821,294**	**887,169**	**952,818**	**1,017,477**

Table 2: Municipal Water Demand Projections by County and River Basin							
COUNTY NAME	**BASIN NAME**	**D1996**	**D2000**	**D2010**	**D2020**	**D2030**	**D2040**
BOWIE	SULPHUR	10,133	13,613	14,031	14,454	15,072	15,674
	RED	1,804	2,044	2,097	2,152	2,241	2,331
CAMP	CYPRESS	1,602	1,747	2,048	2,086	2,139	2,191
CASS	SULPHUR	497	571	588	616	628	646
	CYPRESS	3,751	4,443	4,532	4,585	4,693	4,767
DELTA	SULPHUR	639	926	898	866	838	810
FRANKLIN	SABINE	14	18	20	21	24	25
	CYPRESS	612	754	838	918	1,023	1,079
	SULPHUR	898	1,233	1,358	1,474	1,642	1,726
GREGG	SABINE	16,222	21,481	22,262	23,079	24,353	25,564
	CYPRESS	274	201	225	236	275	310
HARRISON	SABINE	5,772	6,653	6,983	7,116	7,384	7,651
	CYPRESS	2,680	3,224	3,401	3,472	3,592	3,710
HOPKINS	SULPHUR	4,604	4,311	4,548	4,737	5,035	5,292
	CYPRESS	62	51	55	57	61	65
	SABINE	1,375	1,169	1,232	1,284	1,359	1,425
HUNT	SABINE	8,106	10,584	11,309	11,826	12,690	13,428
	SULPHUR	2,091	2,835	3,026	3,194	3,423	3,629
	TRINITY	44	56	59	165	65	70
LAMAR	RED	3,477	5,275	5,514	5,671	5,874	6,082
	SULPHUR	3,728	5,334	5,433	5,479	5,733	5,936
MARION	CYPRESS	1,385	1,696	1,737	1,774	1,813	1,854
MORRIS	CYPRESS	1,443	1,752	1,696	1,631	1,570	1,512
	SULPHUR	135	185	184	176	176	169
RAINS	SABINE	1,219	1,374	1,513	1,637	1,787	1,940
RED RIVER	SULPHUR	1,589	1,647	1,582	1,515	1,458	1,416
	RED	365	371	359	348	337	328
SMITH	SABINE	4,278	3,759	3,992	4,206	4,489	4,786
TITUS	SULPHUR	790	733	785	833	873	909
	CYPRESS	4,839	3,994	4,209	4,407	4,656	4,907
UPSHUR	SABINE	1,567	1,834	1,936	1,933	2,010	2,101
	CYPRESS	2,963	3,233	3,429	3,421	3,573	3,745
VAN ZANDT	NECHES	1,538	1,655	1,832	1,989	2,148	2,286
	SABINE	3,114	3,696	4,063	4,398	4,761	5,074
	TRINITY	977	1,162	1,284	1,392	1,494	1,586
WOOD	SABINE	4,875	4,923	5,222	5,487	5,896	6,197
	CYPRESS	280	265	281	293	313	327
TOTAL		**99,742**	**118,802**	**124,561**	**128,928**	**135,498**	**141,548**

D2050
16,439
2,468
2,250
665
4,865
790
26
1,147
1,829
27,138
355
8,005
3,850
5,648
68
1,522
14,212
3,880
71
6,355
6,214
1,896
1,473
165
2,111
1,370
321
5,154
938
5,191
2,152
3,849
2,428
5,439
1,681
6,785
358
149,108

Table 3: Manufacturing Water Demand Projections by County and River Basin

COUNTY NAME	BASIN NAME	D1996	D2000	D2010	D2020	D2030	D2040	D2050
		(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)
BOWIE	SULPHUR	1,880	1,937	2,143	2,355	2,576	2,809	3,051
	RED	5	7	9	11	14	17	20
CAMP	CYPRESS	33	10	2,242	2,242	2,242	2,242	2,242
CASS	SULPHUR	79,066	80,102	76,834	76,834	74,528	77,507	80,609
	CYPRESS	57	27	33	37	41	48	55
DELTA	SULPHUR	0	8	8	8	8	8	8
FRANKLIN	SABINE	0	0	0	0	0	0	0
	SULPHUR	0	3	3	3	3	3	3
	CYPRESS	0	3	3	3	3	3	3
GREGG	CYPRESS	0	0	0	0	0	0	0
	SABINE	3,826	16,538	18,576	20,934	23,507	26,515	29,716
HARRISON	CYPRESS	432	1,267	1,579	1,643	1,706	1,864	2,049
	SABINE	49,260	109,321	133,587	140,270	146,243	159,506	174,422
HOPKINS	SULPHUR	627	2,646	2,841	3,004	3,131	3,389	3,648
	CYPRESS	0	0	0	0	0	0	0
	SABINE	0	8	12	12	17	21	21
HUNT	TRINITY	0	0	0	0	0	0	0
	SULPHUR	78	190	246	314	396	499	620
	SABINE	725	550	572	589	602	630	656
LAMAR	RED	622	555	565	575	582	621	670
	SULPHUR	4,557	4,867	5,648	6,357	6,993	7,969	8,938
MARION	CYPRESS	35	20	20	20	20	20	20
MORRIS	SULPHUR	4	0	0	0	0	0	0
	CYPRESS	96,267	132,451	135,264	129,869	124,443	119,127	113,929
RAINS	SABINE	1	2	2	2	2	2	2
RED RIVER	SULPHUR	9	11	15	17	19	21	25
	RED	0	0	0	0	0	0	0
SMITH	SABINE	181	262	298	325	346	377	403
TITUS	CYPRESS	2,832	3,734	3,997	4,199	4,357	4,722	5,079
	SULPHUR	0	0	0	0	0	0	0
UPSHUR	CYPRESS	161	215	232	241	243	277	314
	SABINE	0	0	0	0	0	0	0
VAN ZANDT	SABINE	607	280	344	396	451	508	566
	NECHES	0	0	0	0	0	0	0
	TRINITY	0	0	0	0	0	0	0
WOOD	SABINE	149	244	290	341	391	468	544
	CYPRESS	0	0	0	0	0	0	0
TOTAL		**241,414**	**355,258**	**385,363**	**390,601**	**392,864**	**409,173**	**427,613**

Table 4: Irrigation Water Demand Projections by County and River Basin

COUNTY NAME	BASIN NAME	D1996	D2000	D2010	D2020	D2030	D2040	D2050
BOWIE	SULPHUR	0	0	0	0	0	0	0
	RED	5,025	4,400	4,620	4,620	4,620	4,500	4,200
CAMP	CYPRESS	32	87	87	87	87	87	87
CASS	SULPHUR	0	0	0	0	0	0	0
	CYPRESS	13	0	0	0	0	0	0
DELTA	SULPHUR	4	1,978	1,956	1,934	1,913	1,891	1,870
FRANKLIN	SABINE	0	0	0	0	0	0	0
	SULPHUR	0	21	21	21	21	21	21
	CYPRESS	44	12	12	12	12	12	12
GREGG	CYPRESS	0	0	0	0	0	0	0
	SABINE	25	0	0	0	0	0	0
HARRISON	CYPRESS	106	50	50	50	50	50	50
	SABINE	0	50	50	50	50	50	50
HOPKINS	SULPHUR	25	0	0	0	0	0	0
	CYPRESS	0	0	0	0	0	0	0
	SABINE	0	0	0	0	0	0	0
HUNT	TRINITY	0	0	0	0	0	0	0
	SULPHUR	142	0	0	0	0	0	0
	SABINE	476	271	271	271	271	271	271
LAMAR	RED	4,700	4,368	4,319	4,271	4,223	4,176	4,129
	SULPHUR	0	0	0	0	0	0	0
MARION	CYPRESS	98	0	0	0	0	0	0
MORRIS	SULPHUR	0	0	0	0	0	0	0
	CYPRESS	121	190	188	186	184	182	180
RAINS	SABINE	27	20	20	20	20	20	20
RED RIVER	SULPHUR	2,680	45	44	44	43	43	42
	RED	800	54	54	53	53	52	52
SMITH	SABINE	86	446	468	491	516	542	569
TITUS	CYPRESS	0	0	0	0	0	0	0
	SULPHUR	0	0	0	0	0	0	0
UPSHUR	CYPRESS	20	0	0	0	0	0	0
	SABINE	0	0	0	0	0	0	0
VAN ZANDT	SABINE	0	0	0	0	0	0	0
	NECHES	1,015	0	0	0	0	0	0
	TRINITY	0	220	220	220	220	220	220
WOOD	SABINE	179	235	235	235	235	235	235
	CYPRESS	40	119	119	119	119	119	119
TOTAL		**15,658**	**12,566**	**12,734**	**12,684**	**12,637**	**12,471**	**12,127**

Table 5: Steam Electric Water Demand Projections by County and River Basin

COUNTY NAME	BASIN NAME	D1996	D2000	D2010	D2020	D2030	D2040	D2050
		(AF)	(AF)	(AF)	(AF)	(AF)	(AF)	(AF)
BOWIE	SULPHUR	0	0	0	0	0	0	0
	RED	0	0	0	0	0	0	0
CAMP	CYPRESS	0	0	0	0	0	0	0
CASS	SULPHUR	0	0	0	0	0	0	0
	CYPRESS	0	0	0	0	0	0	0
DELTA	SULPHUR	0	0	0	0	0	0	0
FRANKLIN	SABINE	0	0	0	0	0	0	0
	SULPHUR	0	0	0	0	0	0	0
	CYPRESS	0	0	0	0	0	0	0
GREGG	CYPRESS	0	0	0	0	0	0	0
	SABINE	1,723	1,251	1,251	1,251	1,251	1,251	1,251
HARRISON	CYPRESS	0	0	0	0	0	0	0
	SABINE	8,972	5,760	5,760	5,760	5,760	5,760	5,760
HOPKINS	SULPHUR	0	0	0	0	0	0	0
	CYPRESS	0	0	0	0	0	0	0
	SABINE	0	0	0	0	0	0	0
HUNT	TRINITY	0	0	0	0	0	0	0
	SULPHUR	0	0	0	0	0	0	0
	SABINE	405	516	516	516	516	516	516
LAMAR	RED	0	12,209	12,209	12,209	12,209	12,209	12,209
	SULPHUR	0	0	0	0	0	0	0
MARION	CYPRESS	3,321	2,868	2,868	2,868	2,868	2,868	2,868
MORRIS	SULPHUR	0	0	0	0	0	0	0
	CYPRESS	16	48	48	48	48	48	48
RAINS	SABINE	0	0	0	0	0	0	0
RED RIVER	SULPHUR	227	1,500	5,000	7,000	10,000	10,000	10,000
	RED	0	0	0	0	0	0	0
SMITH	SABINE	0	0	0	0	0	0	0
TITUS	CYPRESS	31,388	28,280	31,280	31,280	36,280	36,280	36,280
	SULPHUR	0	0	0	0	0	0	0
UPSHUR	CYPRESS	0	0	5,601	5,601	5,601	5,601	5,601
	SABINE	0	0	0	0	0	0	0
VAN ZANDT	SABINE	0	0	0	0	0	0	0
	NECHES	0	0	0	0	0	0	0
	TRINITY	0	0	0	0	0	0	0
WOOD	SABINE	0	0	7,500	7,500	7,500	7,500	15,000
	CYPRESS	0	0	0	0	0	0	0
TOTAL		**46,052**	**52,432**	**72,033**	**74,033**	**82,033**	**82,033**	**89,533**

Table 6: Mining Water Demand Projections by County and River Basins

COUNTY NAME	BASIN NAME	D1996 (AF)	D2000 (AF)	D2010 (AF)	D2020 (AF)	D2030 (AF)	D2040 (AF)	D2050 (AF)
BOWIE	SULPHUR	16	29	29	30	32	36	41
	RED	25	24	23	23	24	25	25
CAMP	CYPRESS	24	132	131	131	131	131	131
CASS	SULPHUR	626	709	535	523	509	494	483
	CYPRESS	419	545	455	419	393	378	13
DELTA	SULPHUR	0	0	0	0	0	0	0
FRANKLIN	SABINE	0	0	0	0	0	0	0
	SULPHUR	501	596	571	553	535	538	550
	CYPRESS	853	883	813	785	743	759	809
GREGG	CYPRESS	0	0	0	0	0	0	0
	SABINE	129	96	67	46	37	29	27
HARRISON	CYPRESS	209	180	192	197	211	204	201
	SABINE	283	190	178	173	159	166	169
HOPKINS	SULPHUR	148	125	122	120	117	116	116
	CYPRESS	0	0	0	0	0	0	0
	SABINE	0	0	0	0	0	0	0
HUNT	TRINITY	0	0	0	0	0	0	0
	SULPHUR	0	0	0	0	0	0	0
	SABINE	67	70	71	73	75	77	79
LAMAR	RED	11	13	13	13	13	13	13
	SULPHUR	11	12	11	11	12	12	12
MARION	CYPRESS	99	71	43	30	24	20	34
MORRIS	SULPHUR	0	0	0	0	0	0	0
	CYPRESS	39	31	16	12	10	10	11
RAINS	SABINE	0	0	0	0	0	0	0
RED RIVER	SULPHUR	0	0	0	0	0	0	0
	RED	0	0	0	0	0	0	0
SMITH	SABINE	203	425	178	91	32	18	6
TITUS	CYPRESS	3,045	2,518	1,870	1,735	1,692	1,695	1,744
	SULPHUR	304	254	121	61	30	10	0
UPSHUR	CYPRESS	1	1	1	1	1	1	0
	SABINE	0	0	0	0	0	0	0
VAN ZANDT	SABINE	1,328	1,233	1,073	1,026	1,014	1,025	1,055
	NECHES	48	80	48	28	19	14	14
	TRINITY	45	46	46	45	44	45	46
WOOD	SABINE	562	2,102	17,584	17,344	17,107	16,107	4,641
	CYPRESS	0	0	0	0	0	0	0
TOTAL		**8,996**	**10,365**	**24,191**	**23,470**	**22,964**	**21,923**	**10,220**

Table 7: Livestock Water Demand Projections by County and River Basin

COUNTY NAME	BASIN NAME	D1996 (AF)	D2000 (AF)	D2010 (AF)	D2020 (AF)	D2030 (AF)	D2040 (AF)	D2050 (AF)
BOWIE	SULPHUR	1,233	2,331	2,445	2,445	2,445	2,223	1,905
	RED	708	1,340	1,405	1,405	1,405	1,277	1,095
CAMP	CYPRESS	982	800	800	800	800	800	800
CASS	SULPHUR	246	255	255	255	255	255	255
	CYPRESS	574	596	596	596	596	596	596
DELTA	SULPHUR	344	770	770	770	770	770	770
FRANKLIN	SABINE	2	2	2	2	2	2	2
	SULPHUR	880	990	990	990	990	990	990
	CYPRESS	536	603	603	603	603	603	603
GREGG	CYPRESS	28	35	35	35	35	35	35
	SABINE	187	230	230	230	230	230	230
HARRISON	CYPRESS	410	570	599	628	660	694	727
	SABINE	302	421	441	464	487	511	537
HOPKINS	SULPHUR	4,532	4,771	4,771	4,771	4,771	4,771	4,771
	CYPRESS	189	199	199	199	199	199	199
	SABINE	2,023	2,130	2,130	2,130	2,130	2,130	2,130
HUNT	TRINITY	14	10	10	10	10	10	10
	SULPHUR	477	331	331	331	331	331	331
	SABINE	1,288	896	896	896	896	896	896
LAMAR	RED	1,233	953	953	953	953	953	953
	SULPHUR	737	570	570	570	570	570	570
MARION	CYPRESS	165	182	182	182	182	182	182
MORRIS	SULPHUR	157	200	200	200	200	200	200
	CYPRESS	333	424	424	424	424	424	424
RAINS	SABINE	721	700	700	700	700	700	700
RED RIVER	SULPHUR	1,142	698	698	698	698	698	698
	RED	787	482	482	482	482	482	482
SMITH	SABINE	383	453	453	453	453	453	453
TITUS	CYPRESS	479	370	370	370	370	370	370
	SULPHUR	632	488	488	488	488	488	488
UPSHUR	CYPRESS	1,885	1,510	1,510	1,510	1,510	1,510	1,510
	SABINE	522	418	418	418	418	418	418
VAN ZANDT	SABINE	1,068	1,100	1,100	1,100	1,100	1,100	1,100
	NECHES	638	657	657	657	657	657	657
	TRINITY	605	624	624	624	624	624	624
WOOD	SABINE	2,513	2,360	2,360	2,360	2,360	2,360	2,360
	CYPRESS	215	202	202	202	202	202	202
TOTAL		**29,170**	**29,671**	**29,899**	**29,951**	**30,006**	**29,714**	**29,273**

Table 8: Population and Water Demand Projections for Bowie County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
DE KALB	1,863	2,026	2,190	2,353	2,516	2,680
HOOKS	2,822	3,070	3,318	3,565	3,813	4,061
MAUD	1,023	1,112	1,202	1,292	1,382	1,471
NASH	2,313	2,516	2,719	2,922	3,125	3,328
NEW BOSTON	5,043	5,485	5,928	6,370	6,813	7,255
REDWATER	843	917	991	1,065	1,139	1,213
TEXARKANA	42,193	45,896	49,599	53,301	57,004	60,707
WAKE VILLAGE	5,098	5,546	5,993	6,441	6,888	7,336
COUNTY-OTHER	30,551	33,233	35,913	38,596	41,277	43,958
TOTAL POPULATION	**91,749**	**99,801**	**107,853**	**115,905**	**123,957**	**132,009**
WATER DEMAND						
DE KALB	246	252	255	263	274	288
HOOKS	440	454	465	484	495	528
MAUD	132	138	144	149	153	157
NASH	298	313	326	337	347	354
NEW BOSTON	1,109	1,164	1,217	1,280	1,346	1,425
REDWATER	109	114	119	123	126	129
TEXARKANA	7,421	7,660	7,889	8,240	8,557	8,976
WAKE VILLAGE	657	690	718	743	764	781
COUNTY-OTHER	5,245	5,343	5,473	5,694	5,943	6,269
TOTAL MUNICIPAL WATER DEMAN	**15,657**	**16,128**	**16,606**	**17,313**	**18,005**	**18,907**
MANUFACTURING WATER DEMANI	**1,944**	**2,152**	**2,366**	**2,590**	**2,826**	**3,071**
IRRIGATION WATER DEMAND	**4,400**	**4,620**	**4,620**	**4,620**	**4,500**	**4,200**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**53**	**52**	**53**	**56**	**61**	**66**
LIVESTOCK WATER DEMAND	**3,671**	**3,850**	**3,850**	**3,850**	**3,500**	**3,000**
TOTAL WATER DEMAND	**25,725**	**26,802**	**27,495**	**28,429**	**28,892**	**29,244**

Table 9: Population and Water Demand Projections for Camp County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
PITTSBURG	4,454	4,790	5,126	5,463	5,799	6,135
COUNTY-OTHER	6,395	8,878	9,362	9,844	10,328	10,811
TOTAL POPULATION	**10,849**	**13,668**	**14,488**	**15,307**	**16,127**	**16,946**
WATER DEMAND						
PITTSBURG	923	944	964	1,003	1,046	1,100
COUNTY-OTHER	824	1,104	1,122	1,136	1,145	1,150
TOTAL MUNICIPAL WATER DEMAND	**1,747**	**2,048**	**2,086**	**2,139**	**2,191**	**2,250**
MANUFACTURING WATER DEMAND	**10**	**2242**	**2242**	**2242**	**2242**	**2242**
IRRIGATION WATER DEMAND	**87**	**87**	**87**	**87**	**87**	**87**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**132**	**131**	**131**	**131**	**131**	**131**
LIVESTOCK WATER DEMAND	**800**	**800**	**800**	**800**	**800**	**800**
TOTAL WATER DEMAND	**2,776**	**5,308**	**5,346**	**5,399**	**5,451**	**5,510**

Table 10: Population and Water Demand Projections for Cass County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
ATLANTA	6,342	6,637	6,857	7,038	7,133	7,229
HUGHES SPRINGS	2,148	2,281	2,308	2,354	2,354	2,354
LINDEN	2,465	2,635	2,806	2,976	3,146	3,317
QUEEN CITY	2,058	2,201	2,343	2,485	2,627	2,770
COUNTY-OTHER	19,172	20,655	22,320	24,005	25,822	27,637
TOTAL POPULATION	**32,185**	**34,409**	**36,634**	**38,858**	**41,082**	**43,307**
WATER DEMAND						
ATLANTA	1,421	1,420	1,406	1,411	1,406	1,417
HUGHES SPRINGS	488	496	478	480	469	467
LINDEN	326	325	327	337	342	357
QUEEN CITY	309	311	315	323	332	348
COUNTY-OTHER	2,470	2,568	2,675	2,770	2,864	2,941
TOTAL MUNICIPAL WATER DEMAND	**5,014**	**5,120**	**5,201**	**5,321**	**5,413**	**5,530**
MANUFACTURING WATER DEMAND	**80129**	**76867**	**76871**	**74569**	**77555**	**80664**
IRRIGATION WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**1254**	**990**	**942**	**902**	**872**	**496**
LIVESTOCK WATER DEMAND	**851**	**851**	**851**	**851**	**851**	**851**
TOTAL WATER DEMAND	**87,248**	**83,828**	**83,865**	**81,643**	**84,691**	**87,541**

Table 11: Population and Water Demand Projections for Delta County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
COOPER	2,346	2,382	2,403	2,403	2,403	2,403
COUNTY-OTHER	3,745	3,745	3,745	3,745	3,745	3,745
TOTAL POPULATION	**6,091**	**6,127**	**6,148**	**6,148**	**6,148**	**6,148**
WATER DEMAND						
COOPER	423	411	396	385	374	371
COUNTY-OTHER	503	487	470	453	436	419
TOTAL MUNICIPAL WATER DEMAND	**926**	**898**	**866**	**838**	**810**	**790**
MANUFACTURING WATER DEMAND	**8**	**8**	**8**	**8**	**8**	**8**
IRRIGATION WATER DEMAND	**1,978**	**1,956**	**1,934**	**1,913**	**1,891**	**1,870**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
LIVESTOCK WATER DEMAND	**770**	**770**	**770**	**770**	**770**	**770**
TOTAL WATER DEMAND	**3,682**	**3,632**	**3,578**	**3,529**	**3,479**	**3,438**

Table 12: Population and Water Demand Projections for Franklin County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
MOUNT VERNON	2,631	3,031	3,428	3,874	4,120	4,382
WINNSBORO	776	903	1,030	1,171	1,250	1,334
COUNTY-OTHER	5,835	6,826	7,805	8,905	9,516	10,169
TOTAL POPULATION	**9,242**	**10,760**	**12,263**	**13,950**	**14,886**	**15,885**
WATER DEMAND						
MOUNT VERNON	545	594	637	707	738	780
WINNSBORO	146	162	176	196	205	217
COUNTY-OTHER	1,314	1,460	1,600	1,786	1,887	2,005
TOTAL MUNICIPAL WATER DEMANI	**2,005**	**2,216**	**2,413**	**2,689**	**2,830**	**3,002**
MANUFACTURING WATER DEMAND	**6**	**6**	**6**	**6**	**6**	**6**
IRRIGATION WATER DEMAND	**33**	**33**	**33**	**33**	**33**	**33**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**1,479**	**1,384**	**1,338**	**1,278**	**1,297**	**1,359**
LIVESTOCK WATER DEMAND	**1,595**	**1,595**	**1,595**	**1,595**	**1,595**	**1,595**
TOTAL WATER DEMAND	**5,118**	**5,234**	**5,385**	**5,601**	**5,761**	**5,995**

Table 13: Population and Water Demand Projections for Gregg County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
CLARKSVILLE CITY	964	1,057	1,151	1,244	1,337	1,431
GLADEWATER	4,126	4,525	4,925	5,325	5,724	6,124
KILGORE	9,276	10,174	11,073	11,971	12,870	13,769
LAKEPORT	1,834	2,012	2,190	2,367	2,545	2,723
LIBERTY CITY	945	1,036	1,128	1,219	1,311	1,402
LONGVIEW	76,438	82,596	89,188	95,336	101,080	107,170
WHITE OAK	6,056	6,643	7,230	7,817	8,403	8,990
COUNTY-OTHER	14,350	16,989	19,190	21,840	24,892	27,596
TOTAL POPULATION	**113,989**	**125,032**	**136,075**	**147,119**	**158,162**	**169,205**
WATER DEMAND						
CLARKSVILLE CITY	124	131	138	144	148	152
GLADEWATER	721	745	767	811	853	906
KILGORE	1,984	2,074	2,158	2,280	2,407	2,560
LAKEPORT	122	129	135	141	145	149
LIBERTY CITY	345	356	368	390	414	439
LONGVIEW	15,498	15,913	16,484	17,193	17,889	18,847
WHITE OAK	848	870	890	928	969	1,027
COUNTY-OTHER	2,040	2,269	2,375	2,741	3,049	3,413
TOTAL MUNICIPAL WATER DEMANI	**21,682**	**22,487**	**23,315**	**24,628**	**25,874**	**27,493**
MANUFACTURING WATER DEMAND	**16,538**	**18,576**	**20,934**	**23,507**	**26,515**	**29,716**
IRRIGATION WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
STEAM ELECTRIC WATER DEMAND	**1,251**	**1,251**	**1,251**	**1,251**	**1,251**	**1,251**
MINING WATER DEMAND	**96**	**67**	**46**	**37**	**29**	**27**
LIVESTOCK WATER DEMAND	**265**	**265**	**265**	**265**	**265**	**265**
TOTAL WATER DEMAND	**39,832**	**42,646**	**45,811**	**49,688**	**53,934**	**58,752**

Table 14: Population and Water Demand Projections for Harrison County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
HALLSVILLE	2,849	3,133	3,335	3,565	3,808	4,042
LONGVIEW	1,807	1,987	2,115	2,261	2,415	2,564
MARSHALL	25,316	27,835	29,631	31,674	33,832	35,918
WASKOM	1,890	2,078	2,212	2,364	2,525	2,681
COUNTY-OTHER	29,352	32,272	34,353	36,723	39,224	41,645
TOTAL POPULATION	**61,214**	**67,305**	**71,646**	**76,587**	**81,804**	**86,850**
WATER DEMAND						
HALLSVILLE	383	407	418	431	444	453
LONGVIEW	366	382	391	408	427	451
MARSHALL	4,906	5,113	5,177	5,393	5,609	5,955
WASKOM	277	289	292	301	312	331
COUNTY-OTHER	3,945	4,193	4,310	4,443	4,569	4,665
TOTAL MUNICIPAL WATER DEMANI	**9,877**	**10,384**	**10,588**	**10,976**	**11,361**	**11,855**
MANUFACTURING WATER DEMAND	**110,588**	**135,166**	**141,913**	**147,949**	**161,370**	**176,471**
IRRIGATION WATER DEMAND	**100**	**100**	**100**	**100**	**100**	**100**
STEAM ELECTRIC WATER DEMAND	**5,760**	**5,760**	**5,760**	**5,760**	**5,760**	**5,760**
MINING WATER DEMAND	**370**	**370**	**370**	**370**	**370**	**370**
LIVESTOCK WATER DEMAND	**991**	**1,040**	**1,092**	**1,147**	**1,205**	**1,264**
TOTAL WATER DEMAND	**127,686**	**152,820**	**159,823**	**166,302**	**180,166**	**195,820**

Table 15: Population and Water Demand Projections for Hopkins County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
COMO	643	713	783	853	923	992
CUMBY	701	777	853	929	1,005	1,081
SULPHUR SPRINGS	15,367	17,034	18,701	20,369	22,036	23,703
COUNTY-OTHER	15,284	16,943	18,601	20,259	21,917	23,577
TOTAL POPULATION	**31,995**	**35,467**	**38,938**	**42,410**	**45,881**	**49,353**
WATER DEMAND						
COMO	100	105	109	115	121	129
CUMBY	105	110	113	120	125	133
SULPHUR SPRINGS	2,771	2,920	3,037	3,240	3,407	3,637
COUNTY-OTHER	2,555	2,700	2,819	2,980	3,129	3,339
TOTAL MUNICIPAL WATER DEMANI	**5,531**	**5,835**	**6,078**	**6,455**	**6,782**	**7,238**
MANUFACTURING WATER DEMAND	**2,654**	**2,853**	**3,016**	**3,148**	**3,410**	**3,669**
IRRIGATION WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**125**	**122**	**120**	**117**	**116**	**116**
LIVESTOCK WATER DEMAND	**7,100**	**7,100**	**7,100**	**7,100**	**7,100**	**7,100**
TOTAL WATER DEMAND	**15,410**	**15,910**	**16,314**	**16,820**	**17,408**	**18,123**

Table 16: Population and Water Demand Projections for Hunt County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
CADDO MILLS	1,180	1,315	1,450	1,585	1,720	1,855
CAMPBELL	836	932	1,027	1,123	1,219	1,314
CELESTE	915	1,019	1,124	1,229	1,333	1,438
COMMERCE	7,271	8,103	8,935	9,767	10,599	11,430
GREENVILLE	25,764	28,711	31,658	34,605	37,553	40,500
LONE OAK	627	698	770	842	914	985
QUINLAN	1,650	1,838	2,027	2,216	2,405	2,593
WEST TAWAKONI	1,192	1,329	1,465	1,602	1,738	1,874
WOLFE CITY	1,633	1,820	2,007	2,194	2,381	2,568
COUNTY-OTHER	31,451	35,049	38,647	42,243	45,840	49,440
TOTAL POPULATION	**72,519**	**80,814**	**89,110**	**97,406**	**105,702**	**113,997**
WATER DEMAND						
CADDO MILLS	152	164	174	183	191	197
CAMPBELL	112	121	129	136	142	147
CELESTE	118	127	135	142	148	153
COMMERCE	2,036	2,178	2,302	2,483	2,647	2,855
GREENVILLE	6,291	6,689	7,021	7,520	8,034	8,620
LONE OAK	81	87	92	97	101	105
QUINLAN	213	229	243	256	267	276
WEST TAWAKONI	207	219	228	244	258	275
WOLFE CITY	214	222	229	243	256	274
COUNTY-OTHER	4,051	4,358	4,632	4,874	5,083	5,261
TOTAL MUNICIPAL WATER DEMANI	**13,475**	**14,394**	**15,185**	**16,178**	**17,127**	**18,163**
MANUFACTURING WATER DEMAND	**740**	**818**	**903**	**998**	**1,129**	**1,276**
IRRIGATION WATER DEMAND	**271**	**271**	**271**	**271**	**271**	**271**
STEAM ELECTRIC WATER DEMAND	**516**	**516**	**516**	**516**	**516**	**516**
MINING WATER DEMAND	**70**	**71**	**73**	**75**	**77**	**79**
LIVESTOCK WATER DEMAND	**1,237**	**1,237**	**1,237**	**1,237**	**1,237**	**1,237**
TOTAL WATER DEMAND	**16,309**	**17,307**	**18,185**	**19,275**	**20,357**	**21,542**

Table 17: Population and Water Demand Projections for Lamar County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
BLOSSOM	1,734	1,853	1,972	2,092	2,211	2,330
DEPORT	876	936	996	1,056	1,117	1,177
PARIS	26,970	28,826	30,682	32,538	34,394	36,250
RENO	3,059	4,327	4,869	5,424	5,852	6,314
ROXTON	724	773	823	873	923	973
COUNTY-OTHER	14,173	15,150	16,125	17,100	18,075	19,051
TOTAL POPULATION	**47,536**	**51,865**	**55,467**	**59,083**	**62,572**	**66,095**
WATER DEMAND						
BLOSSOM	223	230	236	241	245	248
DEPORT	113	116	119	122	124	125
PARIS	7,583	7,750	7,904	8,237	8,552	8,973
RENO	411	562	611	656	682	707
ROXTON	93	96	99	101	102	103
COUNTY-OTHER	2,186	2,193	2,181	2,250	2,313	2,413
TOTAL MUNICIPAL WATER DEMANI	**10,609**	**10,947**	**11,150**	**11,607**	**12,018**	**12,569**
MANUFACTURING WATER DEMAND	**5,422**	**6,213**	**6,932**	**7,575**	**8,590**	**9,608**
IRRIGATION WATER DEMAND	**4,368**	**4,319**	**4,271**	**4,223**	**4,176**	**4,129**
STEAM ELECTRIC WATER DEMAND	**12,209**	**12,209**	**12,209**	**12,209**	**12,209**	**12,209**
MINING WATER DEMAND	**25**	**24**	**24**	**25**	**25**	**25**
LIVESTOCK WATER DEMAND	**1,523**	**1,523**	**1,523**	**1,523**	**1,523**	**1,523**
TOTAL WATER DEMAND	**34,156**	**35,235**	**36,109**	**37,162**	**38,541**	**40,063**

Table 18: Population and Water Demand Projections for Marion County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
JEFFERSON	2,642	2,813	2,983	3,154	3,324	3,494
COUNTY-OTHER	8,322	8,858	9,395	9,931	10,468	11,005
TOTAL POPULATION	**10,964**	**11,671**	**12,378**	**13,085**	**13,792**	**14,499**
WATER DEMAND						
JEFFERSON	624	636	648	667	693	725
COUNTY-OTHER	1,072	1,101	1,126	1,146	1,161	1,171
TOTAL MUNICIPAL WATER DEMAN	**1,696**	**1,737**	**1,774**	**1,813**	**1,854**	**1,896**
MANUFACTURING WATER DEMAND	**20**	**20**	**20**	**20**	**20**	**20**
IRRIGATION WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
STEAM ELECTRIC WATER DEMAND	**2,868**	**2,868**	**2,868**	**2,868**	**2,868**	**2,868**
MINING WATER DEMAND	**71**	**43**	**30**	**24**	**20**	**34**
LIVESTOCK WATER DEMAND	**182**	**182**	**182**	**182**	**182**	**182**
TOTAL WATER DEMAND	**4,837**	**4,850**	**4,874**	**4,907**	**4,944**	**5,000**

Table 19: Population and Water Demand Projections for Morris County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
DAINGERFIELD	2,881	2,892	2,892	2,892	2,892	2,892
HUGHES SPRINGS	12	12	12	11	11	10
LONE STAR	2,069	2,077	2,077	2,077	2,077	2,077
NAPLES	1,660	1,790	1,852	1,883	1,883	1,883
OMAHA	1,163	1,227	1,269	1,289	1,289	1,289
COUNTY-OTHER	6,661	6,661	6,661	6,661	6,661	6,661
TOTAL POPULATION	**14,446**	**14,659**	**14,763**	**14,813**	**14,813**	**14,812**
WATER DEMAND						
DAINGERFIELD	400	379	357	340	327	327
HUGHES SPRINGS	3	3	2	2	2	2
LONE STAR	267	258	249	240	230	221
NAPLES	246	249	243	239	232	230
OMAHA	163	163	158	156	151	149
COUNTY-OTHER	858	828	798	769	739	709
TOTAL MUNICIPAL WATER DEMANI	**1,937**	**1,880**	**1,807**	**1,746**	**1,681**	**1,638**
MANUFACTURING WATER DEMAND	**132,451**	**135,264**	**129,869**	**124,443**	**119,127**	**113,929**
IRRIGATION WATER DEMAND	**190**	**188**	**186**	**184**	**182**	**180**
STEAM ELECTRIC WATER DEMAND	**48**	**48**	**48**	**48**	**48**	**48**
MINING WATER DEMAND	**31**	**16**	**12**	**10**	**10**	**11**
LIVESTOCK WATER DEMAND	**624**	**624**	**624**	**624**	**624**	**624**
TOTAL WATER DEMAND	**135,281**	**138,020**	**132,546**	**127,055**	**121,672**	**116,430**

Table 20: Population and Water Demand Projections for Rains County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
EAST TAWAKONI	762	886	1,011	1,135	1,259	1,384
EMORY	1,056	1,228	1,401	1,573	1,745	1,918
POINT	816	949	1,082	1,216	1,349	1,482
COUNTY-OTHER	5,131	5,970	6,806	7,643	8,481	9,317
TOTAL POPULATION	**7,765**	**9,033**	**10,300**	**11,567**	**12,834**	**14,101**
WATER DEMAND						
EAST TAWAKONI	107	117	126	138	147	160
EMORY	209	232	252	278	302	329
POINT	110	122	131	141	151	164
COUNTY-OTHER	948	1,042	1,128	1,230	1,340	1,458
TOTAL MUNICIPAL WATER DEMANI	**1,374**	**1,513**	**1,637**	**1,787**	**1,940**	**2,111**
MANUFACTURING WATER DEMAND	**2**	**2**	**2**	**2**	**2**	**2**
IRRIGATION WATER DEMAND	**20**	**20**	**20**	**20**	**20**	**20**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
LIVESTOCK WATER DEMAND	**700**	**700**	**700**	**700**	**700**	**700**
TOTAL WATER DEMAND	**2,096**	**2,235**	**2,359**	**2,509**	**2,662**	**2,833**

Table 21: Population and Water Demand Projections for Red River County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
BOGATA	1,495	1,495	1,495	1,495	1,495	1,495
CLARKSVILLE	4,330	4,330	4,330	4,330	4,330	4,330
DETROIT	822	853	868	901	950	998
COUNTY-OTHER	8,114	8,114	8,114	8,114	8,114	8,114
TOTAL POPULATION	**14,761**	**14,792**	**14,807**	**14,840**	**14,889**	**14,937**
WATER DEMAND						
BOGATA	193	186	179	172	166	159
CLARKSVILLE	674	640	607	583	573	563
DETROIT	106	106	104	104	105	106
COUNTY-OTHER	1,045	1,009	973	936	900	863
TOTAL MUNICIPAL WATER DEMANI	**2,018**	**1,941**	**1,863**	**1,795**	**1,744**	**1,691**
MANUFACTURING WATER DEMAND	**11**	**15**	**17**	**19**	**21**	**25**
IRRIGATION WATER DEMAND	**99**	**98**	**97**	**96**	**95**	**94**
STEAM ELECTRIC WATER DEMAND	**1,500**	**5,000**	**7,000**	**10,000**	**10,000**	**10,000**
MINING WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
LIVESTOCK WATER DEMAND	**1,180**	**1,180**	**1,180**	**1,180**	**1,180**	**1,180**
TOTAL WATER DEMAND	**4,808**	**8,234**	**10,157**	**13,090**	**13,040**	**12,990**

Table 22: Population and Water Demand Projections for Smith County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
LINDALE	1,377	1,556	1,735	1,913	2,092	2,271
OVERTON	78	88	98	109	119	129
TYLER	8	9	10	11	13	14
COUNTY-OTHER	22,894	25,864	28,835	31,805	34,775	37,745
TOTAL POPULATION	**24,357**	**27,517**	**30,678**	**33,838**	**36,999**	**40,159**
WATER DEMAND						
LINDALE	262	279	295	319	342	369
OVERTON	16	18	19	20	21	22
TYLER	2	2	2	2	3	3
COUNTY-OTHER	3,479	3,693	3,890	4,148	4,420	4,760
TOTAL MUNICIPAL WATER DEMANI	**3,759**	**3,992**	**4,206**	**4,489**	**4,786**	**5,154**
MANUFACTURING WATER DEMAND	**262**	**298**	**325**	**346**	**377**	**403**
IRRIGATION WATER DEMAND	**446**	**468**	**491**	**516**	**542**	**569**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**425**	**178**	**91**	**32**	**18**	**6**
LIVESTOCK WATER DEMAND	**453**	**453**	**453**	**453**	**453**	**453**
TOTAL WATER DEMAND	**5,345**	**5,389**	**5,566**	**5,836**	**6,176**	**6,585**

Table 23: Population and Water Demand Projections for Titus County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
MOUNT PLEASANT	13,790	15,201	16,611	18,022	19,433	20,844
TALCO	606	668	729	791	853	915
COUNTY-OTHER	12,178	13,424	14,672	15,918	17,163	18,409
TOTAL POPULATION	**26,574**	**29,293**	**32,012**	**34,731**	**37,449**	**40,168**
WATER DEMAND						
MOUNT PLEASANT	3,012	3,167	3,312	3,512	3,722	3,970
TALCO	78	83	87	91	95	97
COUNTY-OTHER	1,637	1,744	1,841	1,926	1,999	2,062
TOTAL MUNICIPAL WATER DEMANI	**4,727**	**4,994**	**5,240**	**5,529**	**5,816**	**6,129**
MANUFACTURING WATER DEMAND	**3,734**	**3,997**	**4,199**	**4,357**	**4,722**	**5,079**
IRRIGATION WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
STEAM ELECTRIC WATER DEMAND	**28,280**	**31,280**	**31,280**	**36,280**	**36,280**	**36,280**
MINING WATER DEMAND	**2,772**	**1,991**	**1,796**	**1,722**	**1,705**	**1,744**
LIVESTOCK WATER DEMAND	**858**	**858**	**858**	**858**	**858**	**858**
TOTAL WATER DEMAND	**40,371**	**43,120**	**43,373**	**48,746**	**49,381**	**50,090**

Table 24: Population and Water Demand Projections for Upshur County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
BIG SANDY	1,400	1,548	1,611	1,732	1,870	1,970
EAST MOUNTAIN	1,003	1,109	1,154	1,241	1,340	1,411
GILMER	5,815	6,430	6,693	7,195	7,769	8,183
GLADEWATER	2,560	2,831	2,947	3,168	3,421	3,603
ORE CITY	1,124	1,243	1,294	1,391	1,501	1,581
COUNTY-OTHER	21,313	23,572	24,537	26,375	28,478	29,994
TOTAL POPULATION	**33,215**	**36,733**	**38,236**	**41,102**	**44,379**	**46,742**
WATER DEMAND						
BIG SANDY	231	239	237	247	260	272
EAST MOUNTAIN	135	144	145	150	156	158
GILMER	1,354	1,426	1,417	1,499	1,593	1,669
GLADEWATER	448	466	459	482	509	533
ORE CITY	154	159	155	162	170	177
COUNTY-OTHER	2,745	2,931	2,941	3,043	3,158	3,192
TOTAL MUNICIPAL WATER DEMANI	**5,067**	**5,365**	**5,354**	**5,583**	**5,846**	**6,001**
MANUFACTURING WATER DEMAND	**215**	**232**	**241**	**243**	**277**	**314**
IRRIGATION WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
STEAM ELECTRIC WATER DEMAND	**0**	**5,601**	**5,601**	**5,601**	**5,601**	**5,601**
MINING WATER DEMAND	**1**	**1**	**1**	**1**	**1**	**0**
LIVESTOCK WATER DEMAND	**1,928**	**1,928**	**1,928**	**1,928**	**1,928**	**1,928**
TOTAL WATER DEMAND	**7,211**	**13,127**	**13,125**	**13,356**	**13,653**	**13,844**

Table 25: Population and Water Demand Projections for Van Zandt County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
CANTON	3,559	4,094	4,628	5,163	5,698	6,232
EDGEWOOD	1,588	1,826	2,064	2,303	2,541	2,780
GRAND SALINE	3,010	3,462	3,914	4,366	4,818	5,270
VAN	2,255	2,594	2,932	3,271	3,610	3,949
WILLS POINT	3,504	4,030	4,556	5,083	5,609	6,135
COUNTY-OTHER	30,436	35,008	39,582	44,152	48,724	53,295
TOTAL POPULATION	**44,352**	**51,014**	**57,676**	**64,338**	**71,000**	**77,661**
WATER DEMAND						
CANTON	694	757	814	891	951	1,039
EDGEWOOD	215	231	248	266	281	309
GRAND SALINE	583	636	684	749	804	880
VAN	511	560	605	663	715	782
WILLS POINT	589	642	684	740	792	867
COUNTY-OTHER	3,921	4,353	4,744	5,094	5,403	5,671
TOTAL MUNICIPAL WATER DEMANI	**6,513**	**7,179**	**7,779**	**8,403**	**8,946**	**9,548**
MANUFACTURING WATER DEMAND	**280**	**344**	**396**	**451**	**508**	**566**
IRRIGATION WATER DEMAND	**220**	**220**	**220**	**220**	**220**	**220**
STEAM ELECTRIC WATER DEMAND	**0**	**0**	**0**	**0**	**0**	**0**
MINING WATER DEMAND	**1,359**	**1,167**	**1,099**	**1,077**	**1,084**	**1,115**
LIVESTOCK WATER DEMAND	**2,381**	**2,381**	**2,381**	**2,381**	**2,381**	**2,381**
TOTAL WATER DEMAND	**10,753**	**11,291**	**11,875**	**12,532**	**13,139**	**13,830**

Table 26: Population and Water Demand Projections for Wood County

WATER USER GROUP	2000 (Demand in AF)	2010 (Demand in AF)	2020 (Demand in AF)	2030 (Demand in AF)	2040 (Demand in AF)	2050 (Demand in AF)
POPULATION						
HAWKINS	1,447	1,632	1,817	2,002	2,187	2,372
MINEOLA	4,838	5,457	6,076	6,695	7,314	7,933
QUITMAN	1,881	2,122	2,362	2,603	2,844	3,084
WINNSBORO	2,623	2,958	3,294	3,629	3,965	4,300
COUNTY-OTHER	22,513	25,393	28,273	31,153	34,032	36,914
TOTAL POPULATION	**33,302**	**37,562**	**41,822**	**46,082**	**50,342**	**54,603**
WATER DEMAND						
HAWKINS	244	260	273	294	309	337
MINEOLA	867	929	980	1,057	1,114	1,209
QUITMAN	392	423	450	484	517	560
WINNSBORO	493	530	564	606	648	699
COUNTY-OTHER	3,192	3,361	3,513	3,768	3,936	4,338
TOTAL MUNICIPAL WATER DEMANI	**5,188**	**5,503**	**5,780**	**6,209**	**6,524**	**7,143**
MANUFACTURING WATER DEMAND	**244**	**290**	**341**	**391**	**468**	**544**
IRRIGATION WATER DEMAND	**354**	**354**	**354**	**354**	**354**	**354**
STEAM ELECTRIC WATER DEMAND	**0**	**7,500**	**7,500**	**7,500**	**7,500**	**15,000**
MINING WATER DEMAND	**2,102**	**17,584**	**17,344**	**17,107**	**16,107**	**4,641**
LIVESTOCK WATER DEMAND	**2,562**	**2,562**	**2,562**	**2,562**	**2,562**	**2,562**
TOTAL WATER DEMAND	**10,450**	**33,793**	**33,881**	**34,123**	**33,515**	**30,244**

Table 16: Titus County Water Supply

			Supply Available, ac-ft/yr					
System Name	**Supply Source Type**	**Supply Source Name**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
City Of Talco	Ground Water	Nacatoch	436	436	436	436	436	436
City Of Talco	Ground Water	Nacatoch	109	109	109	109	109	109
Bi-County Water Supply Corp.	Ground Water	Carrizo-Wilcox	119	119	119	119	119	119
City Of Winfield	Contract	City Of Mount Pleasant	153	153	153	0	0	0
Cypress Springs Wsc	Contract	Franklin County Water District	35	35	35	35	0	0
Cypress Springs Wsc	Ground Water	Carrizo-Wilcox	1	1	1	1	1	1
Lake Bob Sandlin State Park	Contract	Tri Water Supply Corp	5	5	5	5	5	5
Northeast Texas Comm. College	Ground Water	Carrizo-Wilcox	1,613	1,613	1,613	1,613	1,613	1,613
Tri Water Supply Corporation	Contract	City Of Mount Pleasant	515	0	0	0	0	0
Tri Water Supply Corporation	Contract	City Of Mount Pleasant	753	0	0	0	0	0
TOTAL			**3,739**	**2,471**	**2,471**	**2,318**	**2,283**	**2,283**
Manufacturing	Surface Water	Lake Tankersley	550	550	550	550	550	550
Manufacturing	Contract	City Of Mount Pleasant	3,420	3,420	3,420	3,420	3,650	3,882
Manufacturing	Ground Water	Carrizo-Wilcox	2,427	2,598	2,729	2,832	2,840	2,840
Manufacturing	Surface Water	Lake Bob Sandlin	38,500	38,500	38,500	38,500	38,500	38,500
TOTAL			**44,897**	**45,068**	**45,199**	**45,302**	**45,540**	**45,772**
Steam Electric	Surface Water	NETMWD	10,000	10,000	10,000	10,000	10,000	10,000
Steam Electric	Surface Water	Welsh/Swauno Creek	11,000	11,000	11,000	11,000	11,000	11,000
Steam Electric	Surface Water	Blundell Creek	16,300	16,300	16,300	16,300	16,300	16,300
Steam Electric	Surface Water	Monticello	7,700	7,700	7,700	0	0	0
TOTAL			**45,000**	**45,000**	**15,000**	**37,300**	**37,300**	**37,00**
Mining	Ground Water	Carrizo-Wilcox	254	121	61	30	10	0
Mining	Surface Water	Titus County Fresh Water District	1,098	450	315	272	275	324
Mining	Ground Water	Carrizo-Wilcox	1,420	1,420	1,420	1,420	1,420	1,420
TOTAL			**2,772**	**1,991**	**1,796**	**1,722**	**1,705**	**1,744**
Livestock	Ground Water	Carrizo-Wilcox	355	355	355	355	355	355
Livestock	Surface Water	Livestock Local Supply	133	133	133	133	133	133
Livestock	Ground Water	Carrizo-Wilcox	370	370	370	370	370	370
TOTAL			**858**	**858**	**858**	**858**	**858**	**858**

SOCIO-ECONOMIC IMPACTS OF NOT MEETING WATER NEEDS

NORTH EAST TEXAS REGIONAL WATER PLANNING GROUP (REGION D)

SECTION 1 SUMMARY OF RESULTS

Section 357.7(4) of the rules for implementing Senate Bill 1 require that the social and economic impact of not meeting regional water supply needs be evaluated by the Regional Water Planning Groups (RWPG). The Texas Water Development Board (TWDB) is required to provide technical assistance, upon request, to complete the evaluations. The Board has offered its staff to conduct the required analysis of the impacts of the identified needs for each region, using a common methodological approach for all regions.

The North East Texas Regional Water Planning Group submitted a request to TWDB for assistance. Board staff has completed the analysis of the social and economic impacts of not meeting water needs as identified in Exhibit B, Table 7. TWDB evaluated each negative value, showing an unmet water need for an individual water user group (WUG), using data that connected water use with the economy and the population of the region.

The detailed results of the analysis are found in Tables 9 and 10, included in Section 3 of this report. Each water user group with a need is evaluated in terms of direct and indirect economic and social impact on the region resulting from the shortage. Economic variables chosen by TWDB for this analysis include gross economic output (sales and business gross income), employment (number of jobs) and personal income (wages, salaries and proprietors net receipts). The effects of shortages on population and school enrollments are the social variables of the analysis. Declining populations indicate a deprecation of social services in most, but not every case, while declining school enrollment indicates loss of younger cohorts of the population and possibilities of strains on the tax bases, when combined with economic losses. RWPGs are allowed to expand this analysis at their discretion.

The purpose of this element of Senate Bill 1 planning is to give the regions an estimate of the potential costs of not acting to meet anticipated needs in each water user group, or conversely, the potential benefit to be gained from devising a strategy to meet a particular need. Collectively, the summation of all the impacts gives the region a view of the ultimate magnitude of the impacts caused by not meeting all of the entire list of needs. These summations should be considered a worst-case scenario for the region, since the likelihood of not meeting the entire list of needs is very small.

IMPACTS OF UNMET WATER NEEDS FOR THE REGION

The North East Texas Regional Water Planning Group identified individual water user groups which showed an unmet need during drought-of-record supply conditions for each decade from 2000 to 2050.

The region projected that total water demands would increase from 579 thousand acre-feet in 2000 to 676 thousand acre-feet in 2030, and continuing to increase to 718 thousand acre-feet in 2050.

Under extreme supply limitations and with no management strategies in place, water shortages would amount to 19 thousand acre-feet in 2000, rising to 62 thousand acre-feet in 2030 and to 122 thousand acre-feet by 2050.

The water needs of the region amount to about 7% of the forecasted demand by 2020, rising to 11.5% of demand in 2040 and 17% in 2050. This means that by 2050 the region would be able to supply only 83% of the projected needs unless supply development or other water management strategies are implemented.

(See Figure 1 and Table 1)

Economic Growth Limitations

The difference between expected future growth, unrestricted by water shortage, and expected growth restricted by unmet water needs provides the measure of impact.

Employment–
Left entirely unmet, the level of shortage in 2010 results in 64 thousand fewer jobs than would be expected in unrestricted development (without water needs) by 2010. The gap between unrestricted and restricted job growth grows to 97 thousand by 2030, and to 171 thousand jobs that the restricted economy could not create by 2050.

Population–
The forecasted population growth of the region would be economically restricted by curtailed potential job creation. This in turn causes both an outmigration of some current population and an expected curtailment of future population growth. Compared to the baseline growth in population, the region could expect 134 thousand fewer people in 2010, growing to 205 thousand fewer in 2030 and 368 thousand fewer in 2050. The expected 2050 population under the severe shortage conditions would be 36% lower than projected in the region's most likely growth forecast.

Income–
The potential loss of economic development in the region amounts to about 23% less income to people in 2010, with the gap growing to 33% less than expected in 2030. By 2050 the region would have 51.5% less income than is currently projected assuming no water restrictions.

Water User Groups with Shortages

The economic and social impact of an unmet water need varies greatly depending on the type of Water User Group for which the shortage is anticipated. On a per acre-foot basis, the largest impacts will generally result from shortages in manufacturing and municipal uses, while shortages for irrigation will typically result in the smallest impact. Table 2 (in Section 2 of this report) presents the impacts of unmet water needs summarized for each of the six types of Water User Group.

The majority of the economic and social impacts of unmet water needs in North East Texas results from municipal and manufacturing water shortages. In 2010, municipalities have unmet needs of 22 thousand acre-feet, 56% of the total unmet needs. The economic impacts of this shortage (31 thousand jobs, $2.2 billion in output, and $965 million of income) represent between 40 and 50% of the total impacts. By 2050, unmet municipal needs total 64 thousand acre-feet (53% of the total) resulting in 89 thousand jobs not created, and reductions of $6.5 billion in potential output and $2.8 billion in potential income.

The impact of not meeting manufacturing needs increases from 2000 through 2050. In 2010, manufacturing has unmet needs of 11 thousand acre-feet, 29% of the total unmet needs. The economic impacts of this shortage include loss of 33 thousand jobs (51% of the total employment impact) and $3.9 billion in output (63% of the total output impact). In 2050, unmet manufacturing needs are nearly 44 thousand acre-feet (36% of the total) resulting in 81 thousand jobs not created and reduction of $9.7 billion in output (59% of the total output impact).

Shortages are also expected in the generation of steam electric power, but these shortages result in less than one percent of the total economic impact in any year.

INTERPRETATION OF THE RESULTS

Users are cautioned not to assume that the entire list of needs with impacts is a prediction of future water disasters. These data simply give regional planners one source of information by which to develop efficient and effective means to meet the needs and avoid calamities.

Some clarification is needed to understand the impact numbers. The following points must be kept in mind when using the data:

a) The impacts are expressed in terms of regional impact. Thus, individual water user group shortages are shown as they influence the entire region's economy and not just the limits of the direct impact. The total impact of municipal shortage for a particular city, for example, includes the direct impact within the city limits and the impact indirectly through the region. The indirect linkages were derived from regional economic models. There are no models for individual water user groups.

b) While the entirety of an estimated impact applies to the region as a whole, a significant portion will generally be felt in the local area where the shortage occurs. An impact that is of a small magnitude relative to impacts of other shortages on other areas may be extremely severe if its magnitude is large relative to the size of the local economy. Thus, while the absolute magnitude of agricultural shortages may appear to be small, the true severity of the impact may be much more significant to the surrounding rural area.

c) Water supplies are calculated on drought-of-record levels. Shortages that show up for the 2000 decade and beyond are considered to be mostly the result of severe dry conditions; this contributes to the apparent abnormally large size of some impacts. This approach to supply analysis results in a worst-case scenario. Historically, most water user groups have at least partially met their needs through management of the remaining supplies, either by conservation, limitations on lower-valued uses such as lawn watering, or finding alternative sources of water. The results in this report assume no applied management strategies. The entirety of the needs is not met in any fashion.

d) The analysis begins by calculating water use coefficients–defined as production (dollars of sales to final customers, or final demand) resulting from use of an acre-foot of water. This measure is considered an average, not marginal measure of water use. Thus, the analysis does not attempt to measure the market forces that would tend to drive the price of water higher or reserve limited water for the highest-valued uses, as it becomes scarce. The average value approach was used because the analysis is intended to show the present value in today's regional economies of differing amounts of water use. With this information analysts can answer the question, "How much water does it take to support the current level and structure of economic activity and population?" The baseline projections for the future of regional economies assume a continuation of this known relationship of volumes of water use to economic output, under current structures of use. The models do not attempt to estimate the market allocation of the resource among competing activities because this change in structure is considered a possible management strategy–relying on market forces to work in a water-marketing system. Marginal cost analysis would be necessary for evaluating such an approach.

e) The Municipal water use category includes commercial establishments. The impacts from even small shortages in many such establishments are considerably higher on a per-acre-foot basis than in any other category. Thus, relatively small Municipal shortages can have a very large amount of economic impact, since the analysis assumes a direct relationship between curtailed water use and lost economic production. Since this analysis is intended to provide impacts without assuming any strategies, the normal response of conservation programs is not assumed. The impact data appear to overstate the Municipal category, but the results are consistently measured, since no response to the shortage is assumed that would mitigate loss of critical water used in commercial and residential settings.

f) The sizes of the projected impacts do not represent reductions from the current levels of economic activity or population. That is, the data are a <u>comparison</u> between a <u>baseline forecast</u>, assuming no water shortages, and a <u>restricted forecast,</u> based on the assumption of future water shortages. In some cases, with severe water shortages the regional economy could actually decline, dropping employment below current levels. For most regions, however, the measurement of impact represents an <u>opportunity cost</u>, or lost potential development that would be foregone in the absence of water management strategies.

OVERVIEW OF THE METHODOLOGY

Estimation of the socioeconomic impact of unmet water needs begins with estimation of the direct impact of the absence of water on the individual or business making productive use of the water. The direct economic impact of unmet water needs is defined as the dollar value of final demand (production for sale to final consumers) that could not be produced because of the absence of water. This direct impact per acre-foot was estimated by region for each type of water user – residential, commercial, manufacturing, irrigation, livestock, mining, and steam-electric.

The term *Water Use Coefficients* is used in this study to refer to the direct impact on the different water user groups of the loss of one acre-foot of water. Estimates were based on the average value of output added per acre-foot of water used by those firms/individuals that are reliant on water (i.e., where lack of water would result in inability to operate or at least cause significant curtailment of operations).

The total regional impact of water shortage does not end with the direct impact. Indirect impacts (often referred to as third-party impacts) refer to the reduction of output by firms/individuals which result from change in operations by those who are directly impacted by lack of water. Those who are directly impacted, producing less due to lack of water, will make fewer purchases of inputs, thus resulting in losses to the firms/individuals who produce and sell those products. These firms, facing less demand for their products, then reduce their purchases from their own suppliers. Indirect impacts can thus be said to continue to ripple throughout the economy.

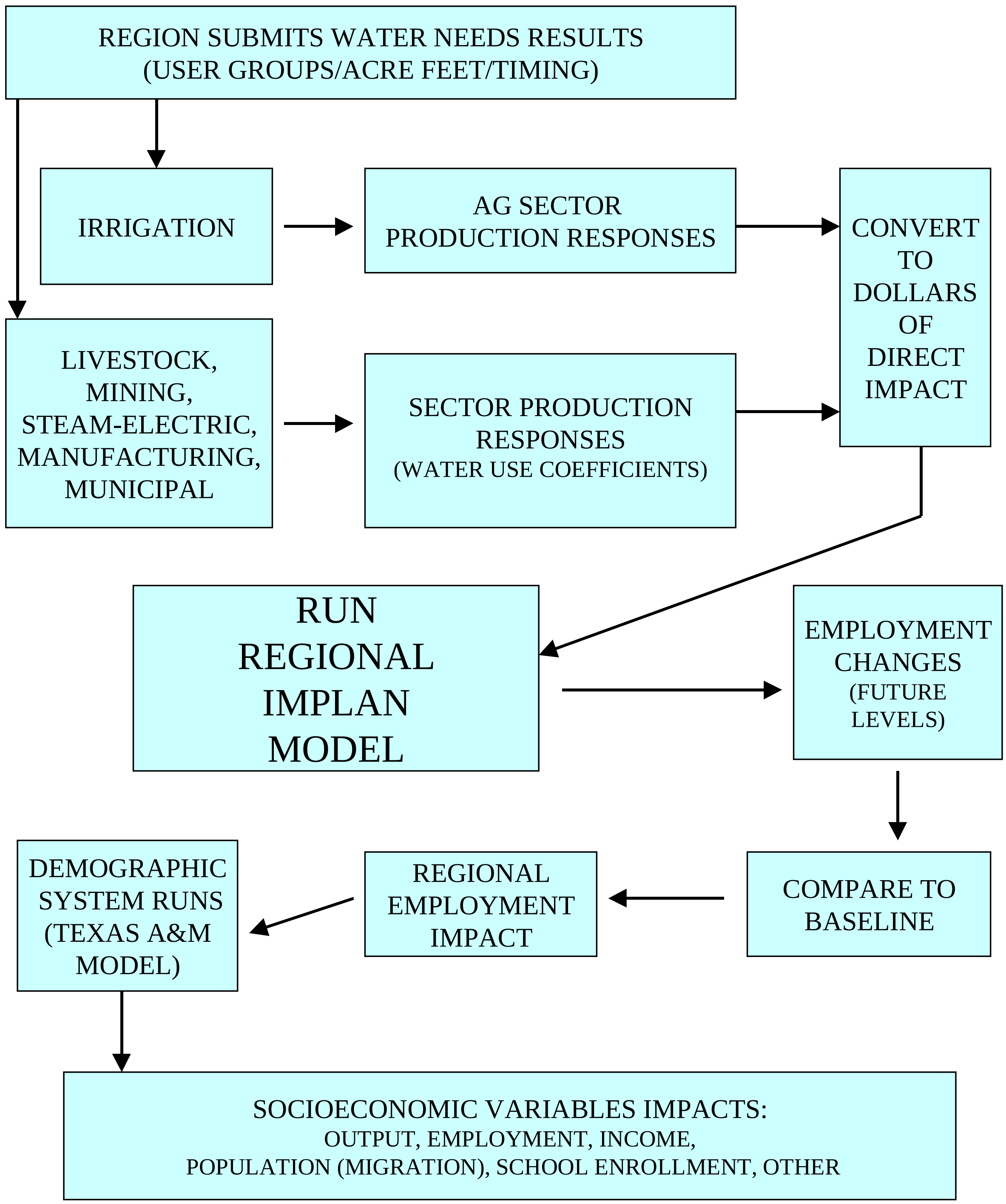
The most common method of estimating the extent of indirect impact is the *Input-Output Model*. This type of model uses actual data from local economies to show the buying and selling linkages among the different economic sectors. For this study, input-output models were assembled for each of the 16 regions from county-level input-output models developed by the Minnesota Implan Group. Data from these models are available in Attachment B.

The total extent of economic loss, direct plus indirect impact relative to the estimated direct impact, is derived from the input-output model in the form of a *multiplier*. Multipliers have been derived to estimate the total impact on three important economic variables – Total business output, personal income, and employment.

In addition to the economic impacts related to water shortages, demographic changes would also be expected to take place. While availability of jobs is not the sole reason for living in a given place, the absence of jobs created would be expected to cause many current residents to leave a region in search of other opportunities or cause reduction of anticipated migration into the region by current nonresidents. Thus, the estimated employment impact was used to estimate change in two important social variables – regional population and school enrollment.

The relationship between employment change and change in population and school enrollment was estimated using the model developed for the Texas Population Estimates and Projections Program, specifically modified for the purposes of this study by the Department of Rural Sociology at Texas A&M University.

FLOW OF THE ANALYSIS SYSTEM



Detailed Data Availability

The data in Section 3, Tables 9.00 through 9.50 show the impacts on the socioeconomic variables for each water user group by decade, 2000 (Table 9.00) through 2050 (Table 9.50). Tables 10.00 through 10.50 correspond to the same decades as for Table(s) 9, but provides additional detail on the impact in each river basin where a shortage for a particular water user group occurs in two or more basins. Users can consult the tables to determine any remaining unmet needs after the management strategies to meet the needs are determined by the RWPG. Each unmet, or partially met, need can be added together to determine the remaining economic development costs of not meeting the needs.

Under the Rules the RWPG can determine any social impact or other economic variables of impact at its discretion. The analysis submitted by TWDB represents the assistance provided upon request. The underlying data and calculation techniques are available to each region.

The Attachments to this report will provide the RWPG with details of the data used in its region and the worksheets used in the calculations. Staff of TWDB is available to answer technical questions about the data.

SECTION 2 SUMMARY DATA

Table 2 provides details of the summary of regional water needs before management strategies are in place, including the needs impacts listed by category of use.

The Table should be used only for measuring the extreme limit of lost potential economic development for the region as a whole, caused by complete lack of development of water supplies in the region for those water user groups in need of supply.

The data are not a prediction or forecast of water shortages, but show the cumulative effect of simultaneous unmet needs for those with potential shortages.

Water use categories include Municipal (residential and commercial), Manufacturing (industry), Steam Electric Power (consumptive use), Mining (including oil and gas), Irrigation (on-farm water use) and Livestock. The level of impact is largely determined by which category has an unmet shortage. Under the analysis system, small amounts of water shortage in the Municipal category can cause relatively large economic impacts, since water use is measured against value of production. Thus, unmet needs in the Municipal category often overshadow those in other categories. Often, however, relatively small adjustments to the supply allocations can be strategically made to meet less water intensive needs, producing large positive impacts. These decisions are part of the RWPGs responsibilities. The data provided by the Summary tables can point to the sources of most of the potential economic and social impacts.

SECTION 3 EXHIBIT B, TABLES 9 AND 10

Tables 9.00 through 9.50 show the impacts on the socioeconomic variables for each water user group by decade, 2000 (Table 9.00) through 2050 (Table 9.50). Tables 10.00 through 10.50 correspond to the same decades as for Table(s) 9, but provides additional detail on the impact in each river basin where a shortage for a particular water user group occurs in two or more basins.

Note: In these tables, for all entities other than cities, the last three digits of the Water User Group identifier represent the county code. The following list shows county codes and corresponding county names for this region.

CODE	COUNTY NAME
19	BOWIE
32	CAMP
34	CASS
60	DELTA
80	FRANKLIN
92	GREGG
102	HARRISON
112	HOPKINS
116	HUNT
139	LAMAR
158	MARION
172	MORRIS
190	RAINS
194	RED RIVER
212	SMITH
225	TITUS
230	UPSHUR
234	VAN ZANDT
250	WOOD

ATTACHMENT A

WATER USE COEFFICIENTS

NORTH EAST TEXAS WATER PLANNING REGION
(REGION D)

Water Use Coefficients, as used in this study, represent the average dollar value of output sold to final demand per acre-foot of water used in the production of this output.

For 4 of the 6 types of Water User Group, a single Water Use Coefficient has been estimated for all users in the region:

Water User Group	Water Use Coefficient ($ per acre-foot)
Steam Electric	8,867
Mining	35,447
Irrigation	111
Livestock	16,503

The Municipal water user group provides water for both commercial and residential users, each of which were estimated to have a different water use coefficient. The distribution of water use between the two types of users was assumed to vary depending on whether the water user group had a city or a "county other" classification. For cities, the assumed distribution is dependent on population.

User Type	Water Use Coefficient ($ per acre-foot)
Residential	50,653
Commercial	176,674

Population	% Sales to Residential	% Sales to Commercial
< 5000	87.58%	12.42%
5,000-10,000	81.53%	18.47%
10,000-25,000	72.94%	27.06%
25,000-50,000	61.56%	38.44%
50,000-250,000	80.28%	19.72%
> 250,000	61.49%	38.51%
"County Other"	94.94%	5.06%

Water use coefficients for manufacturing were estimated separately for individual counties, based on the distribution of water use among different manufacturing industries in the county and the average productivity of water in different types of manufacturing industries.

County	Water Use Coefficient ($ per acre-foot)
BOWIE	347,844
CAMP	130,986
CASS	15,182
GREGG	226,971
HARRISON	63,163
HOPKINS	151,981
HUNT	359,438
LAMAR	145,361
MARION	198,092
MORRIS	51,235
RAINS	51,213
RED RIVER	237,511
TITUS	140,212
UPSHUR	326,935
VAN ZANDT	49,259
WOOD	200,842

ATTACHMENT B

REGIONAL ECONOMIC MODEL DATA, MULTIPLIERS AND BASE YEAR VARIABLES

NORTH EAST TEXAS WATER PLANNING REGION
(REGION D)

The impact analysis was conducted using a regional interindustry (input/output) model for the region. These models were developed by TWDB using IMPLAN Professional™ Version 2.0 software, a proprietary product of MIG, Inc. of Stillwater, MN. The county economic data was provided in a dataset containing details for 586 economic sectors in Texas for 1995. TWDB collapsed these sectors into models of seven sectors, representing the major water use categories used in water development planning. The data are unique to the region.

For this region, the summary data in IMPLAN for the 1995 base year for major economic variables were as follows:

POPULATION	628,916	
EMPLOYMENT	313,101	
HOUSEHOLDS	259,917	
TOTAL PERSONAL INCOME	$11.259 Billion	In 1999 dollars– $12.306 Billion

The tables on the following pages include 1) the base year Final Demands for the seven water use sectors and 2) the multipliers used to estimate the indirect impacts from economic changes due to water shortages by sector.

The Final Demand data were used to calculate the Water Use Coefficients by matching each sector's dollar totals to volumes of water use in the corresponding category for the calendar year–base year 1995. The result is an average of production associated with an acre-foot of water use. This measure produces an average value of water in terms that can be used to apply the IMPLAN multipliers. Regional indirect economic changes can then be estimated.

The multipliers are ratios that, when applied to the direct changes (estimated by the Water Use Coefficients in Attachment A), result in a total impact on the entire region. The impact totals represent the sum of successive changes among all economic sectors caused by the initial change in the affected sector. Multipliers are listed for Employment, Output (Gross Sales or Receipts), and Income (earned income from business and labor activity, not including transfer payments).

ATTACHMENT C LETTER OF REQUEST FOR TECHNICAL ASSISTANCE

SUMMARY INFORMATION FOR ENTITIES WITH ACTUAL SHORTAGES

BOWIE COUNTY

There were no actual shortages identified in Bowie County.

CAMP COUNTY

Water User Group: Camp County Manufacturing	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	0	0	0	0	0	0
Water Demand (ac-ft/yr)	10	2242	2242	2242	2242	2242
Current Supply (ac-ft/yr)	10	10	10	10	10	10
Supply – Demand (ac-ft/yr)	0	**-2232**	**-2232**	**-2232**	**-2232**	**-2232**
Recommended Strategy: Groundwater (ac-ft/yr)		2232	2232	2232	2232	2232

CASS COUNTY

Water User Group: Bloomburg WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	543	702	863	1023	1183	1343
Water Demand (ac-ft/yr)	70	87	103	118	131	143
Current Supply (ac-ft/yr)	123	123	123	123	123	123
Supply – Demand (ac-ft/yr)	+53	+36	+20	+5	**-8**	**-20**
Recommended Strategy: Groundwater (ac-ft/yr)					62	62

Water User Group: City of Linden	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	2465	2635	2806	2976	3146	3317
Water Demand (ac-ft/yr)	326	325	327	337	342	357
Current Supply (ac-ft/yr)	231	221	211	201	191	181
Supply – Demand (ac-ft/yr)	**-95**	**-104**	**-116**	**-136**	**-151**	**-176**
Recommended Strategy: Surface Water (ac-ft/yr)	95	104	116	136	151	176

DELTA COUNTY

Water User Group: Ben Franklin WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	241	241	241	241	241	241
Water Demand (ac-ft/yr)	94	93	92	29	28	27
Current Supply (ac-ft/yr)	85	85	85	0	0	0
Supply – Demand (ac-ft/yr)	**-9**	**-8**	**-7**	**-29**	**-28**	**-27**
Recommended Strategy: Surface Water (ac-ft/yr)	32	31	30	29	29	29

Water User Group: City of Pecan Gap	2000	2010	2020	2030	2040	2050
Population	286	286	286	286	286	286
Water Demand (ac-ft/yr)	65	63	61	59	56	55
Current Supply (ac-ft/yr)	50	50	50	50	49	49
Supply – Demand (ac-ft/yr)	**-15**	**-13**	**-11**	**-9**	**-7**	**-6**
Recommended Strategy: Surface Water (ac-ft/yr)	38	38	38	38	38	38

FRANKLIN COUNTY

There were no actual shortages identified in Franklin County.

GREGG COUNTY

Water User Group: City of Gladewater	2000	2010	2020	2030	2040	2050
Population	6896	7576	8102	8733	9395	9987
Water Demand (ac-ft/yr)	1835.7	1877.7	1892.7	1960.7	2029.7	2107.7
Current Supply (ac-ft/yr)	1679	1679	1679	1679	1679	1679
Supply – Demand (ac-ft/yr)	**-156.7**	**-198.7**	**-213.7**	**-281.7**	**-350.7**	**-428.7**
Recommended Strategy: Surface Water (ac-ft/yr)	1,679	1,679	1,679	1,679	1,679	1,679

Water User Group: Manufacturing in Gregg County	2000	2010	2020	2030	2040	2050
Population	0	0	0	0	0	0
Water Demand (ac-ft/yr)	16538	18576	20934	23507	26515	29716
Current Supply (ac-ft/yr)	5821	9488	10366	10836	11385	11970
Supply – Demand (ac-ft/yr)	**-10717**	**-9088**	**-10568**	**-12671**	**-15130**	**-17746**
Recommended Strategy: Surface Water (ac-ft/yr)	10,717	9,088	10,568	12,671	15,130	17,746

Water User Group: Liberty City WSC	2000	2010	2020	2030	2040	2050
Population	3600	4208	4816	5423	6031	6639
Water Demand (ac-ft/yr)	596	649	693	773	841	923
Current Supply (ac-ft/yr)	461.8	461.8	461.8	461.8	461.8	461.8
Supply – Demand (ac-ft/yr)	**-134.2**	**-187.2**	**-231.2**	**-311.2**	**-379.2**	**-461.2**
Recommended Strategy: Groundwater (ac-ft/yr) (wells)	188	188	282	376	470	470

Water User Group: West Gregg WSC	2000	2010	2020	2030	2040	2050
Population	2291	2985	3681	4376	5070	5764
Water Demand (ac-ft/yr)	334	409	471	558	630	719
Current Supply (ac-ft/yr)	333.8	333.8	333.8	333.8	333.8	333.8
Supply – Demand (ac-ft/yr)	**-0.2**	**-75.2**	**-137.2**	**-224.2**	**-296.2**	**-385.2**
Recommended Strategy: Groundwater (ac-ft/yr) (wells)	80.6	80.6	161.2	241.8	322.4	403.0

HARRISON COUNTY

Water User Group: Blocker-Crossroads WSC	2000	2010	2020	2030	2040	2050
Population	677	877	1077	1277	1477	1677
Water Demand (ac-ft/yr)	91	114	135	154	172	188
Current Supply (ac-ft/yr)	128	128	128	128	128	128
Supply – Demand (ac-ft/yr)	+37	+14	**-7**	**-26**	**-44**	**-60**
Recommended Strategy: Groundwater (ac-ft/yr)			64	64	64	64

Water User Group: Caddo Lake WSC	2000	2010	2020	2030	2040	2050
Population	838	998	1158	1318	1478	1638
Water Demand (ac-ft/yr)	113	130	145	159	172	183
Current Supply (ac-ft/yr)	143.4	143.4	143.4	143.4	143.4	143.4
Supply – Demand (ac-ft/yr)	+30.4	+13.4	**-1.6**	**-15.6**	**-28.6**	**-39.6**
Recommended Strategy: Groundwater (ac-ft/yr)			36	36	36	72

Water User Group: City of Waskom	2000	2010	2020	2030	2040	2050
Population	2301	2529	2703	3056	3096	3292
Water Demand (ac-ft/yr)	332	348	354	365	379	399
Current Supply (ac-ft/yr)	352	352	352	352	352	352
Supply – Demand (ac-ft/yr)	+20	+4	**-2**	**-13**	**-27**	**-47**
Recommended Strategy: Groundwater (ac-ft/yr)			44	44	44	88

Water User Group: Elysian Fields WSC	2000	2010	2020	2030	2040	2050
Population	452	532	612	692	772	852
Water Demand (ac-ft/yr)	61	69	77	84	90	95
Current Supply (ac-ft/yr)	89.4	89.4	89.4	89.4	89.4	89.4
Supply – Demand (ac-ft/yr)	+28.4	+20.4	+12.4	+5.4	**-0.6**	**-5.6**
Recommended Strategy: Groundwater (ac-ft/yr)					50	50

Water User Group: Harleton WSC	2000	2010	2020	2030	2040	2050
Population	1808	2528	3248	3968	4688	5408
Water Demand (ac-ft/yr)	242	327	406	477	543	602
Current Supply (ac-ft/yr)	299.3	299.3	299.3	299.3	299.3	299.3
Supply – Demand (ac-ft/yr)	+57.3	**-27.7**	**-106.7**	**-177.7**	**-243.7**	**-302.7**
Recommended Strategy: Surface Water (ac-ft/yr)		168	203	239	274	309

Water User Group: North Harrison WSC	2000	2010	2020	2030	2040	2050
Population	696	906	1116	1326	1536	1746
Water Demand (ac-ft/yr)	94	118	140	160	179	196
Current Supply (ac-ft/yr)	134.3	134.3	134.3	134.3	134.3	134.3
Supply – Demand (ac-ft/yr)	+40.3	+16.3	**-5.7**	**-25.7**	**-44.7**	**-61.7**
Recommended Strategy: Groundwater (ac-ft/yr)			67	67	67	67

Water User Group: Waskom Rural WSC #1	2000	2010	2020	2030	2040	2050
Population	506	746	986	1224	1466	1706
Water Demand (ac-ft/yr)	68	97	124	148	171	191
Current Supply (ac-ft/yr)	117.1	117.1	117.1	117.1	117.1	117.1
Supply – Demand (ac-ft/yr)	+49.1	+20.1	**-6.9**	**-30.9**	**-53.9**	**-73.9**
Recommended Strategy: Groundwater (ac-ft/yr)			59	59	59	118

Water User Group: West Harrison WSC	2000	2010	2020	2030	2040	2050
Population	922	1132	1342	1552	1762	1972
Water Demand (ac-ft/yr)	124	147	168	188	205	221
Current Supply (ac-ft/yr)	161.5	161.5	161.5	161.5	161.5	161.5
Supply – Demand (ac-ft/yr)	+37.5	+14.5	**-6.5**	**-26.5**	**-43.5**	**-59.5**
Recommended Strategy: Groundwater (ac-ft/yr)			108	108	108	108

HOPKINS COUNTY

Water User Group: City of Como	2000	2010	2020	2030	2040	2050
Population	643	713	783	853	923	992
Water Demand (ac-ft/yr)	100	105	109	115	121	129
Current Supply (ac-ft/yr)	0	0	0	0	0	0
Supply – Demand (ac-ft/yr)	2	2	6	12	18	26
Recommended Strategy: Groundwater (ac-ft/yr)		46	46	46	46	46

Water User Group: Pickton WSC	2000	2010	2020	2030	2040	2050
Population	503	558	612	667	721	776
Water Demand (ac-ft/yr)	84	89	93	98	103	110
Current Supply (ac-ft/yr)	98	98	98	98	98	98
Supply – Demand (ac-ft/yr)	+14	+9	+5	0	**-5**	**-12**
Recommended Strategy: Groundwater (ac-ft/yr)					41	41

Water User Group: Shirley WSC	2000	2010	2020	2030	2040	2050
Population	1394	1573	1752	1932	2111	2290
Water Demand (ac-ft/yr)	239	259	276	298	318	344
Current Supply (ac-ft/yr)	278	278	278	278	278	278
Supply – Demand (ac-ft/yr)	+39	+19	+3	**-20**	**-40**	**-66**
Recommended Strategy: Groundwater (ac-ft/yr)				46	46	92

HUNT COUNTY

Water User Group: City of Wolfe City	2000	2010	2020	2030	2040	2050
Population	1633	1820	2007	2194	2381	2568
Water Demand (ac-ft/yr)	214	222	229	243	256	274
Current Supply (ac-ft/yr)	220	220	220	220	220	220
Supply – Demand (ac-ft/yr)	+6	**-2**	**-9**	**-43**	**-56**	**-74**
Recommended Strategy: Groundwater (ac-ft/yr)		80	80	80	80	80

Water User Group: Tri-County Water Corporation	2000	2010	2020	2030	2040	2050
Population	1357	1458	1458	1458	1458	1458
Water Demand (ac-ft/yr)	190	196	190	180	175	167
Current Supply (ac-ft/yr)	158	158	158	158	158	158
Supply – Demand (ac-ft/yr)	-32	-38	-32	-22	-17	-9
Recommended Strategy: Surface Water (ac-ft/yr)	38	38	38	38	38	38

LAMAR COUNTY

Water User Group: Petty WSC	2000	2010	2020	2030	2040	2050
Population	114	122	130	137	137	137
Water Demand (ac-ft/yr)	18	18	18	18	18	17
Current Supply (ac-ft/yr)	18	18	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-18**	**-18**	**-18**	**-17**
Recommended Strategy: Surface Water (ac-ft/yr)			18	18	18	17

MARION COUNTY

Water User Group: Kellyville-Berea WSC	2000	2010	2020	2030	2040	2050
Population	581	831	1081	1331	1581	1831
Water Demand (ac-ft/yr)	75	103	130	154	175	195
Current Supply (ac-ft/yr)	87	87	87	87	87	87
Supply – Demand (ac-ft/yr)	+12	**-16**	**-43**	**-67**	**-88**	**-108**
Surface Water (ac-ft/yr)		16	43	67	88	108

Water User Group: Pine Harbor WSC	2000	2010	2020	2030	2040	2050
Population	692	922	1152	1382	1612	1842
Water Demand (ac-ft/yr)	89	115	138	159	179	196
Current Supply (ac-ft/yr)	153.24	153.24	153.24	153.24	153.24	153.24
Supply – Demand (ac-ft/yr)	+64.24	+38.24	+15.24	**-5.76**	**-25.76**	**-42.76**
Recommended Strategy: Groundwater (ac-ft/yr)				108	108	108

Water User Group: Shady Shores WSC	2000	2010	2020	2030	2040	2050
Population	308	378	448	518	588	658
Water Demand (ac-ft/yr)	40	47	54	60	65	70
Current Supply (ac-ft/yr)	45.7	45.7	45.7	45.7	45.7	45.7
Supply – Demand (ac-ft/yr)	+5.3	**-1.3**	**-8.3**	**-14.3**	**-19.3**	**-24.3**
Groundwater (ac-ft/yr)		46	46	46	46	46

MORRIS COUNTY

There were no actual shortages identified in Morris County.

RAINS COUNTY

Water User Group: Bright Star-Salem WSC	2000	2010	2020	2030	2040	2050
Population	2692	3096	3500	3904	4308	4713
Water Demand (ac-ft/yr)	455	523	583	654	720	800
Current Supply (ac-ft/yr)	586	586	586	586	586	586
Supply – Demand (ac-ft/yr)	+131	+63	+3	**-68**	**-134**	**-214**
Recommended Short Term Strategy: Groundwater (ac-ft/yr)	46	46	46			
Recommended Long Term Strategy: Surface Water (ac-ft/yr)				560	560	560

RED RIVER COUNTY

Water User Group: City of Detroit	2000	2010	2020	2030	2040	2050
Population	822	853	868	901	950	998
Water Demand (ac-ft/yr)	106	106	104	104	105	106
Current Supply (ac-ft/yr)	60	60	60	60	60	60
Supply – Demand (ac-ft/yr)	**-46**	**-46**	**-44**	**-44**	**-45**	**-46**
Recommended Strategy: Surface Water (ac-ft/yr)	106	106	106	106	106	106

Water User Group: Town of English	2000	2010	2020	2030	2040	2050
Population	163	161	155	150	145	130
Water Demand (ac-ft/yr)	21	20	19	17	16	14
Current Supply (ac-ft/yr)	14	14	14	14	14	14
Supply – Demand (ac-ft/yr)	**-7**	**-6**	**-5**	**-3**	**-2**	0
Recommended Strategy: Surface Water (ac-ft/yr)	7	7	7	7	7	7

SMITH COUNTY

Water User Group: Enchanted Lakes Water Corporation	2000	2010	2020	2030	2040	2050
Population	434	600	768	868	868	868
Water Demand (ac-ft/yr)	66	86	104	113	111	110
Current Supply (ac-ft/yr)	62	62	62	62	62	62
Supply – Demand (ac-ft/yr)	**-4**	**-24**	**-42**	**-51**	**-49**	**-48**
Recommended Strategy: Groundwater (ac-ft/yr)	62	62	62	62	62	62

Water User Group: Lindale Rural WSC	2000	2010	2020	2030	2040	2050
Population	5164	7147	9130	11114	13098	15079
Water Demand (ac-ft/yr)	786	1022	1233	1452	1668	1905
Current Supply (ac-ft/yr)	1086	1086	1086	1086	1086	1086
Supply – Demand (ac-ft/yr)	+300	+64	**-147**	**-366**	**-582**	**-819**
Recommended Strategy: Groundwater (ac-ft/yr)			591	591	591	1,182

Water User Group: Star Mountain WSC	2000	2010	2020	2030	2040	2050
Population	1220	1688	2156	2624	3094	3562
Water Demand (ac-ft/yr)	186	241	291	343	394	450
Current Supply (ac-ft/yr)	108	108	108	108	108	108
Supply – Demand (ac-ft/yr)	**-78**	**-133**	**-183**	**-235**	**-286**	**-342**
Recommended Strategy: Groundwater (ac-ft/yr)	108	216	216	323	323	323

TITUS COUNTY

There were no actual shortages identified in Titus County.

UPSHUR COUNTY

Water User Group: City of East Mountain	2000	2010	2020	2030	2040	2050
Population	1237	1453	1608	1805	2014	2195
Water Demand (ac-ft/yr)	168	190	201	221	239	255
Current Supply (ac-ft/yr)	80.6	80.6	80.6	80.6	80.6	80.6
Supply – Demand (ac-ft/yr)	**-87.4**	**-109.4**	**-120.4**	**-140.4**	**-158.4**	**-174.4**
Recommended Strategy: Groundwater (ac-ft/yr)	107	187	187	187	187	187

Water User Group: Diana WSC	2000	2010	2020	2030	2040	2050
Population	3061	3941	4821	5701	6581	7461
Water Demand (ac-ft/yr)	396	492	579	660	733	797
Current Supply (ac-ft/yr)	498	498	498	498	498	498
Supply – Demand (ac-ft/yr)	+102	+6	**-81**	**-162**	**-235**	**-299**
Recommended Strategy:						
Groundwater (ac-ft/yr)		71	71	71	71	71
Surface Water (ac-ft/yr)			248	248	248	248
Total (ac-ft/yr)			319	319	319	319

Water User Group: Harmony ISD	2000	2010	2020	2030	2040	2050
Population	200	330	460	590	720	850
Water Demand (ac-ft/yr)	26	41	55	68	80	90
Current Supply (ac-ft/yr)	24.1	24.1	24.1	24.1	24.1	24.1
Supply – Demand (ac-ft/yr)	**-1.9**	**-16.9**	**-30.9**	**-43.9**	**-55.9**	**-65.9**
Recommended Strategy: Groundwater (ac-ft/yr)	24	24	48	48	73	73

Water User Group: Pritchett WSC	2000	2010	2020	2030	2040	2050
Population	4660	5662	6672	7682	8692	9702
Water Demand (ac-ft/yr)	599	704	800	886	964	1033
Current Supply (ac-ft/yr)	504.4	504.4	504.4	504.4	504.4	504.4
Supply – Demand (ac-ft/yr)	**-94.6**	**-199.6**	**-295.6**	**-381.6**	**-459.6**	**-528.6**
Recommended Strategy: Surface Water (ac-ft/yr)	532	532	532	532	532	532

Water User Group: Steam Electric in Upshur County	2000	2010	2020	2030	2040	2050
Population	0	0	0	0	0	0
Water Demand (ac-ft/yr)	0	5601	5601	5601	5601	5601
Current Supply (ac-ft/yr)	0	0	0	0	0	0
Supply – Demand (ac-ft/yr)	0	**-5601**	**-5601**	**-5601**	**-5601**	**-5601**
Recommended Strategy: Surface Water (ac-ft/yr)	0	5,601	5,601	5,601	5,601	5,601

Water User Group: Union Grove WSC	2000	2010	2020	2030	2040	2050
Population	1637	1977	2317	2657	2997	3337
Water Demand (ac-ft/yr)	211	246	278	307	332	355
Current Supply (ac-ft/yr)	249.5	249.5	249.5	249.5	249.5	249.5
Supply – Demand (ac-ft/yr)	+38.5	+3.5	**-28.5**	**-57.5**	**-82.5**	**-105.5**
Recommended Strategy: Groundwater (ac-ft/yr)			83.5	83.5	83.5	167

VAN ZANDT COUNTY

Water User Group: City of Canton	2000	2010	2020	2030	2040	2050
Population	3559	4094	4628	5163	5698	6232
Water Demand (ac-ft/yr)	694	757	814	891	951	1039
Current Supply (ac-ft/yr)	818	818	818	818	818	818
Supply – Demand (ac-ft/yr)	+124	+61	+4	**-73**	**133**	**-221**
Recommended Strategy: Groundwater (ac-ft/yr)				108	216	216

Water User Group: City of Grand Saline	2000	2010	2020	2030	2040	2050
Population	3010	3462	3914	4366	4818	5270
Water Demand (ac-ft/yr)	583	636	684	749	804	880
Current Supply (ac-ft/yr)	586	586	586	586	586	586
Supply – Demand (ac-ft/yr)	+3	**-50**	**-98**	**-163**	**-218**	**-294**
Recommended Strategy: Groundwater (ac-ft/yr)		161	161	323	323	323

Water User Group: City of Van	2000	2010	2020	2030	2040	2050
Population	2255	2594	2932	3271	3610	3949
Water Demand (ac-ft/yr)	511	560	605	663	715	782
Current Supply (ac-ft/yr)	575	575	575	575	575	575
Supply – Demand (ac-ft/yr)	+64	+15	**-30**	**-88**	**-140**	**-207**
Recommended Strategy: Groundwater (ac-ft/yr)			269	269	269	269

Water User Group: Ben Wheeler WSC	2000	2010	2020	2030	2040	2050
Population	1417	1630	1842	2054	2267	2479
Water Demand (ac-ft/yr)	183	203	221	237	252	264
Current Supply (ac-ft/yr)	214.5	214.5	214.5	214.5	214.5	214.5
Supply – Demand (ac-ft/yr)	+31.5	+11.5	**-6.5**	**-22.5**	**-37.5**	**-49.5**
Recommended Strategy: Groundwater (ac-ft/yr)			134	134	134	134

Water User Group: Corinth WSC	2000	2010	2020	2030	2040	2050
Population	678	958	1237	1517	1796	2074
Water Demand (ac-ft/yr)	87	119	148	175	199	221
Current Supply (ac-ft/yr)	139	139	139	139	139	139
Supply – Demand (ac-ft/yr)	+52	+20	**-9**	**-36**	**-60**	**-82**
Recommended Strategy: Groundwater (ac-ft/yr)			108	108	108	108

Water User Group: Crooked Creek WSC	2000	2010	2020	2030	2040	2050
Population	541	764	986	1208	1431	1653
Water Demand (ac-ft/yr)	70	95	118	139	159	176
Current Supply (ac-ft/yr)	106	106	106	106	106	106
Supply – Demand (ac-ft/yr)	+36	+11	**-12**	**-33**	**-53**	**-70**
Recommended Strategy: Groundwater (ac-ft/yr)			108	108	108	108

Water User Group: Edom WSC	2000	2010	2020	2030	2040	2050
Population	795	1122	1450	1777	2105	2433
Water Demand (ac-ft/yr)	102	140	174	205	233	259
Current Supply (ac-ft/yr)	183	183	183	183	183	183
Supply – Demand (ac-ft/yr)	+81	+43	+9	**-22**	**-50**	**-76**
Recommended Strategy: Groundwater (ac-ft/yr)				46	92	92

Water User Group: Fruitvale WSC	2000	2010	2020	2030	2040	2050
Population	2324	3282	4239	5196	6153	7111
Water Demand (ac-ft/yr)	299	408	508	599	682	757
Current Supply (ac-ft/yr)	358	358	358	358	358	358
Supply – Demand (ac-ft/yr)	+58.5	**-50.5**	**-150.5**	**-241.5**	**-324.5**	**-399.5**
Recommended Strategy: Groundwater (ac-ft/yr)		54	161	269	377	430

Water User Group: Little Hope-Moore WSC	2000	2010	2020	2030	2040	2050
Population	1282	1810	2338	2865	3394	3922
Water Demand (ac-ft/yr)	165	225	280	331	376	417
Current Supply (ac-ft/yr)	186	186	186	186	186	186
Supply – Demand (ac-ft/yr)	+21	**-39**	**-94**	**-145**	**-190**	**-231**
Recommended Strategy: Surface Water From City of Tyler (ac-ft/yr)		145	145	145		

WOOD COUNTY

Water User Group: City of Mineola	2000	2010	2020	2030	2040	2050
Population	5128	5747	6366	6985	7604	8223
Water Demand (ac-ft/yr)	908	967	1006	1092	1148	1243
Current Supply (ac-ft/yr)	967	967	967	967	967	967
Supply – Demand (ac-ft/yr)	+5.9	0	**-49**	**-125**	**-181**	**-276**
Recommended Strategy: Groundwater (ac-ft/yr)			323	323	323	323

Water User Group: Fouke WSC	2000	2010	2020	2030	2040	2050
Population	2837	3367	3897	4427	4957	5487
Water Demand (ac-ft/yr)	402	445	484	535	574	643
Current Supply (ac-ft/yr)	616	616	616	616	616	616
Supply – Demand (ac-ft/yr)	+214	+171	+132	+81	+42	**-27**
Recommended Strategy: Groundwater (ac-ft/yr)						108

Water User Group: Lake Fork WSC	2000	2010	2020	2030	2040	2050
Population	1396	2116	2836	3556	4276	4996
Water Demand (ac-ft/yr)	198	280	352	430	495	587
Current Supply (ac-ft/yr)	182	182	182	182	182	182
Supply – Demand (ac-ft/yr)	**-16**	**-98**	**-170**	**-248**	**-313**	**-405**
Recommended Strategy: Groundwater (ac-ft/yr)	161	161	430	430	430	430

SUMMARY INFORMATION
FOR ENTITIES WITH CONTRACTUAL SHORTAGES

BOWIE COUNTY

Water User Group: DeKalb	2000	2010	2020	2030	2040	2050
Population	2041	2326	2690	3053	3316	3580
Water Demand (ac-ft/yr)	277	300	331	366	389	416
Current Supply (ac-ft/yr)	439	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+162	**-300**	**-331**	**-366**	**-389**	**-416**
Recommended Strategy: Surface Water (ac-ft/yr)		300	331	366	389	416

Water User Group: Hooks	2000	2010	2020	2030	2040	2050
Population	2822	3070	3318	3565	3813	4061
Water Demand (ac-ft/yr)	440	454	465	484	495	528
Current Supply (ac-ft/yr)	371	0	0	0	0	0
Supply – Demand (ac-ft/yr)	**-69**	**-454**	**-465**	**-484**	**-495**	**-528**
Recommended Strategy: Surface Water (ac-ft/yr)	69	454	465	484	495	528

Water User Group: Maud	2000	2010	2020	2030	2040	2050
Population	1023	1112	1202	1292	1382	1471
Water Demand (ac-ft/yr)	132	138	144	149	153	157
Current Supply (ac-ft/yr)	246	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+114	**-138**	**-144**	**-149**	**-153**	**-157**
Recommended Strategy: Surface Water (ac-ft/yr)		138	144	149	153	157

Water User Group: Nash	2000	2010	2020	2030	2040	2050
Population	2313	2516	2719	2922	3125	3328
Water Demand (ac-ft/yr)	298	313	326	337	347	354
Current Supply (ac-ft/yr)	381	13	13	13	13	13
Supply – Demand (ac-ft/yr)	+83	**-300**	**-313**	**-324**	**-334**	**-341**
Recommended Strategy: Surface Water (ac-ft/yr)		300	313	324	334	341

Water User Group: New Boston	2000	2010	2020	2030	2040	2050
Population	5043	5485	5928	6370	6813	7255
Water Demand (ac-ft/yr)	1109	1164	1217	1280	1346	1425
Current Supply (ac-ft/yr)	784	0	0	0	0	0
Supply – Demand (ac-ft/yr)	**-325**	**-1164**	**-1217**	**-1280**	**-1346**	**-1425**
Recommended Strategy: Surface Water (ac-ft/yr)	325	1164	1217	1280	1346	1425

Water User Group: Redwater	2000	2010	2020	2030	2040	2050
Population	2104	2289	2473	3658	4343	5027
Water Demand (ac-ft/yr)	326	335	345	506	587	673
Current Supply (ac-ft/yr)	192	45	45	45	45	45
Supply – Demand (ac-ft/yr)	**-134**	**-290**	**-300**	**-461**	**-542**	**-628**
Recommended Strategy: Surface Water (ac-ft/yr)	134	290	300	461	542	628

Water User Group: Wake Village	2000	2010	2020	2030	2040	2050
Population	5098	5546	5993	6441	6888	7336
Water Demand (ac-ft/yr)	657	690	718	743	764	781
Current Supply (ac-ft/yr)	358	0	0	0	0	0
Supply – Demand (ac-ft/yr)	**-299**	**-690**	**-718**	**-743**	**-764**	**-781**
Recommended Strategy: Surface Water (ac-ft/yr)	299	690	718	743	764	781

Water User Group: Burns Redbank WSC	2000	2010	2020	2030	2040	2050
Population	1150	1751	1952	2153	2354	2555
Water Demand (ac-ft/yr)	197	281	297	318	339	364
Current Supply (ac-ft/yr)	129	0	0	0	0	0
Supply – Demand (ac-ft/yr)	**-68**	**-281**	**-297**	**-318**	**-339**	**-364**
Recommended Strategy: Surface Water (ac-ft/yr)						

Water User Group: Central Bowie WSC	2000	2010	2020	2030	2040	2050
Population	4434	4823	7212	7601	8990	12379
Water Demand (ac-ft/yr)	761	775	1099	1121	1294	1765
Current Supply (ac-ft/yr)	258	258	0	0	0	0
Supply – Demand (ac-ft/yr)	**-503**	**-517**	**-1099**	**-1121**	**-1294**	**-1765**
Recommended Strategy: Surface Water (ac-ft/yr)	503	517	1099	1121	1294	1765

Water User Group: Macedonia-Eylau MUD #1	2000	2010	2020	2030	2040	2050
Population	3741	5392	6597	7804	9114	9900
Water Demand (ac-ft/yr)	642	867	1005	1151	1312	1412
Current Supply (ac-ft/yr)	552	552	552	0	0	0
Supply – Demand (ac-ft/yr)	**-90**	**-315**	**-453**	**-1151**	**-1312**	**-1412**
Recommended Strategy: Surface Water (ac-ft/yr)	90	315	453	1151	1312	1412

Water User Group: Oak Grove WSC	2000	2010	2020	2030	2040	2050
Population	585	723	861	999	1137	1275
Water Demand (ac-ft/yr)	98	114	129	145	162	180
Current Supply (ac-ft/yr)	82	82	0	0	0	0
Supply – Demand (ac-ft/yr)	**-16**	**-32**	**-129**	**-145**	**-162**	**-180**
Recommended Strategy: Surface Water (ac-ft/yr)	16	32	129	145	162	180

CAMP COUNTY

There are no shortages identified in Camp County that can be satisfied by an extension of an existing contract.

CASS COUNTY

Water User Group: Atlanta	2000	2010	2020	2030	2040	2050
Population	6389	6684	6904	7085	7181	7276
Water Demand (ac-ft/yr)	1427	1426	1412	1416	1411	1422
Current Supply (ac-ft/yr)	1878	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+451	**-1426**	**-1412**	**-1416**	**-1411**	**-1422**
Recommended Strategy: Surface Water (ac-ft/yr)		1426	1412	1416	1411	1422

Water User Group: Queen City	2000	2010	2020	2030	2040	2050
Population	2143	2336	2528	2720	2912	3105
Water Demand (ac-ft/yr)	320	328	337	350	364	384
Current Supply (ac-ft/yr)	657	292	292	292	292	292
Supply – Demand (ac-ft/yr)	+337	**-36**	**-34**	**-58**	**-72**	**-92**
Recommended Strategy: Surface Water (ac-ft/yr)		36	34	58	72	92

Water User Group: Domino	2000	2010	2020	2030	2040	2050
Population	203	323	443	563	683	803
Water Demand (ac-ft/yr)	26	40	53	65	76	85
Current Supply (ac-ft/yr)	55	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+29	**-40**	**-53**	**-65**	**-76**	**-85**
Recommended Strategy: Surface Water (ac-ft/yr)		40	53	65	76	85

Water User Group: Holly Springs WSC	2000	2010	2020	2030	2040	2050
Population	875	1305	1735	2165	2595	3025
Water Demand (ac-ft/yr)	113	162	208	250	288	322
Current Supply (ac-ft/yr)	92	92	92	0	0	0
Supply – Demand (ac-ft/yr)	**-21**	**-70**	**-116**	**-250**	**-288**	**-322**
Recommended Strategy: Surface Water (ac-ft/yr)	21	70	116	250	288	322

DELTA COUNTY

Water User Group: Charleston WSC	2000	2010	2020	2030	2040	2050
Population	1051	1075	1078	1082	1085	1094
Water Demand (ac-ft/yr)	141	140	135	131	126	123
Current Supply (ac-ft/yr)	163	163	163	0	0	0
Supply – Demand (ac-ft/yr)	+22	+23	+28	**-131**	**-126**	**-123**
Recommended Strategy: Surface Water (ac-ft/yr)				131	126	123

Water User Group: Enloe-Lake Creek WSC	2000	2010	2020	2030	2040	2050
Population	460	480	480	480	480	480
Water Demand (ac-ft/yr)	62	62	60	58	56	54
Current Supply (ac-ft/yr)	62	62	60	0	0	0
Supply – Demand (ac-ft/yr)	0	0	0	**-58**	**-56**	**-54**
Recommended Strategy: Surface Water (ac-ft/yr)				58	56	54

Water User Group: West Delta WSC	2000	2010	2020	2030	2040	2050
Population	1139	1158	1158	1158	1158	1158
Water Demand (ac-ft/yr)	154	150	145	140	135	128
Current Supply (ac-ft/yr)	247	247	173	0	0	0
Supply – Demand (ac-ft/yr)	+93	+97	+28	**-140**	**-135**	**-128**
Recommended Strategy: Surface Water (ac-ft/yr)				140	135	128

FRANKLIN COUNTY

Water User Group: Mount Vernon	2000	2010	2020	2030	2040	2050
Population	2631	3031	3428	3874	4120	4382
Water Demand (ac-ft/yr)	545	594	637	707	738	780
Current Supply (ac-ft/yr)	3000	3000	3000	0	0	0
Supply – Demand (ac-ft/yr)	+2455	+2406	+2363	**-707**	**-738**	**-780**
Recommended Strategy: Surface Water (ac-ft/yr)				707	738	780

Water User Group: Cypress Springs WSC	2000	2010	2020	2030	2040	2050
Population	5579	7007	8435	9815	10584	11384
Water Demand (ac-ft/yr)	1189	1426	1650	1873	1988	2120
Current Supply (ac-ft/yr)	3525	3517	3520	3522	75	75
Supply – Demand (ac-ft/yr)	+2336	+2091	+1870	+1649	**-1913**	**-2045**
Recommended Strategy: Surface Water (ac-ft/yr)					1913	2045

Water User Group: Pelican Bay (CSWSC)	2000	2010	2020	2030	2040	2050
Population	324	379	379	379	379	379
Water Demand (ac-ft/yr)	73	81	78	76	75	75
Current Supply (ac-ft/yr)	73	81	78	76	0	0
Supply – Demand (ac-ft/yr)	0	0	0	0	**-75**	**-75**
Recommended Strategy: Surface Water (ac-ft/yr)					75	75

GREGG COUNTY

Water User Group: Clarkesville City	2000	2010	2020	2030	2040	2050
Population	984	1087	1191	1294	1397	1501
Water Demand (ac-ft/yr)	127	134	143	150	155	161
Current Supply (ac-ft/yr)	322	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+195	**-135**	**-143**	**-150**	**-155**	**-161**
Recommended Strategy: Surface Water (ac-ft/yr)		135	143	150	155	161

Water User Group: Lakeport	2000	2010	2020	2030	2040	2050
Population	945	1036	1128	1219	1311	1402
Water Demand (ac-ft/yr)	122	129	135	141	145	149
Current Supply (ac-ft/yr)	134	22	22	22	22	22
Supply – Demand (ac-ft/yr)	+12	**-107**	**-113**	**-119**	**-123**	**-127**
Recommended Strategy: Surface Water (ac-ft/yr)		107	113	119	123	127

Water User Group: White Oak	2000	2010	2020	2030	2040	2050
Population	6177	6774	7371	7968	8564	9161
Water Demand (ac-ft/yr)	865	887	907	946	988	1047
Current Supply (ac-ft/yr)	1035	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+170	**-887**	**-907**	**-946**	**-988**	**-1047**
Recommended Strategy: Surface Water (ac-ft/yr)		887	907	946	988	1047

Water User Group: Warren City	2000	2010	2020	2030	2040	2050
Population	249	299	349	399	449	499
Water Demand (ac-ft/yr)	35	40	43	49	54	61
Current Supply (ac-ft/yr)	239	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+204	**-40**	**-43**	**-49**	**-54**	**-61**
Recommended Strategy: Surface Water (ac-ft/yr)		40	43	49	54	61

Water User Group: Elderville WSC	2000	2010	2020	2030	2040	2050
Population	3096	3846	4596	5346	6096	6846
Water Demand (ac-ft/yr)	439	512	567	673	748	847
Current Supply (ac-ft/yr)	484	80	80	80	80	80
Supply – Demand (ac-ft/yr)	+45	**-432**	**-487**	**-593**	**-668**	**-767**
Recommended Strategy: Surface Water (ac-ft/yr)		432	487	593	668	767

Water User Group: Liberty-Danville FWSD 2	2000	2010	2020	2030	2040	2050
Population	373	493	613	733	853	973
Water Demand (ac-ft/yr)	53	66	76	92	104	120
Current Supply (ac-ft/yr)	110	110	110	110	110	110
Supply – Demand (ac-ft/yr)	+57	+44	+34	+18	+6	**-10**
Recommended Strategy: Surface Water (ac-ft/yr)						10

Water User Group: Tryon Road WSC	2000	2010	2020	2030	2040	2050
Population	3045	4185	5325	6465	7605	8745
Water Demand (ac-ft/yr)	431	557	660	808	926	1070
Current Supply (ac-ft/yr)	1179	148	148	148	148	148
Supply – Demand (ac-ft/yr)	+748	**-409**	**-512**	**-660**	**-778**	**-922**
Recommended Strategy: Surface Water (ac-ft/yr)		409	512	660	778	922

<u>HARRISON COUNTY</u>

Water User Group: Hallsville	2000	2010	2020	2030	2040	2050
Population	2849	3133	3335	3565	3808	4042
Water Demand (ac-ft/yr)	383	407	418	431	444	453
Current Supply (ac-ft/yr)	511	143	143	143	143	143
Supply – Demand (ac-ft/yr)	+128	**-264**	**-275**	**-288**	**-301**	**-310**
Recommended Strategy: Surface Water (ac-ft/yr)		264	275	288	301	310

Water User Group: Gum Springs WSC	2000	2010	2020	2030	2040	2050
Population	5016	6546	8067	9606	11136	12666
Water Demand (ac-ft/yr)	673	849	1012	1164	1299	1419
Current Supply (ac-ft/yr)	622	258	258	258	258	258
Supply – Demand (ac-ft/yr)	**-51**	**-591**	**-754**	**-906**	**-1041**	**-1161**
Recommended Strategy: Surface Water (ac-ft/yr)	51	591	754	906	1041	1161

Water User Group: Leigh WSC	2000	2010	2020	2030	2040	2050
Population	1610	1790	1970	2150	2330	2510
Water Demand (ac-ft/yr)	216	233	247	260	271	281
Current Supply (ac-ft/yr)	334	334	334	150	150	150
Supply – Demand (ac-ft/yr)	+118	+101	+87	**-110**	**-121**	**-131**
Recommended Strategy: Surface Water (ac-ft/yr)				110	121	131

Water User Group: Big Oaks Mobile Home Park	2000	2010	2020	2030	2040	2050
Population	475	475	475	475	475	475
Water Demand (ac-ft/yr)	64	62	60	57	55	53
Current Supply (ac-ft/yr)	45	45	45	45	45	45
Supply – Demand (ac-ft/yr)	**-19**	**-17**	**-15**	**-12**	**-10**	**-8**
Recommended Strategy: Surface Water (ac-ft/yr)	19	17	15	12	10	8

Water User Group: Cypress Valley WSC	2000	2010	2020	2030	2040	2050
Population	760	1030	1300	1570	1840	2110
Water Demand (ac-ft/yr)	102	134	163	190	214	236
Current Supply (ac-ft/yr)	160	160	160	160	160	160
Supply – Demand (ac-ft/yr)	+58	+26	**-3**	**-30**	**-54**	**-76**
Recommended Strategy: Surface Water (ac-ft/yr)			3	30	54	76

Water User Group: Talley WSC	2000	2010	2020	2030	2040	2050
Population	1116	1286	1456	1626	1796	1966
Water Demand (ac-ft/yr)	150	167	183	197	209	220
Current Supply (ac-ft/yr)	122	122	122	122	122	122
Supply – Demand (ac-ft/yr)	**-28**	**-45**	**-61**	**-75**	**-87**	**-98**
Recommended Strategy: Surface Water (ac-ft/yr)	28	45	61	75	87	98

HOPKINS COUNTY

Water User Group: Brashear WSC	2000	2010	2020	2030	2040	2050
Population	754	774	794	814	834	854
Water Demand (ac-ft/yr)	126	123	120	120	119	121
Current Supply (ac-ft/yr)	173	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+47	**-123**	**-120**	**-120**	**-119**	**-121**
Recommended Strategy: Surface Water (ac-ft/yr)		123	120	120	119	121

Water User Group: Brinker WSC	2000	2010	2020	2030	2040	2050
Population	1572	1672	1772	1872	1972	2077
Water Demand (ac-ft/yr)	263	267	269	275	281	294
Current Supply (ac-ft/yr)	343	273	273	273	273	273
Supply – Demand (ac-ft/yr)	+80	+6	+4	**-2**	**-8**	**-21**
Recommended Strategy: Surface Water (ac-ft/yr)				2	8	21

Water User Group: Gafford Chapel WSC	2000	2010	2020	2030	2040	2050
Population	950	1155	1398	1590	1783	1976
Water Demand (ac-ft/yr)	159	184	212	234	254	280
Current Supply (ac-ft/yr)	146	84	84	84	84	84
Supply – Demand (ac-ft/yr)	**-13**	**-100**	**-128**	**-150**	**-170**	**-196**
Recommended Strategy: Surface Water (ac-ft/yr)	13	100	128	150	170	196

Water User Group: Martin Springs WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	2320	2570	2820	3070	3244	3395
Water Demand (ac-ft/yr)	388	410	427	452	463	481
Current Supply (ac-ft/yr)	626	403	403	403	403	403
Supply – Demand (ac-ft/yr)	+238	**-7**	**-24**	**-49**	**-60**	**-78**
Recommended Strategy: Surface Water (ac-ft/yr)		7	24	49	60	78

Water User Group: Miller Grove WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	1135	1282	1431	1579	1729	1875
Water Demand (ac-ft/yr)	194	208	221	237	252	272
Current Supply (ac-ft/yr)	200	197	197	197	197	197
Supply – Demand (ac-ft/yr)	+6	**-11**	**-24**	**-40**	**-55**	**-75**
Recommended Strategy: Surface Water (ac-ft/yr)		11	24	40	55	75

Water User Group: North Hopkins WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	4278	4878	5478	6078	6678	7278
Water Demand (ac-ft/yr)	713	778	831	893	954	1030
Current Supply (ac-ft/yr)	713	778	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-831**	**-893**	**-954**	**-1030**
Recommended Strategy: Surface Water (ac-ft/yr)			831	893	954	1030

Water User Group: Pleasant Hill WSC 2	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	169	187	206	224	242	261
Water Demand (ac-ft/yr)	28	30	31	33	35	37
Current Supply (ac-ft/yr)	28	30	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-31**	**-33**	**-35**	**-37**
Recommended Strategy: Surface Water (ac-ft/yr)			31	33	35	37

Water User Group: Shady Grove #2 WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	430	477	524	570	617	664
Water Demand (ac-ft/yr)	72	76	79	84	88	94
Current Supply (ac-ft/yr)	72	0	0	0	0	0
Supply – Demand (ac-ft/yr)	0	**-76**	**-79**	**-84**	**-88**	**-94**
Recommended Strategy: Surface Water (ac-ft/yr)		76	79	84	88	94

HUNT COUNTY

Water User Group: Caddo Mills	2000	2010	2020	2030	2040	2050
Population	1180	1315	1450	1585	1720	1855
Water Demand (ac-ft/yr)	152	164	174	183	191	197
Current Supply (ac-ft/yr)	166	166	0	0	0	0
Supply – Demand (ac-ft/yr)	+14	+2	**-174**	**-183**	**-191**	**-197**
Recommended Strategy: Surface Water (ac-ft/yr)			174	183	191	197

Water User Group: Commerce	2000	2010	2020	2030	2040	2050
Population	7271	8103	8935	9767	10599	11430
Water Demand (ac-ft/yr)	2036	2178	2302	2483	2647	2855
Current Supply (ac-ft/yr)	4591	4727	4821	351	351	351
Supply – Demand (ac-ft/yr)	+2555	+2549	+2519	**-2132**	**-2296**	**-2504**
Recommended Strategy: Surface Water (ac-ft/yr)				2132	2296	2504

Water User Group: Greenville	2000	2010	2020	2030	2040	2050
Population	25764	28711	31658	34605	37553	40500
Water Demand (ac-ft/yr)	6291	6689	7021	7520	8034	8620
Current Supply (ac-ft/yr)	23684	2323	2404	2645	2514	2364
Supply – Demand (ac-ft/yr)	+17393	**-4366**	**-4617**	**-4875**	**-5520**	**-6256**
Recommended Strategy: Surface Water (ac-ft/yr)		4366	4617	4875	5520	6256

Water User Group: Lone Oak	2000	2010	2020	2030	2040	2050
Population	627	698	770	842	914	995
Water Demand (ac-ft/yr)	97	104	110	117	123	129
Current Supply (ac-ft/yr)	410	15	15	15	15	15
Supply – Demand (ac-ft/yr)	+313	**-89**	**-95**	**-102**	**-108**	**-114**
Recommended Strategy: Surface Water (ac-ft/yr)		89	95	102	108	114

Water User Group: Quinlan	2000	2010	2020	2030	2040	2050
Population	1650	1838	2027	2216	2405	2593
Water Demand (ac-ft/yr)	213	229	243	256	267	276
Current Supply (ac-ft/yr)	224	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+11	**-229**	**-243**	**-256**	**-267**	**-276**
Recommended Strategy: Surface Water (ac-ft/yr)		229	243	256	267	276

Water User Group: West Tawakoni	2000	2010	2020	2030	2040	2050
Population	1192	1329	1465	1602	1738	1874
Water Demand (ac-ft/yr)	207	219	228	244	258	275
Current Supply (ac-ft/yr)	1120	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+913	**-219**	**-228**	**-244**	**-258**	**-275**
Recommended Strategy: Surface Water (ac-ft/yr)		219	228	244	258	275

Water User Group: Steam Electric	2000	2010	2020	2030	2040	2050
Population	0	0	0	0	0	0
Water Demand (ac-ft/yr)	516	516	516	516	516	516
Current Supply (ac-ft/yr)	800	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+284	**-516**	**-516**	**-516**	**-516**	**-516**
Recommended Strategy: Surface Water (ac-ft/yr)		516	516	516	516	516

Water User Group: BHP WSC	2000	2010	2020	2030	2040	2050
Population	1614	1926	2282	2612	3031	2978
Water Demand (ac-ft/yr)	208	239	274	301	336	317
Current Supply (ac-ft/yr)	182	0	0	0	0	0
Supply – Demand (ac-ft/yr)	**-26**	**-239**	**-274**	**-301**	**-336**	**-317**
Recommended Strategy: Surface Water (ac-ft/yr)	26	239	274	301	336	317

Water User Group: Caddo Basin SUD	2000	2010	2020	2030	2040	2050
Population	5334	6230	6674	7192	8046	8811
Water Demand (ac-ft/yr)	687	775	800	830	892	938
Current Supply (ac-ft/yr)	687	775	800	830	0	0
Supply – Demand (ac-ft/yr)	0	0	0	0	**-892**	**-938**
Recommended Strategy: Surface Water (ac-ft/yr)					892	938

Water User Group: Cash WSC	2000	2010	2020	2030	2040	2050
Population	10006	11321	12679	14009	15162	14696
Water Demand (ac-ft/yr)	1321	1445	1557	1664	1731	1803
Current Supply (ac-ft/yr)	4809	3559	245	245	245	245
Supply – Demand (ac-ft/yr)	+3488	+2114	**-1312**	**-1419**	**-1486**	**-1558**
Recommended Strategy: Surface Water (ac-ft/yr)			1312	1419	1486	1558

Water User Group: Combined Consumers WSC	2000	2010	2020	2030	2040	2050
Population	6998	7969	8948	9959	10510	11629
Water Demand (ac-ft/yr)	730	799	864	925	928	988
Current Supply (ac-ft/yr)	1409	1344	0	0	0	0
Supply – Demand (ac-ft/yr)	+679	+545	**-864**	**-925**	**-928**	**-988**
Recommended Strategy: Surface Water (ac-ft/yr)			864	925	928	988

Water User Group: Community Water	2000	2010	2020	2030	2040	2050
Population	815	889	910	930	950	969
Water Demand (ac-ft/yr)	92	95	92	88	85	81
Current Supply (ac-ft/yr)	221	221	0	0	0	0
Supply – Demand (ac-ft/yr)	+129	+126	**-92**	**-88**	**-85**	**-81**
Recommended Strategy: Surface Water (ac-ft/yr)			92	88	85	81

Water User Group: Jacobia WSC	2000	2010	2020	2030	2040	2050
Population	768	778	788	798	808	818
Water Demand (ac-ft/yr)	99	97	94	92	90	87
Current Supply (ac-ft/yr)	336	336	336	0	0	0
Supply – Demand (ac-ft/yr)	+237	+239	+242	**-92**	**-90**	**-87**
Recommended Strategy: Surface Water (ac-ft/yr)				92	90	87

Water User Group: Maloy WSC	2000	2010	2020	2030	2040	2050
Population	370	395	490	560	650	740
Water Demand (ac-ft/yr)	48	49	59	65	72	79
Current Supply (ac-ft/yr)	114	47	47	47	47	47
Supply – Demand (ac-ft/yr)	+66	**-2**	**-12**	**-18**	**-25**	**-32**
Recommended Strategy: Surface Water (ac-ft/yr)		2	12	18	25	32

Water User Group: North Hunt WSC	2000	2010	2020	2030	2040	2050
Population	2396	2637	2879	3120	3655	4101
Water Demand (ac-ft/yr)	310	329	347	361	407	438
Current Supply (ac-ft/yr)	164	63	63	63	63	63
Supply – Demand (ac-ft/yr)	**-146**	**-266**	**-284**	**-298**	**-344**	**-375**
Recommended Strategy: Surface Water (ac-ft/yr)	146	266	284	298	344	375

LAMAR COUNTY

Water User Group: Blossom	2000	2010	2020	2030	2040	2050
Population	1734	1853	1972	2092	2211	2330
Water Demand (ac-ft/yr)	223	230	236	241	245	248
Current Supply (ac-ft/yr)	223	230	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-236**	**-241**	**-245**	**-248**
Recommended Strategy: Surface Water (ac-ft/yr)			236	241	245	248

Water User Group: Deport	2000	2010	2020	2030	2040	2050
Population	895	955	1015	1075	1136	1196
Water Demand (ac-ft/yr)	115	118	121	123	126	127
Current Supply (ac-ft/yr)	115	0	0	0	0	0
Supply – Demand (ac-ft/yr)	0	**-118**	**-121**	**-124**	**-126**	**-127**
Recommended Strategy: Surface Water (ac-ft/yr)		118	121	124	126	127

Water User Group: Reno	2000	2010	2020	2030	2040	2050
Population	3059	4327	4869	5424	5852	6314
Water Demand (ac-ft/yr)	411	562	611	656	682	707
Current Supply (ac-ft/yr)	411	562	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-611**	**-656**	**-682**	**-707**
Recommended Strategy: Surface Water (ac-ft/yr)			611	656	682	707

Water User Group: Roxton	2000	2010	2020	2030	2040	2050
Population	724	773	823	873	923	973
Water Demand (ac-ft/yr)	93	96	99	101	102	103
Current Supply (ac-ft/yr)	93	96	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-99**	**-101**	**-102**	**-103**
Recommended Strategy: Surface Water (ac-ft/yr)			99	101	102	103

Water User Group: Lamar County WSD	2000	2010	2020	2030	2040	2050
Population	12612	13817	15177	16138	17105	18074
Water Demand (ac-ft/yr)	1944	1999	2051	2122	2188	2289
Current Supply (ac-ft/yr)	4267	4194	5525	0	0	0
Supply – Demand (ac-ft/yr)	+2323	+2195	-3474	**-2122**	**-2188**	**-2289**
Recommended Strategy: Surface Water (ac-ft/yr)				2122	2188	2289

Water User Group: M J C WSC	2000	2010	2020	2030	2040	2050
Population	514	514	514	514	514	514
Water Demand (ac-ft/yr)	79	74	70	68	66	65
Current Supply (ac-ft/yr)	92	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+13	**-74**	**-70**	**-68**	**-66**	**-65**
Recommended Strategy: Surface Water (ac-ft/yr)		74	70	68	66	65

Water User Group: Pattonville WSC	2000	2010	2020	2030	2040	2050
Population	311	316	321	326	331	336
Water Demand (ac-ft/yr)	48	46	43	43	42	43
Current Supply (ac-ft/yr)	54	65	76	0	0	0
Supply – Demand (ac-ft/yr)	+6	+19	+33	**-43**	**-42**	**-43**
Recommended Strategy: Surface Water (ac-ft/yr)				43	42	43

MARION COUNTY

There are no shortages identified in Marion County that can be satisfied by an extension of an existing contract.

MORRIS COUNTY

There are no shortages identified in Morris County that can be satisfied by an extension of an existing contract.

RAINS COUNTY

Water User Group: East Tawakoni	2000	2010	2020	2030	2040	2050
Population	762	886	1011	1135	1259	1384
Water Demand (ac-ft/yr)	107	117	126	138	147	160
Current Supply (ac-ft/yr)	552	552	0	0	0	0
Supply – Demand (ac-ft/yr)	+445	+435	**-126**	**-138**	**-147**	**-160**
Recommended Strategy: Surface Water (ac-ft/yr)			126	138	147	160

Water User Group: Emory	2000	2010	2020	2030	2040	2050
Population	1056	1228	1401	1573	1745	1918
Water Demand (ac-ft/yr)	209	232	252	278	302	329
Current Supply (ac-ft/yr)	1105	1105	1105	0	0	0
Supply – Demand (ac-ft/yr)	+896	+873	+853	**-278**	**-302**	**-329**
Recommended Strategy: Surface Water (ac-ft/yr)				278	302	329

Water User Group: Point	2000	2010	2020	2030	2040	2050
Population	816	949	1082	1216	1349	1482
Water Demand (ac-ft/yr)	110	122	131	141	151	164
Current Supply (ac-ft/yr)	224	224	0	0	0	0
Supply – Demand (ac-ft/yr)	+114	+102	**-131**	**-141**	**-151**	**-164**
Recommended Strategy: Surface Water (ac-ft/yr)			131	141	151	164

Water User Group: South Rains WSC	2000	2010	2020	2030	2040	2050
Population	1708	2054	2398	2742	3079	3401
Water Demand (ac-ft/yr)	316	359	399	441	488	531
Current Supply (ac-ft/yr)	264	264	0	0	0	0
Supply – Demand (ac-ft/yr)	**-52**	**-95**	**-399**	**-441**	**-488**	**-531**
Recommended Strategy: Surface Water (ac-ft/yr)	52	95	399	441	488	531

RED RIVER COUNTY

Water User Group: 410 WSC	2000	2010	2020	2030	2040	2050
Population	1963	2165	2367	2369	2372	2374
Water Demand (ac-ft/yr)	254	270	284	274	263	253
Current Supply (ac-ft/yr)	254	270	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-284**	**-274**	**-263**	**-253**
Recommended Strategy: Surface Water (ac-ft/yr)			284	274	263	253

Water User Group: Annona	2000	2010	2020	2030	2040	2050
Population	352	352	352	352	352	352
Water Demand (ac-ft/yr)	45	44	42	41	39	37
Current Supply (ac-ft/yr)	68	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+23	**-44**	**-42**	**-41**	**-39**	**-37**
Recommended Strategy: Surface Water (ac-ft/yr)		44	42	41	39	37

Water User Group: Avery	2000	2010	2020	2030	2040	2050
Population	650	650	650	650	650	650
Water Demand (ac-ft/yr)	84	81	78	75	72	69
Current Supply (ac-ft/yr)	92	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+8	**-81**	**-78**	**-75**	**-72**	**-69**
Recommended Strategy: Surface Water (ac-ft/yr)		81	78	75	72	69

Water User Group: Red River County WSC	2000	2010	2020	2030	2040	2050
Population	4471	4477	4487	4494	4501	4518
Water Demand (ac-ft/yr)	575	557	539	519	500	481
Current Supply (ac-ft/yr)	730	730	546	435	436	435
Supply – Demand (ac-ft/yr)	+155	+173	+7	**-84**	**-64**	**-46**
Recommended Strategy: Surface Water (ac-ft/yr)				84	64	46

SMITH COUNTY

There are no shortages identified in Smith County that can be satisfied by an extension of an existing contract.

TITUS COUNTY

Water User Group: Winfield	2000	2010	2020	2030	2040	2050
Population	447	691	825	959	1093	1200
Water Demand (ac-ft/yr)	60	90	104	116	127	134
Current Supply (ac-ft/yr)	153	153	153	0	0	0
Supply – Demand (ac-ft/yr)	+93	+63	+49	**-116**	**-127**	**-134**
Recommended Strategy: Surface Water (ac-ft/yr)				116	127	134

Water User Group: Tri WSC	2000	2010	2020	2030	2040	2050
Population	8967	11258	12827	14162	15643	17031
Water Demand (ac-ft/yr)	1216	1476	1624	1730	1843	1935
Current Supply (ac-ft/yr)	1401	0	0	0	0	0
Supply – Demand (ac-ft/yr)	+185	**-1476**	**-1624**	**-1730**	**-1843**	**-1935**
Recommended Strategy: Surface Water (ac-ft/yr)		1476	1624	1730	1843	1935

UPSHUR COUNTY

There are no shortages identified in Upshur County that can be satisfied by an extension of an existing contract.

VAN ZANDT COUNTY

Water User Group: Edgewood	2000	2010	2020	2030	2040	2050
Population	1588	1826	2064	2303	2541	2780
Water Demand (ac-ft/yr)	215	231	248	266	281	309
Current Supply (ac-ft/yr)	950	950	110	110	110	110
Supply – Demand (ac-ft/yr)	+735	+719	**-138**	**-156**	**-171**	**-199**
Recommended Strategy: Surface Water (ac-ft/yr)			138	156	171	199

Water User Group: Wills Point	2000	2010	2020	2030	2040	2050
Population	3504	4030	4556	5083	5609	6135
Water Demand (ac-ft/yr)	589	642	684	740	792	867
Current Supply (ac-ft/yr)	2210	2210	0	0	0	0
Supply – Demand (ac-ft/yr)	+1621	+1568	**-684**	**-740**	**-792**	**-867**
Recommended Strategy: Surface Water (ac-ft/yr)			684	740	792	867

Water User Group: Mac Bee WSC	2000	2010	2020	2030	2040	2050
Population	6210	7131	8052	8973	9941	10892
Water Demand (ac-ft/yr)	800	887	965	1035	1103	1159
Current Supply (ac-ft/yr)	3433	3433	1215	106	106	106
Supply – Demand (ac-ft/yr)	+2633	+2546	+250	**-929**	**-997**	**-1053**
Recommended Strategy: Surface Water (ac-ft/yr)				929	997	1053

Water User Group: South Tawakoni WSC	2000	2010	2020	2030	2040	2050
Population	2853	4028	5204	6378	7553	8729
Water Demand (ac-ft/yr)	368	501	624	736	838	929
Current Supply (ac-ft/yr)	558	558	0	0	0	0
Supply – Demand (ac-ft/yr)	+190	+57	**-624**	**+736**	**+838**	**+929**
Recommended Strategy: Surface Water (ac-ft/yr)			624	736	838	929

WOOD COUNTY

Water User Group: Winnsboro	2000	2010	2020	2030	2040	2050
Population	2623	2958	3294	3629	3965	4300
Water Demand (ac-ft/yr)	493	530	564	606	648	699
Current Supply (ac-ft/yr)	4308	4529	4529	4529	0	0
Supply – Demand (ac-ft/yr)	+3815	+3999	+3965	+3923	**-648**	**-699**
Recommended Strategy: Surface Water (ac-ft/yr)					648	699

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF CAMP COUNTY MANUFACTURING

Description of Water User Group:

Manufacturing in Camp County is projected to have a water supply shortage within the planning period. This projected shortage is directly related to a proposed poultry processing facility being constructed on Walker Creek east of U.S. Highway 271 between Pittsburg and Mt. Pleasant. The facility is being developed by Pilgrim's Pride Corporation, and is projected to need 2232 ac-ft/yr. of supply.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population						
Projected Water Demand	10	2242	2242	2242	2242	2242
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	10	10	10	10	10	10
Projected Supply Surplus (+) / Deficit (-)	0	**-2232**	**-2232**	**-2232**	**-2232**	**-2232**

Evaluation of Potentially Feasible Water Management Strategies:

The four alternative strategies considered for meeting Camp County manufacturing needs are listed in the table below.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annual Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
(ac-ft/yr)		2232	2232	2232	2232	2232

The Pilgrims facility is not in production at this time, and it will be the responsibility of the industry to locate an acceptable water source or sources. Sources that are being considered by the industry include well water from the Carrizo-Wilcox formation, purchase of treated water from area municipal and rural water systems, and surface water purchased from existing water rights holders. Additionally, the plant design will emphasize water reuse and conservation techniques to reduce the need for new water sources.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF LINDEN

Description of Water User Group:

The City of Linden is located in central Cass County. In 1998, the City served 992 connections. The City is expected to grow from a current population of 2,465 persons in 2000 to 3,317 persons by the year 2050. The City of Linden is included in the City WUG for Cass County. The City relies on ground water from four water wells. The four water wells produce a cumulative total of approximately 430 GPM, or 231 ac-ft/yr. The City does not have a water conservation plan nor a drought management plan. The system is bounded on all sides by the Western Cass WSC certificate of convenience and necessity area. The Western Cass WSC is currently under construction. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	2465	2635	2806	2976	3146	3317
Projected Water Demand	326	325	327	337	342	357
Current Water Supply	231	221	211	201	191	181
Projected Supply Surplus(+)/Deficit(-)	**-95**	**-104**	**-116**	**-136**	**-151**	**-176**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the City of Linden's water supply shortages as summarized in the preceding table. Advanced water conservation was not considered because the per capita use per day did not exceed the 115 gpcpd threshold set by the Water Planning Group. Although the City of Linden has a centralized wastewater collection system, water reuse was not considered because Linden does not have a non-potable water user large enough to warrant the creation of a water reuse plant. Groundwater was not considered, as the City of Linden has been noticing a steadily decreasing quantity of water from their existing wells for some time. Surface water was considered, as the Northeast Texas Municipal Water District (NETMWD) has recently entered into an agreement with the City to provide treated water. A worksheet for the surface water – purchase water contract is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water (purchase contract)	**176**	**$ 1,424,805**	**$ 145,014**	**$ 1,209**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr) (purchase contract)	95	104	116	136	151	176

The City of Linden has recently entered into an agreement with the NETMWD to purchase treated water at a maximum of 800,000 GPD, or 896 ac-ft/yr on an annualized basis. The NETMWD has a water supply line approximately 14 miles from the City of Linden. The City intends to construct a pipe line to connect the source to the City. The City of Linden plans to augment their existing well production with the purchased surface water, gradually increasing the water purchased as their existing wells continue to deteriorate in production. The recommended strategy for the City of Linden to meet their projected deficits would be to continue their efforts to acquire treated water from the NETMWD. The recommended supply source, Lake O' The Pines, has an ample supply to meets the needs of the City of Linden.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF BLOOMBURG WSC

Description of Water User Group:

Bloomburg WSC provides water service in the northeastern portion of Cass County. In 1998 the WSC served approximately 225 connections. The WSC currently serves a population of approximately 543 persons, and is expected to grow to 1,343 persons by the year 2050. Bloomburg WSC is included in the County Other water user group for Cass County. The system relies on two wells with a total rated capacity of 230 GPM, or 123 ac-ft/yr on an annualized basis. The system currently has a leak detection program in place for water conservation. The system is not bounded by any immediate water supply corporations or other entities, but is bounded on the east by the State of Arkansas. BWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	543	702	863	1023	1183	1343
Projected Water Demand	70	87	103	118	131	143
Current Water Supply	123	123	123	123	123	123
Projected Supply Surplus (+) / Deficit (-)	+53	+36	+20	+5	**-8**	**-20**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the Bloomburg WSC water supply shortages as summarized in the following table. Advanced water conservation was not considered for Bloomburg WSC because the per capita use per day was below the 115 gpcpd threshold set by the Water Planning Group. Water reuse was omitted from consideration because the Bloomburg service area does not have a centralized wastewater collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the area, and surface water treatment is not economically feasible for a system of this size. A worksheet for the groundwater alternative is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**62**	**$ 221,994**	**$ 24,176**	**$ 391**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)					62	62

The recommended strategy for Bloomburg WSC to meet their projected deficit in the year 2040 would be to drill an additional water well similar to their existing wells. The recommended supply source for the wells would be the Carrizo-Wilcox Aquifer in Cass County. The additional well with a rated capacity of 115 GPM would provide approximately 62 ac-ft/yr. The Carrizo-Wilcox Aquifer in Cass County is projected to have an ample supply availability for Bloomburg WSC.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF BEN FRANKLIN WATER SUPLY CORPORATION

Description of Water User Group:

Ben Franklin WSC is a small public water supply located in northern Delta County. In 1998, Ben Franklin served 91 connections. The system currently serves 241 people, and is not expected to grow over the planning period. Ben Franklin WSC is included in the County Other water user group for Delta County. Current source of supply is a single well into the Trinity formation. Ben Franklin WSC provides water to its own customers and also has a supply contract with the Enloe-Lake Creek WSC. Enloe Lake-Creek is projected to have growth over the planning period. Once contract demands are met, Ben Franklin does not have adequate supply to meet its own needs. In addition, the WSC's well does not meet TNRCC secondary water quality standards and is expected to fail sometime after 2020. The system does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	241	241	241	241	241	241
Projected Water Demand	32	31	30	29	28	27
Water Demand from other entities	62	62	62	0	0	0
Current Water Supply	85	85	85	0	0	0
Projected Supply Surplus (+) / Deficit (-)	**-9**	**-8**	**-7**	**-29**	**-28**	**-27**

Evaluation of Potentially Feasible Water Management Strategies:

The four alternative strategies considered to meet Ben Franklin's water supply shortages are listed in the table below. Advanced conservation is not applicable since per capita use is less than 115 gpcpd. There are no current water needs in Ben Franklin that could be met by water reuse. Finally, groundwater is not sufficient or of appropriate quality, as noted above. Conversion to surface water by contracting or merging with Delta County MUD was the alternative selected for this entity.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annual Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**32**	**$176,648**	**$46,711**	**$1,460**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)	32	31	30	29	29	29

The recommended strategy for Ben Franklin WSC is to enter into a contract for treated surface water with Delta County MUD. The MUD has adequate supply available, and has an expansion project underway which could deliver water to the Ben Franklin area before 2005. Since Delta County MUD already has water available, and since there would be no significant construction, environmental impact would be negligible.

An alternate strategy would be to treat the existing groundwater to meet TNRCC standards. This presumes that the Enloe/Lake Creek need will be met by connection to Delta County MUD, leaving Ben Franklin's well adequate to supply its own needs. Treatment will be required to reduce iron, fluoride and dissolved solids. Disposal of the waste stream plus technological complexity render this alternative problematic.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF PECAN GAP

Description of Water User Group:

The City of Pecan Gap is located in northwestern Delta County, and is situated in the Sulphur River Basin. In 1998, Pecan Gap served 109 connections. The system currently serves 286 people, and is expected to remain at that population until the year 2050. Pecan Gap is served by a city lake and surface water treatment plant. Pecan Gap also wholesales water to the Lone Star WSC. Lone Star is not projected to grow during the planning period. The supply is deficient because the firm yield of Lyndsay Lake, the City's reservoir, is insufficient. The system does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	286	286	286	286	286	286
Projected Water Demand	38	37	36	35	33	32
Water Demand from other entities	27	26	25	24	23	23
Current Water Supply	50	50	50	50	49	49
Projected Supply Surplus (+) / Deficit (-)	**-15**	**-13**	**-11**	**-9**	**-7**	**-6**

Evaluation of Potentially Feasible Water Management Strategies:

The alternative strategies listed in the table below were considered to meet Pecan Gap's water supply needs. Advanced conservation is not applicable since per capita use is less than 115 gpcpd. There are no current water needs which could be met by water reuse. Groundwater quality in the area around Pecan Gap does not meet TNRCC secondary quality standards. Therefore, a water purchase contract with the Delta County MUD was the alternative selected for this entity. There are no other systems in the immediate area with sufficient capacity to supply Pecan Gap.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annual Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**38**	**$1,454,618**	**$145,845**	**$3,838**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)	38	38	38	38	38	38

The recommended strategy for Pecan Gap is to contract with Delta County MUD for purchase of water from Big Creek Lake. In fact, these entities are already in negotiation, and are both agreeable to this strategy. Funding has been offered through the USDA – Rural Development, and that agency has issued a finding of "no significant impact" on the environment. The MUD has adequate supply in the Big Creek Reservoir.

Because the entities involved have agreed to this proposed solution, no further alternatives were analyzed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF GLADEWATER

Description of Water User Group:

The City of Gladewater is located along the Gregg / Upshur county line, near the eastern border of Smith County. The City provides water service to city residents in both Upshur and Gregg counties. In 1998, the City served 2,720 connections. The population is projected to increase from 6,896 persons in 2000 to 9,987 persons in 2050. The City is currently contractually obligated to serve three other entities; Clarksville City, Warren City, and Starrville-Friendship WSC. Of these entities, only Starrville-Friendship has a secondary water supply source to complement Gladewater's supply. The City of Gladewater is included in the City and County Other WUG for Gregg and Upshur Counties. The City relies on surface water from Lake Gladewater, which is owned and operated by the City. The City is currently permitted by the TNRCC to withdraw 1,679 ac-ft/yr. The City has a water conservation plan in place, which includes universal metering and education and information. The City does not have a drought management plan. The system is bounded on the east by the City of Warren City and the City of White Oak; the south by the Sabine River; the west by Starrville-Friendship WSC, and on the north by Pritchett and Union Grove Water Supply Corporations. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	6896	7576	8102	8733	9395	9987
Projected Water Demand	1217	1259	1274	1342	1411	1489
Contractual Demands:						
City of Clarksville City	334.1	334.1	334.1	334.1	334.1	334.1
City of Warren City	238.6	238.6	238.6	238.6	238.6	238.6
Starrville-Friendship WSC	46	46	46	46	46	46
Total Projected Water Demand	1835.7	1877.7	1892.7	1960.7	2029.7	2107.7
Current Water Supply	1679	1679	1679	1679	1679	1679
Projected Supply Surplus(+)/Deficit(-)	**-156.7**	**-198.7**	**-213.7**	**-281.7**	**-350.7**	**-428.7**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the City of Gladewater's water supply shortages as summarized in the preceding table. Advanced water conservation was considered because the per capita use per day exceeded the 115 gpcpd threshold set by the Planning Group. Water reuse was not considered because there are no non-potable water users large enough to warrant creating a water reuse plant. Surface water was considered, as the City's primary source is surface water from Lake Gladewater. Worksheets for the advanced water conservation and surface water alternatives are included as Attachments B and C respectively

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation	**95**	**$ 221,880**	**$ 112,163**	**$ 1,178**	**Minimal**
Water Reuse					
Groundwater					
Surface Water	**1,679**	**$ 773,815**	**$ 275,020**	**$ 164**	**Moderate**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)	1,679	1,679	1,679	1,679	1,679	1,679

The City of Gladewater is requesting a water permit amendment and renewal to expand to 3,358 ac-ft/yr. The recommended strategy for the City to meet their projected deficits would be to continue the permit amendment process, and upgrade their water treatment facilities as necessary to expand their treatment capabilities to meet demands. The recommended supply source, Lake Gladewater, with an estimated firm yield of 6,900 ac-ft/yr, has ample supply to provide for the demands of the City of Gladewater.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF LIBERTY CITY WSC

Description of Water User Group:

Liberty City WSC provides water service in the rural southern portion of Gregg County. In 1998, the WSC served 1,495 connections. The population is projected to increase from 3,600 persons in 2000 to 6,639 persons in 2050. The City of Liberty City is served by the WSC, and in 1998, approximately 2,778 persons of the total population lived within the city limits of Liberty City. The WSC is included in the City and the County Other WUG for Gregg County. The system relies on five wells with a total rated capacity of 860 GPM, or 461.8 ac-ft/yr. The system currently has a leak detection program for water conservation. The system is bounded on the north by Prairie Creek and the Sabine River; the east by SH 31; the south by Liberty-Danville FWSD #1 and West Gregg WSC; and on the west by the Smith County line. LCWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	3600	4208	4816	5423	6031	6639
Projected Water Demand	596	649	693	773	841	923
Current Water Supply	461.8	461.8	461.8	461.8	461.8	461.8
Projected Supply Surplus(+)/Deficit(-)	**-134.2**	**-187.2**	**-231.2**	**-311.2**	**-379.2**	**-461.2**

There were four alternative strategies considered to meet the Liberty City WSC water supply shortages as summarized in the preceding table. Advanced water conservation was not considered for the county other portion of LCWSC because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Advanced water conservation was considered for the City portion. Water reuse was not considered because the Liberty City area does not have a centralized wastewater collection system. Surface water alternatives were omitted since no supply source is within close proximity to the area, and surface water treatment is not economically feasible for a system of this size. LCWSC has purchased water from the City of Kilgore in the recent past, so a purchase agreement alternative was considered. A worksheet for the groundwater alternative, including the purchase agreement alternative, is included as Attachment B. A worksheet for the advanced water conservation is included as Attachment C.

Evaluation of Potentially Feasible Water Management Strategies:

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation	**13**	**$ 70,020**	**$ 30,731**	**$ 1,060**	**Minimal**
Water Reuse					
Groundwater (wells)	**470**	**$ 1,130,716**	**$ 143,413**	**$ 305**	**Minimal**
Groundwater (purchased)	**73.7**	**$ 0**	**$ 147,694**	**$ 24,015**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr) (wells)	188	188	282	376	470	470

Liberty City WSC is currently completing plans to construct an additional water well (June, 2000). The recommended strategy for LCWSC to meet their projected deficits would be to complete construction of this water well, and construct four additional water wells similar to their existing wells. The recommended supply source for the wells would be the Carrizo-Wilcox Aquifer in Gregg County which is projected to have an ample supply availability for Liberty City WSC. A total of five additional wells with a rated capacity of 175 GPM each would provide approximately 470 additional ac-ft/yr. The wells should be constructed in the decades when the deficits are projected to occur. Due to the high unit cost of purchasing water from the City of Kilgore, the purchase agreement option is not recommended. Due to the high unit cost of implementing water conservation, advanced water conservation is not recommended.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF MANUFACTURING IN GREGG COUNTY

Description of Water User Group:

The Manufacturing WUG in Gregg County has a demand that is projected to grow from a current demand of 16,538 ac-ft/yr in 2000 to 29,716 ac-ft/yr in 2050. The projected demand is largely a result of expected industrial growth in and near the City of Longview. Manufacturing in Gregg County relies on four primary supply sources; the Carrizo-Wilcox Aquifer; direct reuse; local supply sources; and the City of Longview water system.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Projected Water Demand	16538	18576	20934	23507	26515	29716
Current Water Supply	5821	9488	10366	10836	11385	11970
Projected Supply Surplus (+)/Deficit(-)	**-10717**	**-9088**	**-10568**	**-12671**	**-15130**	**-17746**

Evaluation of Potentially Feasible Water Management Strategies:

Four alternative strategies were considered to meet the Gregg County Manufacturing WUG's water supply shortages as summarized in the preceding table. Advanced water conservation was not considered because it is not applicable for manufacturing. Water reuse was not considered because there would be no net change in demand required by an entity if reuse were implemented, and the entities are projected entities only, and cannot be construed to benefit from reuse. Groundwater was not considered due to questionable reliability and the large quantity required for manufacturing. Surface water was considered, as the City of Longview has available supply from surface water sources in its water system. A worksheet for the surface water alternative is included as Attachment A.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**12,653**	**$ 0**	**$ 5,360,032**	**$ 424**	**Minimal**

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Surface Water (ac-ft/yr)	10,717	9,088	10,568	12,671	15,130	17,746

The recommended strategy for the Gregg County Manufacturing WUG to meet projected demands during the planning period is to purchase treated water from the City of Longview. The City of Longview has an ample supply of water to meet the needs of manufacturing in Gregg County.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF WEST GREGG WSC

Description of Water User Group:

West Gregg WSC provides water service in the rural southwestern corner of Gregg County, a portion of eastern Smith County, and a small portion of Rusk County. Approximately 3% of the system is outside of Region D. In 1997, the system served approximately 1,223 connections. The population is projected to increase from 2,291 persons in 2000 to 5,764 persons in 2050. The WSC is included in the County Other WUG for Gregg and Smith County. The system relies on five wells with a total rated capacity of 640 GPM, or 344.1 ac-ft/yr. Approximately 10.3 ac-ft of this capacity is allocated to users outside of Region D. The system currently has a water conservation plan and a leak detection program. The system is bounded on the north by Liberty City WSC; the east by Liberty-Danville FWSD #1; the south by the City of Kilgore, and the west by the Browning community in Smith County. WGWSC has a water conservation plan but does not have a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	2291	2985	3681	4376	5070	5764
Projected Water Demand	334	409	471	558	630	719
Current Water Supply	333.8	333.8	333.8	333.8	333.8	333.8
Projected Supply Surplus(+)/Deficit(-)	**-0.2**	**-75.2**	**-137.2**	**-224.2**	**-296.2**	**-385.2**

There were four alternative strategies considered to meet the West Gregg WSC water supply shortages as summarized in the preceding table. Advanced water conservation was considered because the per capita use per day exceeded the 115 gpcpd threshold set by the planning group. Water reuse was not considered because the West Gregg service area does not have a centralized wastewater collection system. Surface water alternatives were omitted since no supply source is within close proximity to the area, and surface water treatment is not economically feasible for a system of this size. A ten-year master plan was recently completed for this system and the supply improvements specified in that plan were considered and listed on the groundwater worksheet. The worksheet for the groundwater alternative is included as Attachment B. A worksheet for the advanced water conservation is included as Attachment C.

Evaluation of Potentially Feasible Water Management Strategies:

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation	**9**	**$ 60,720**	**$ 34,696**	**$ 1,395**	**Minimal**
Water Reuse					
Groundwater	**403**	**$ 1,337,993**	**$ 149,701**	**$ 371**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr) (wells)	80.6	80.6	161.2	241.8	322.4	403.0

The recommended strategy for West Gregg WSC to meet their projected deficits would be to construct five additional water wells similar to their existing wells. The recommended supply source for the wells would be the Carrizo-Wilcox Aquifer in Gregg County which is projected to have an ample supply availability for WGWSC. A total of five additional wells at 150 GPM each would provide approximately 403 additional ac-ft/yr. The wells should be constructed in the decades when the deficits are projected to occur. Advanced water conservation is not recommended for WGWSC due to the higher unit cost, as compared to the groundwater strategy. Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF WASKOM

Description of Water User Group:

The City of Waskom is located in southeastern Harrison County and serves the incorporated city limits and an area immediately north, east, and south of the City of Waskom. In 1999 the system had 876 members. The population is projected to increase from 2,301 persons in 2000 to 3,292 persons in 2050. The City is included in the County Other WUG for Harrison County. The system's current water supply consists of eight water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these wells is 654 GPM, or 352 ac-ft/yr. The system is bound on the east, south, and west by the Waskom Rural Water WSC #1. The City does not have a water conservation plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	2301	2529	2703	3056	3096	3292
Projected Water Demand	332	348	354	365	379	399
Current Water Supply	352	352	352	352	352	352
Projected Supply Surplus (+)/Deficit(-)	+20	+4	**-2**	**-13**	**-27**	**-47**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the City of Waskom water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse was not considered because the City does not have a demand for non-potable water. Surface water alternatives were omitted since there is not a supply source within close proximity to the City and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**88**	**$ 224,805**	**$ 27,815**	**$ 315**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)			44	44	44	88

The recommended strategy for the City of Waskom to meet their projected deficit of 2 ac-ft/yr in 2020 and 47 ac-ft/yr in 2050 would be to construct one additional water well similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo-Wilcox Aquifer in Harrison County. Two wells with rated capacity of 82 gpm each would provide approximately 44 acre-feet each or 88 ac-ft/yr. The Carrizo-Wilcox Aquifer in Harrison County is projected to have a more than ample supply availability to meet the needs of the City of Waskom for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF BLOCKER-CROSSROADS WSC

Description of Water User Group:

Blocker-Crossroads WSC is located in south eastern Harrison County and serves an area east of US Hwy 59 and South of Interstate Highway 20. In 1999 the system had 330 members. The population is projected to increase from 677 persons in 2000 to 1677 persons in 2050. The BCWSC is included in the County Other water user group for Harrison County. The systems current water supply consist of two water wells which provide water from the Carrizo-Wilcox Aquifer. The total rated capacity of these two wells is 240 GPM which equates to 128 ac-ft/yr on an annual average basis. The system is bound on the west by Gill WSC, on the north by the City of Scottsville, on the east by Waskom Rural Water WSC, and on the south by Elysian Fields WSC. BCWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	677	877	1077	1277	1477	1677
Projected Water Demand	91	114	135	154	172	188
Current Water Supply	128	128	128	128	128	128
Projected Supply Surplus(+)/Deficit(-)	+37	+14	**-7**	**-26**	**-44**	**-60**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the BCWSC water supply shortages as summarized in the following table. Advanced conservation was omitted from consideration because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was omitted from consideration because the BCWSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the BCWSC and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**65**	**$ 203,001**	**$ 23,147**	**$ 359**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)			64	64	64	64

The recommended strategy for the Blocker-Crossroads WSC to meet their projected deficit of 7 acre-feet in the year 2020 and 60 acre-feet in the year 2050 would be to construct one additional water well similar to their existing two wells. The recommended supply source will be the Carrizo-Wilcox aquifer in Harrison County. A well with rated capacity of 120 gpm would provide approximately 64 acre-feet on an annualized basis. The Carrizo-Wilcox Aquifer in Harrison County is projected to have a more than ample supply availability to meet the needs of BCWSC for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF CADDO LAKE WSC

Description of Water User Group:

Caddo Lake WSC is located in northeastern Harrison County and serves the community of Uncertain east of Karnack and west of Caddo Lake. In 1999 the system had 397 members. The population is projected to increase from 838 persons in 2000 to 1638 persons in 2050. The CLWSC is included in the County Other water user group for Harrison County. The systems current water supply consist of four water wells which provide water from the Carrizo-Wilcox Aquifer. The total rated capacity of these four wells is 267 GPM which equates to 144 ac-ft/year on an annual average basis. The system is bound on the west by Karnack WSC, on the north by the Big Cypress Bayou, on the east by Caddo Lake, and on the south by the Longhorn Army Ammunition Plant. The CLWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	838	998	1158	1318	1478	1638
Projected Water Demand	113	130	145	159	172	183
Current Water Supply	143.4	143.4	143.4	143.4	143.4	143.4
Projected Supply Surplus(+)/Deficit(-)	+30.4	+13.4	**-1.6**	**-15.6**	**-28.6**	**-39.6**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the CLWSC water supply shortages as summarized in the following table. Advanced conservation was omitted from consideration because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was omitted from consideration because the CLWSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the CLWSC and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**72**	**$ 278,537**	**$ 29,613**	**$ 411**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)			36	36	36	72

The recommended strategy for the Caddo Lake WSC to meet their projected deficit of 1.6 acre-feet in the year 2020 and 39.6 acre-feet in the year 2050 would be to construct one additional water well similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo-Wilcox aquifer in Harrison County. Two wells with rated capacity of 67 gpm each would provide approximately 36 acre-feet each or 72 acre-feet total on an annualized basis. The Carrizo-Wilcox Aquifer in Harrison County is projected to have a more than ample supply availability to meet the needs of CLWSC for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF ELYSIAN FIELDS WSC

Description of Water User Group:

Elysian Fields WSC is located in southeastern Harrison County (90% Region D) and northeastern Panola County (10% Region I). The service area is located along State Highway 31and in the Elysian Fields Community. In 1999 the system had 214 members. The population is projected to increase from 452 persons in 2000 to 852 persons in 2050. The EFWSC is included in the County Other WUG for Harrison County. The system's current water supply consists of two water wells which provide water from the Carrizo-Wilcox Aquifer. The total rated capacity of these two wells is 185 GPM which equates to 100 ac-ft/yr. The supply is distributed proportionately between the two Counties for this evaluation. The system is bound on the west by Gill WSC, on the north by Blocker-Crossroads WSC, on the east by Waskom Rural Water WSC, and on the south by Rock Hill WSC. EFWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	452	532	612	692	772	852
Projected Water Demand	61	69	77	84	90	95
Current Water Supply	89.4	89.4	89.4	89.4	89.4	89.4
Projected Supply Surplus(+)/Deficit(-)	+28.4	+20.4	+12.4	+5.4	**-0.6**	**-5.6**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the EFWSC water supply shortages as summarized in the following table. Advanced conservation was omitted from consideration because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was omitted from consideration because the EFWSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the EFWSC and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**50**	**$ 176,135**	**$ 19,305**	**$ 386**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)					50	50

The recommended strategy for the Elysian Fields WSC to meet their projected deficit of 5.6 ac-ft in the year 2050 would be to construct one additional water well similar to their existing two wells. The recommended supply source will be the Carrizo-Wilcox Aquifer in Harrison County. A well with rated capacity of 90 gpm would provide approximately 50 ac-ft/yr. The Carrizo-Wilcox Aquifer in Harrison County is projected to have a more than ample supply availability to meet the needs of EFWSC for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF HARLETON WSC

Description of Water User Group:

Harleton WSC is located in north western Harrison County and south western Marion County and serves an area around the communities of Harleton, Smyrna, Lake Deerwood, and Jackson. In 1999 the system had 867 members with 87% in Harrison County and 13% in Marion County. The population is projected to increase from 1,808 persons in 2000 to 5,408 persons in 2050. The HWSC is included in the County Other WUG for Harrison and Marion Counties. The system's current water supply consists of five water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these wells is 557 GPM, or 299 ac-ft/yr. The system is bound on the west by Diana WSC, on the north by Lake O' the Pines, on the south by Little Cypress Creek, and nothing on the east. HWSC does not have a water conservation plan and a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	1808	2528	3248	3968	4688	5408
Projected Water Demand	242	327	406	477	543	602
Current Water Supply	299.3	299.3	299.3	299.3	299.3	299.3
Projected Supply Surplus(+)/Deficit(-)	+57.3	**-27.7**	**-106.7**	**-177.7**	**-243.7**	**-302.7**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the HWSC water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse was not considered because the HWSC does not have a centralized sewerage collection system. One surface water alternative was completed which included purchasing treated water from the Northeast Texas Municipal Water District near Jefferson. Worksheets for the ground and surface water alternatives are included as Attachments B and C respectively. The groundwater alternative assumes that HWSC can construct water wells of adequate quantity and quality for domestic use. HWSC has had difficulty in the past developing acceptable wells due to poor quality groundwater. The HWSC recently received funding assistance from USDA Rural Utility Services to expand their service area and connect to the NETMWD near Jefferson.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**309**	**$1,661,164**	**$ 160,899**	**$ 520**	**Moderate**
Surface Water	**308**	**$ 2,890,805**	**$ 353,604**	**$ 1,486**	**Moderate**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)		168	203	239	274	309

The recommended strategy for the Harleton WSC to meet their projected deficit of 28 ac-ft/yr in 2010 and 303 ac-ft/yr in 2050 would be to construct a treated water main and related facilities to purchase surface water from the Northeast Texas Municipal Water District. The recommended supply source will be the Lake O' The Pines in Marion County. NETMWD would initially provide approximately 168 ac-ft/yr and ultimately could provide 309 ac-ft/yr to the HWSC. The Lake O' The Pines in Marion County is projected to have a more than ample supply availability to meet the short term needs of HWSC for the planning period.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF NORTH HARRISON WSC

Description of Water User Group:

North Harrison WSC is located in north central Harrison County and serves an area along US Highway 59 around the community of Woodlawn. In 1999 the system had 330 members. The population is projected to increase from 696 persons in 2000 to 1,746 persons in 2050. The NHWSC is included in the County Other WUG for Harrison County. The system's current water supply consists of two water wells which provide water from the Carrizo-Wilcox Aquifer. The total rated capacity of these two wells is 250 GPM which equates to 134 ac-ft/yr. The system is bound on the west by the Cypress Valley WSC, on the north and east by a proposed expansion project by Harleton WSC, and on the south by Leigh WSC. NHWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	696	906	1116	1326	1536	1746
Projected Water Demand	94	118	140	160	179	196
Current Water Supply	134.3	134.3	134.3	134.3	134.3	134.3
Projected Supply Surplus(+)/Deficit(-)	+40.3	+16.3	**-5.7**	**-25.7**	**-44.7**	**-61.7**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the NHWSC water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse was not considered because the NHWSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since no supply source is within close proximity to the NHWSC and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**67**	**$ 254,202**	**$ 27,216**	**$ 405**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)			67	67	67	67

The recommended strategy for the North Harrison WSC to meet their projected deficit of 5.7 acre-feet in the year 2020 and 61.7 acre-feet in the year 2050 would be to construct one additional water well similar to their existing wells. The recommended supply source will be the Carrizo-Wilcox Aquifer in Harrison County. One well with rated capacity of 125 gpm would provide approximately 67 ac-ft/yr. The Carrizo-Wilcox Aquifer in Harrison County is projected to have a more than ample supply availability to meet the needs of NHWSC for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF WASKOM RURAL WSC #1

Description of Water User Group:

Waskom Rural WSC #1 is located in southeastern Harrison County and serves an area east, south, and west of the City of Waskom. In 1999 the system had 240 members. The population is projected to increase from 506 persons in 2000 to 1,706 persons in 2050. The WWSC #1 is included in the County Other WUG for Harrison County. The system's current water supply consist of two water wells which provide water from the Carrizo-Wilcox Aquifer. The total rated capacity of these two wells is 220 GPM which equates to 118 ac-ft/yr. The system is bound on the west by the City of Scottsville, on the east by the State of Louisiana, and on the south by De Berry WSC. WRWSC#1 does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	506	746	986	1224	1466	1706
Projected Water Demand	68	97	124	148	171	191
Current Water Supply	117.1	117.1	117.1	117.1	117.1	117.1
Projected Supply Surplus(+)/Deficit(-)	+49.1	+20.1	**-6.9**	**-30.9**	**-53.9**	**-73.9**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the WRWSC#1 water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse not considered because the WRWSC#1 does not have a centralized sewerage collection system. Surface water alternatives were omitted since no supply source is within close proximity to the WRWSC#1 and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**118**	**$ 278,537**	**$ 35,640**	**$ 301**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)			59	59	59	118

The recommended strategy for the Waskom Rural WSC #1 to meet their projected deficit of 6.9 ac-ft in the year 2020 and 73.9 ac-ft in the year 2050 would be to construct one additional water well similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo-Wilcox Aquifer in Harrison County. Two wells with rated capacity of 110 gpm each would provide approximately 59 ac-ft each or 118 ac-ft/yr. The Carrizo-Wilcox Aquifer in Harrison County is projected to have a more than ample supply availability to meet the needs of WRWSC #1 for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF WEST HARRISON WSC

Description of Water User Group:

West Harrison WSC is located in western Harrison County and serves an area on the north, east, and south side of the City of Hallsville. In 1999 the system had 397 members. The population is projected to increase from 922 persons in 2000 to 1,972 persons in 2050. The WHWSC is included in the County Other WUG for Harrison County. The system's current water supply consist of three water wells from the Queen City and Carrizo-Wilcox Aquifers. The total rated capacity of these three wells is 300 GPM, or 161 ac-ft/yr. The system is bound on the west by the City of Hallsville and Gum Springs WSC, on the north and east by Talley WSC, and on the south by the Sabine River. WHWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	922	1132	1342	1552	1762	1972
Projected Water Demand	124	147	168	188	205	221
Current Water Supply	161.5	161.5	161.5	161.5	161.5	161.5
Projected Supply Surplus(+)/Deficit(-)	+37.5	+14.5	**-6.5**	**-26.5**	**-43.5**	**-59.5**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the WHWSC water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was not considered because the WHWSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since no supply source is within close proximity to the WHWSC and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**108**	**$ 254,202**	**$ 32,472**	**$ 302**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)			108	108	108	108

The recommended strategy for the West Harrison WSC to meet their projected deficit of 6.5 acre-feet in the year 2020 and 59.5 acre-feet in the year 2050 would be to construct one additional water well similar to their largest existing well. The recommended supply source will be the Carrizo-Wilcox Aquifer in Harrison County. One well with rated capacity of 200 gpm would provide approximately 108 ac-ft/yr. The Carrizo-Wilcox Aquifer in Harrison County is projected to have a more than ample supply availability to meet the needs of WHWSC for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF COMO

Description of Water User Group:

The City of Como is located in southeast Hopkins County, and is situated in both the Sabine and Sulphur river basins. It is surrounded by multiple WSCs. Como served 261 connections in 1998. The City's estimated population is 643 people, which is expected to increase to 992 by the year 2050. Como's current source of supply comes from two wells in the Carrizo-Wilcox formation. Water quality meets current TNRCC standards, however the quantity is not sufficient to meet demands. The system does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	643	713	783	853	923	992
Projected Water Demand	100	105	109	115	121	129
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	103	103	103	103	103	103
Projected Supply Surplus (+) / Deficit (-)	+3	**-2**	**-6**	**-12**	**-18**	**-26**

Evaluation of Potentially Feasible Water Management Strategies:

Four alternative strategies were evaluated in meeting Como's water supply needs, listed in the table below. There are no current water needs which could be met by water reuse. Advanced conservation is not applicable since per capita use would be less than 115 gpcpd. Finally, connection with a surface water supply source would prove significantly more costly than continued reliance on groundwater. Drilling an additional well was the alternative selected for this entity. The average production capacity of Como's current wells is 95 GPM, which can be projected to yield 46 ac-ft/yr under drought-of-record conditions. One additional well would be sufficient to meet projected demands.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	46	$155,922	$17,098	$372	Minimal
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)		46	46	46	46	46

The recommended strategy for the City of Como is to drill an additional well by the year 2010, into the Carrizo-Wilcox Aquifer. An additional well with a yield of 46 ac-ft would be sufficient to supply the 26 ac-ft deficit. Currently, groundwater quality meets TNRCC standards, and the aquifer is adequate in this area. Environmental impact would be minimal, and primarily related to any pipeline required to connect the new well to the system.

Como is located approximately 8 miles from the City of Sulphur Springs, a major water provider in the North East Texas Region. In the event that groundwater is not available, or should other factors dictate, it is recommended that Como consider soliciting future supply from Sulphur Springs. Sulphur Springs has adequate supply to meet the system's needs.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF PICKTON WSC

Description of Water User Group:

The Pickton WSC is located Hopkins County, along S.H. 11. It is surrounded by several WSCs serving Hopkins and Wood Counties. In 1998, Pickton served 208 connections. The estimated population served in the year 2000 is 503, and it is projected to increase to 776 persons by the year 2050. Pickton's current source of supply consists of two wells in the Carrizo-Wilcox formation. The rated capacity of these wells is 93 GPM under drought of record conditions, which equates to 100 ac-ft/yr on an annual average basis. Water quality from these wells is in compliance with TNRCC standards, however quantity will not prove sufficient to meet projected demands. The WSC does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	503	558	612	667	721	776
Projected Water Demand	84	89	93	98	103	110
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	98	98	98	98	98	98
Projected Supply Surplus (+) / Deficit (-)	+14	+9	+5	0	**-5**	**-12**

Evaluation of Potentially Feasible Water Management Strategies:

The four alternative strategies considered to meet Pickton WSC's water supply shortages are summarized in the table below. Advanced conservation was not considered applicable since per capita use is less than 115 gpcpd. Water reuse was not considered applicable since the WSC does not have a wastewater collection or treatment system in place. No surface supplies exist within a reasonable proximity. Continued use of groundwater is the preferred option.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annual Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**41**	**$206,532**	**$20,338**	**$496**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)					41	41

The recommended strategy for the Pickton WSC would be to drill one additional well into the Carrizo-Wilcox formation, at a depth of about 500 feet. Environmental impacts are considered minimal, and this aquifer can adequately supply the increase in demand. Purchase of treated surface water from the City of Sulphur Springs would also be feasible, but does not appear cost-effective as long as an adequate quality and quantity of groundwater is available.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that Pickton consider combining resources and/or soliciting future water supply from the City of Sulphur Springs. If this alternative becomes feasible, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF SHIRLEY WATER SUPPLY CORPORATION

Description of Water User Group:

The Shirley WSC is located in the southwest corner of Hopkins County and the northeast corner of Rains County. It is situated in the Sabine River basin. Shirley is bound on the west by Miller Grove WSC, and on the east by various small WSCs. In 1998, Shirley served 609 connections. The estimated population in the year 2000 is 1394, and is projected to grow to 2290 by the year 2050. Shirley's current water supply comes from seven wells in the Carrizo-Wilcox formation. Water quality meets current TNRCC standards, however the quantity will not be sufficient to meet projected demands. The system does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	1394	1573	1752	1932	2111	2290
Projected Water Demand	239	259	276	298	318	344
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	278	278	278	278	278	278
Projected Supply Surplus (+) / Deficit(-)	+39	+19	+3	**-20**	**-40**	**-66**

Evaluation of Potentially Feasible Water Management Strategies:

Four alternatives were considered for solving Shirley's water shortage and these are listed in the table below. Water reuse is not applicable since Shirley has no wastewater collection or treatment system. Advanced conservation is not applicable since per capita use is less than 115 gpcpd. Connection with a surface water supply source would prove more costly than a groundwater supply. Shirley's existing wells produce an average of 96 GPM, which can be equated to 46 ac-ft/yr in a drought of record situation. Drilling two additional wells will meet the need for this entity.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**92**	**$319,964**	**$35,219**	**$383**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)				46	46	46
Groundwater (ac-ft/yr)						46

The recommended strategy for the Shirley WSC is to drill one additional well into the Carrizo-Wilcox around the year 2030, and a second well between 2030 and 2050. Currently, groundwater quality meets TNRCC standards. Environmental impact would be negligible.

An alternative strategy would be to purchase water from the City of Sulphur Springs. Sulphur Springs is a major water provider, located about five miles from the Shirley service area, which has sufficient water to meet Shirley's need. Connection to Sulphur Springs would initially be more costly than additional well development; however, Shirley's service area is on the outcrop of the Carrizo-Wilcox, and in this area quality and quantity problems are common. Difficulties in obtaining additional wells or the increasing complexity of operating a groundwater system could make surface water supply an attractive alternative.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF WOLFE CITY

Description of Water User Group:

The City of Wolfe City is located in northern Hunt County, and is situated in the Sulphur River Basin. Wolfe City is bound on the west side by the Hickory Creek SUD, and the City of Commerce is located southeast of the City. In 1998, Wolfe City served 744 connectionsThe system currently serves 1633 people, and the population is expected to increase to 2568 by the year 2050. Wolfe City's current source of supply comes from two city lakes located on Turkey Creek in the South Sulphur River Basin, as well as one well in the Woodbine formation about seven miles west of the city. Water quality meets current TNRCC standards, however the quantity will not be sufficient to meet projected demands. The system does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	1633	1820	2007	2194	2381	2568
Projected Water Demand	214	222	229	243	256	274
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	220	220	220	220	220	220
Projected Supply Surplus (+) / Deficit (-)	+6	**-2**	**-9**	**-43**	**-56**	**-74**

Evaluation of Potentially Feasible Water Management Strategies:

Listed in the table below are the four strategies that were considered to meet water supply needs in Wolfe City. There are no current water needs which could be met by water reuse. Advanced conservation is not applicable since per capita use is less than 115 gpcpd. The system has a number of surface water options, including connection to the City of Commerce, City of Greenville, and the proposed Ralph Hall Reservoir in Region C. Additional groundwater was the alternative selected for this entity.

Strategy	**Firm Yield (ac-ft)**	**Total Capital Cost**	**Total Annual Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**80**	**$ 828,714**	**$ 70,591**	**$882**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)		80	80	80	80	80

The recommended strategy for the City of Wolfe City is to drill another 150 gpm well into the Woodbine formation west of the city, in Fannin County. The time frame for this alternative would be around 2010. The well would discharge into the existing transmission main from the City's current well to town. An intermediate pumping and storage facility would be added to enhance the capacity of the transmission main. This recommendation is made based on limited knowledge of firm yield of the city lakes. No in-depth studies were available indicating either the current firm yield of the reservoirs, or whether dredging or similar enhancements to the storage capacity could improve the firm yield. It is recommended that the City pursue such a study.

Surface water from the proposed Ralph Hall reservoir in Fannin County near Ladonia could be a long-range future supply. The lake is proposed in the Region C plan, but the permit process has not begun and the date of impoundment, if any, is unknown. The City currently operates its own surface water treatment plant; should the future regulatory or economic environment significantly affect this operation, purchase of treated surface water from Commerce or Greenville could be an option.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF PETTY WATER SUPLY CORPORATION

Description of Water User Group:

Petty WSC is a small public water supply located in western Lamar County along State Highway 82. It is surrounded on all sides by the Lamar County WSD. In 1998, Petty served 53 connections. The estimated population is 114 in the year 2000, and is projected to be 137 by the year 2050. Petty WSC is included in the County Other water user group for Lamar County. Current source of supply is a single well into the Woodbine formation. Water quality does not meet current TNRCC standards. Backup for the single well is provided through a 6" connection to Lamar County WSD. The system does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	114	122	130	137	137	137
Projected Water Demand	18	18	18	18	18	17
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	18	18	0	0	0	0
Projected Supply Surplus (+) / Deficit (-)	0	0	**-18**	**-18**	**-18**	**-17**

Evaluation of Potentially Feasible Water Management Strategies:

The alternative strategies listed in the table below were considered to meet Petty's water supply shortage. Advanced conservation is not applicable since per capita use is less than 115 gpcpd, the threshold set by the planning group. There are no current water needs which could be met by water reuse. Groundwater is not of suitable quality. The existing well is projected to fail by 2020, and a replacement well will not be a viable option, since water quality is below TNRCC minimum standards. Conversion to surface water by contracting with LCWSD was the alternative selected for this entity.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**18**	**$38,583**	**$16,349**	**$908**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)			18	18	18	17

The recommended strategy is for Petty WSC to enter into a contract for treated surface water with Lamar County Water Supply District when necessary. LCWSD has adequate supply available, and already has facilities in-place to provide this service. There are no other suppliers in the Petty area with adequate facilities to meet Petty's needs. Given that facilities are in-place, capital costs would be negligible. Since LCWSD already has water available, and no significant construction would be required, environmental impact would be negligible.

An alternative scenario would be to treat the existing groundwater to remove fluoride and dissolved solids. The capital cost of this technology, coupled with the problems of disposal of the waste stream, results in surface water being the proposed alternative.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF KELLYVILLE-BEREA WSC

Description of Water User Group:

The Kellyville-Berea WSC is located in central Marion County, west of the City of Jefferson. In 1998, the WSC provided water service to 320 connections. The population is projected to increase from 581 persons in 2000 to 1,831 persons in 2050. The system is included in the County Other WUG for Marion County. The system relies on groundwater from two water wells. The two wells provide a cumulative total of 165 GPM, or 87 ac-ft/yr. The system does not have a water conservation plan nor a drought management plan, but does have a leak detection system in place. The system is bounded on the east by the City of Jefferson; the south by the Big Cypress River; the west by Mims WSC; and on the north by East Marion County WSC. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	581	831	1081	1331	1581	1831
Projected Water Demand	75	103	130	154	175	195
Current Water Supply	87	87	87	87	87	87
Projected Supply Surplus(+)/Deficit(-)	+12	**-16**	**-43**	**-67**	**-88**	**-108**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the Kellyville-Berea WSC water supply shortages as summarized in the preceding table. Advanced water conservation was considered because the per capita use per day exceeded the 115 gpcpd threshold set by the water planning group. Water reuse not considered because the Kellyville-Berea WSC service area does not have a centralized wastewater collection system, nor is a reuse system economically feasible for an entity of this size. Surface water was considered, as the Northeast Texas Municipal Water District (NETMWD) is currently completing construction of a water main to serve the City of Jefferson, which will be located near the Kellyville-Berea system. Worksheets for the advanced water conservation, groundwater, and surface water alternatives are included as Attachments B, C, and D respectively.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation	**8**	**$ 32,430**	**$ 16,826**	**$ 2,139**	**Minimal**
Water Reuse					
Groundwater	**108**	**$ 665,782**	**$ 62,353**	**$ 580**	**Minimal**
Surface Water	**108**	**$ 285,022**	**$ 45,272**	**$ 836**	**Moderate**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)		16	43	67	88	108

The Kellyville-Berea WSC has met with the NETMWD regarding the purchase of treated water from the NETMWD's Jefferson supply line. The NETMWD has an ample supply in their Jefferson line to meet the projected needs of Kellyville-Berea WSC. The WSC intends to enter into negotiations with the NETMWD before their supply deficit occurs. The WSC may choose to augment their existing well production with the purchased surface water, gradually increasing the water purchased. The recommended strategy for the Kellyville-Berea WSC to meet their projected deficits would be to continue their efforts to enter into a water purchase contract with the NETMWD for treated water. The recommended supply source, Lake O' The Pines, has an ample supply to meets the needs of the Kellyville-Berea WSC.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF PINE HARBOR WSC

Description of Water User Group:

Pine Harbor WSC provides water service on the north side of Lake O' The Pines, in Marion County. The system currently serves approximately 379 customers. The population is projected to increase from 692 persons in 2000 to 1,842 persons in 2050. The system is included in the County Other water user group for Marion County. Pine Harbor WSC relies on two water wells with a combined rated capacity of 285 GPM, or 153 ac-ft/yr. The WSC has a leak detection program in place. The system is bounded on the north by Mims WSC, on the east by Indian Hills Harbor Subdivision, and on the south and west by Lake O' The Pines. PHWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	692	922	1152	1382	1612	1842
Projected Water Demand	89	115	138	159	179	196
Current Water Supply	153.24	153.24	153.24	153.24	153.24	153.24
Projected Supply Surplus(+)/Deficit(-)	+64.24	+38.24	+15.24	**-5.76**	**-25.76**	**-42.76**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the Pine Harbor WSC water supply shortages as summarized in the following table. Advanced water conservation was not considered for PHWSC because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was not considered because the Pine Harbor area does not have a centralized wastewater collection system. Surface water alternatives were omitted since no supply source is within close proximity to the area, and surface water treatment is not economically feasible for a system of this size. A worksheet for the groundwater alternative is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**108**	**$ 152,242**	**$ 25,070**	**$ 233**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)				108	108	108

The recommended strategy for Pine Harbor WSC to meet their projected deficits in 2030 would be to construct an additional water well similar to their existing well No. 2. The well should be constructed before the year 2030. The recommended supply source for the well is the Carrizo-Wilcox Aquifer in Marion County. One well with a rated capacity of 200 GPM would provide approximately 108 ac-ft/yr. The Carrizo-Wilcox Aquifer in Marion County is projected to have an ample supply availability for the Pine Harbor WSC.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF SHADY SHORES WSC

Description of Water User Group:

Shady Shores WSC provides water service on the south side of Lake O' The Pines, in Marion County. The system currently serves approximately 170 customers. The population is projected to increase from 308 persons in 2000 to 658 persons in 2050. The system is included in the County Other WUG for Marion County. Shady Shores WSC relies on one water well with a rated capacity of 85 GPM, or 45 ac-ft/yr. The WSC has a conservation plan in place, but the plan has not been submitted to the State. The system is bounded on the north by the lake, and there are no organized water supply systems bounding the system on the west, south, or east. SSWSC does not have a water conservation plan nor a drought managment plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	308	378	448	518	588	658
Projected Water Demand	40	47	54	60	65	70
Current Water Supply	45.7	45.7	45.7	45.7	45.7	45.7
Projected Supply Surplus(+)/Deficit(-)	+5.3	**-1.3**	**-8.3**	**-14.3**	**-19.3**	**-24.3**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the Shady Shores WSC water supply shortages as summarized in the following table. Advanced water conservation was not considered for Shady Shores WSC because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was not considered because the Shady Shores area does not have a centralized wastewater collection system. Surface water alternatives were omitted since no supply source is within close proximity to the area, and surface water treatment is not economically feasible for a system of this size. A worksheet for the groundwater alternative is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**46**	**$ 201,844**	**$ 20,611**	**$ 451**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)		46	46	46	46	46

The recommended strategy for Shady Shores WSC to meet their projected deficits in 2010 would be to construct an additional water well similar to their existing well. The well should be constructed before the year 2010. The recommended supply source for the well is the Carrizo-Wilcox Aquifer in Marion County. One well with a rated capacity of 85 GPM would provide approximately 46 ac-ft/yr. The Carrizo-Wilcox Aquifer in Marion County is projected to have an ample supply availability for the Shady Shores WSC.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF BRIGHT STAR-SALEM WSC

Description of Water User Group:

The Bright Star-Salem WSC is located in Wood and Rains Counties, near Lake Fork Reservoir. In 1998, the system served 1460 connections. The estimated population in the year 2000 is 2692 people, and it is expected to increase to 4713 persons by the year 2050. Bright Star's current source of supply consists of ten wells in the Carrizo-Wilcox Aquifer. Water quality from these wells is generally in compliance with TNRCC standards, except that iron and manganese are a problem in some wells. A filtration plant is used for iron/manganese removal at one well, and chemical sequestration is employed at another. Quantity will not prove sufficient to meet projected demands. The system lies on the outcrop of the Carrizo-Wilcox, where the aquifer is poorly developed and both quality and quantity are spotty. The WSC does not have a water conservation plan, but is in the process of creating a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	2692	3096	3500	3904	4308	4713
Projected Water Demand	455	523	583	654	720	800
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	586	586	586	586	586	586
Projected Supply Surplus (+) / Deficit (-)	+131	+63	+3	**-68**	**-134**	**-214**

Evaluation of Potentially Feasible Water Management Strategies:

The four alternative strategies considered to meet Bright Star-Salem WSC's water supply shortages are summarized in the table below. Advanced conservation was not considered applicable since per capita use is less than 115 gpcpd. Water reuse was not considered applicable since the WSC does not have a wastewater collection or treatment system in place. Continued use of groundwater is not the preferred long- term option because Bright Star's existing well water quantity and quality is unreliable. Conversion to surface water by contracting with the Sabine River Authority would be the preferred alternative for this entity, although there is presently no water available in Lake Fork Reservoir. Should water not be available at the time required, additional wells may be the only available option.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annual Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**46**	**$202,052**	**$20,664**	**$449**	**Minimal**
Surface Water	**560**	**$1,378,389**	**$227,796**	**$407**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)	46	46	46			
Surface Water (ac-ft/yr)				560	560	560

The recommended strategy for the Bright Star-Salem WSC is to connect with the Sabine River Authority for water from Lake Fork Reservoir. At present, all Lake Fork water is under contract, and the implementation of this strategy will depend on water becoming available in an appropriate time frame. The system has requested a 750,000-gpd allotment from SRA. It is anticipated, however, that Bright Star would convert partially to this surface water supply, while retaining several of its more productive wells. While the current supply shows to be adequate, most of the well supply is in the southwestern part of the system, while a substantial part of the growth is in the far north. Consequently, shortages are being experienced in the northern portions of the system, and another well in that area will be required near-term. Should surface water not become available in time, additional wells would be required. These would likely be located in the southern part of the system, and would require associated pumping and transmission facilities to service the northern areas.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF DETROIT

Description of Water User Group:

The City of Detroit is located in western Red River County along U.S. Highway 82, and is situated in both the Red and Sulphur Basins. It is surrounded on three sides by the 410 WSC, and on the west by the Lamar County WSD. In 1998, Detroit served 279 connections. The system currently serves 822 people, and is anticipated to grow to 998 by the year 2050. Detroit's current source of supply is a single well into the Trinity formation. The rated capacity of this well is 40 GPM which equates to 60 ac-ft/yr on an annual average basis. The City does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	822	853	868	901	950	998
Projected Water Demand	106	106	104	104	105	106
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	60	60	60	60	60	60
Projected Supply Surplus (+) / Deficit (-)	**-46**	**-46**	**-44**	**-44**	**-45**	**-46**

Evaluation of Potentially Feasible Water Management Strategies:

The four alternative strategies considered to meet the City of Detroit's water supply shortages are summarized in the table below. Advanced conservation was not considered applicable since per capita use is less than 115 gpcpd. There are no current needs that could be met by water reuse. Continued use of groundwater is not the preferred option because Detroit's existing well water quantity is unreliable, and water quality is below TNRCC secondary standards because of fluoride and total solids. Conversion to surface water by contracting with Lamar County Water Supply District was the alternative selected for this entity.

Strategy	**Firm Yield (ac-ft)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**106**	**$665,936**	**$128,129**	**$1,209**	**Minimal**

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Surface Water (ac-ft/yr)	106	106	106	106	106	106

The recommended strategy is for the City of Detroit to enter into a contract for treated surface water with Lamar County Water Supply District as soon as possible. LCWSD has adequate supply available, and there are no other systems in the Detroit area with sufficient supply to serve the City. Detroit already has plans and funding in place to tie on to the LCWSD system. A finding of "no significant impact" on the environment has been issued by the USDA for construction of the necessary tie-in facilities.

An alternative strategy would be to treat the existing groundwater. This is considered less desirable than the selected alternative, because (1) an additional well would still be required; (2) technology for this treatment is expensive; and (3) disposal of the waste stream is problematic in the Detroit area.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE TOWN OF ENGLISH

Description of Water User Group:

The Town of English is located in northeastern Red River County, and is situated in the Red River Basin. It is surrounded on all sides by the Red River County Water Supply District. In 1998, English served 65 connections. The system's year 2000 projected population is 163 people, which is expected to decline to 130 by the year 2050. English's current source of supply comes from two wells in an alluvial formation. The system does not have a water conservation plan or a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	163	161	155	150	145	130
Projected Water Demand	21	20	19	17	16	14
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	14	14	14	14	14	14
Projected Supply Surplus (+) / Deficit (-)	**-7**	**-6**	**-5**	**-3**	**-2**	0

Evaluation of Potentially Feasible Water Management Strategies:

The four alternative strategies considered for meeting English's needs are listed in the table below. English does not have a centralized wastewater collection or treatment system, therefore water reuse is not an option. Advanced conservation is not applicable since per capita use is less than 115 gpcpd. The alluvial formation in which current wells are located is not considered adequate for increased production. Therefore, surface water was the alternative selected for this entity. Red River WSC has lines very close to English, and is willing to supply the small quantity required to meet the projected deficit.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annual Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**7**	**$72,873**	**$12,133**	**$1,733**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)	7	7	7	7	7	7

The recommended strategy for the Town of English is to contract with the Red River WSC for a supplemental supply. The water would be surface water from Lake Wright Patman, purchased by Red River WSC from Texarkana Water Utilities. Red River WSC has three potential points of connection, all within ½ mile of the English system.

English could also purchase its water directly from Texarkana, but the capital cost would be substantially greater, particularly in light of the small amount of water required. A pump station and storage tank would be required, as well as a significant amount of water main.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF ENCHANTED WATER LAKES CO

Description of Water User Group:

Enchanted Water Lakes Company provides water service in the Smith County. Enchanted Water Lakes Company has been sold to and is operated by Aqua Source based in Houston, Texas. In 2000, the WSC served 130 connections, representing a population of approximately 434 persons. The population is projected to be 868 in the year 2050. The system doesn't expect to have more than 260 connections since they only serve one older subdivision. Enchanted Water Lakes Company is included in the County Other water user group for Smith County. The Golden WSC is located northwest of Enchanted Lakes Water Company. The system's current water supply consists of one well which provide water from the Carrizo-Wilcox aquifer. The total pumping capacity of this one well is 39 GPM, which equates to 62 ac-ft/yr on an annual average basis. A location map is included in Attachment A

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	434	600	768	868	868	868
Projected Water Demand	66	86	104	113	111	110
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	62	62	62	62	62	62
Projected Supply Surplus (+) / Deficit (-)	**-4**	**-24**	**-42**	**-51**	**-49**	**-48**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Enchanted Water Lakes Company water supply shortages as summarized in the Table below. Water reuse was omitted from consideration because the system does not have a centralized sewerage collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the system. A ground water worksheet is included as Attachment B and an advanced water conservation worksheet is included as Attachment C.

Strategy	Firm Yield (ac-ft/yr)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation	**8**	**$ 28,020**	**$ 10,168**	**$ 1,205**	**Minimal**
Water Reuse					
Groundwater	**62**	**$ 254,133**	**$ 26,579**	**$ 426**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)	62	62	62	62	62	62

The recommended strategy for Enchanted Water Lakes Company to meet their projected deficit of 4 ac-ft in the year 2000 and 48 ac-ft in the year 2050 would be to construct another ground water well similar to the one existing. The recommended supply source will be the Carrizo-Wilcox aquifer in Smith County. A well with a rated capacity of 116 GPM would provide approximately 62 ac-ft/yr. This is enough to meet their projected shortages.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluatio

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF LINDALE RURAL WSC

Description of Water User Group:

Lindale Rural WSC provides water service in the Smith County. The service area extends to about 6 miles North of Downtown Tyler on US HWY 69, bound on East by Saline and Hills Creeks, South by County Road 46, West by County RD 411, and North by the old Sabine River channel. In 1998, the WSC served 1914 connections. The estimated population is 5,164 in the year 2000 and is projected to be 15,079 in the year 2050. Lindale Rural WSC is included in the County Other water user group for Smith County. The system relies on four wells with a total pumping capacity of 340 GPM, or 548 ac-ft/yr on an annual average basis. The WSC is currently drilling a well in the same location as the abandoned well #4. When this well is completed, the projected total pumping capacity will be 673 GPM, or 1086 ac-ft/yr. They have a drought contingency plan, which will be ratified by the board on July 13, 2000. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	5164	7147	9130	11114	13098	15079
Projected Water Demand	786	1022	1233	1452	1668	1905
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	1086	1086	1086	1086	1086	1086
Projected Supply Surplus (+) / Deficit (-)	+300	+64	**-147**	**-366**	**-582**	**-819**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Lindale Rural WSC water supply shortages as summarized in the Table below. Water reuse was omitted from consideration because the WSC does not have a centralized sewerage collection system. Lindale Rural WSC currently has an emergency water connection with the City of Lindale and is negotiating for surface water with the City of Tyler, therefore surface water alternatives were considered. A surface water worksheet is included in Attachment B. A ground water worksheet is included as Attachment B and an advanced water conservation worksheet is included as Attachment C.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation	**115**	**$ 169,920**	**$ 129,688**	**$ 1,126**	**Minimal**
Water Reuse					
Groundwater	**591**	**$ 771,157**	**$ 133,073**	**$ 225**	**Minimal**
Surface Water	**132**	**$ 20,000**	**$ 173,848**	**$ 1,314**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)			591	591	591	1,182

The recommended strategy for Lindale Rural WSC to meet their projected deficit of 147 ac-ft in the year 2020 and 819 ac-ft in the year 2050 would be to construct ground water wells. The recommended supply source will be the Carrizo-Wilcox aquifer in Smith County. A well with a rated capacity of 1,100 GPM would provide approximately 591 ac-ft per year. This is enough to meet their projected shortages through the year 2040 but falls short of meeting their projected shortages for the decade of 2050 by 228 ac-ft. The most viable strategy (in terms of unit cost) is to drill another well by the year 2050.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF STAR MOUNTAIN WSC

Description of Water User Group:

Star Mountain WSC provides water service in Smith and Gregg Counties. Its service area extends along Texas Highway 271, approximately seven miles rural and several county roads. In 1998, the WSC served 430 connections. The estimated population is 1,220 in the year 2000 and is projected to be 3,562 in the year 2050. Star Mountain WSC is included in the County Other water user group for Smith County. The system is served by two wells from the Carrizo-Wilcox aquifer with a total pumping capacity of 67 GPM, or 108 ac-ft/yr on an average annual basis. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	1220	1688	2156	2624	3094	3562
Projected Water Demand	186	241	291	343	394	450
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	108	108	108	108	108	108
Projected Supply Surplus (+) / Deficit (-)	**-78**	**-133**	**-183**	**-235**	**-286**	**-342**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Star Mountain WSC water supply shortages as summarized in the Table below. Water reuse was omitted from consideration because the WSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since surface water treatment is not available. A ground water worksheet is included as Attachment B and an advanced water conservation worksheet is included as Attachment C.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation	**27**	**$ 51,600**	**$ 31,185**	**$ 1,146**	**Minimal**
Water Reuse					
Groundwater	**323**	**$ 2,192,735**	**$ 201,240**	**$ 624**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)	108	216	216	323	323	323

The recommended strategy for Star Mountain WSC to meet their projected deficit of 78 ac-ft in the year 2000 and 342 ac-ft in the year 2050 would be to construct three additional water wells in the Carrizo-Wilcox aquifer. Three wells with a total rated capacity of 600 GPM would provide approximately 323 ac-ft on an average per year. The first well has to be constructed in the year 2000, the second well has to be constructed by the year 2010, and the third well has to be constructed by the year 2030 for the WSC to meet their water demands.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF BEN WHEELER WSC

Description of Water User Group:

Ben Wheeler WSC provides water service in Van Zandt and Smith Counties. The service area extends to FM 1995 in the North, SH 64 in the South, FM 773 in the West, County line in the East and a long FM 1995 and local roads in Smith County. In 1998, the WSC served 617 connections. The estimated population is 1,417 in the year 2000 and is projected to be 2,479 in the year 2050. Ben Wheeler WSC is included in the County Other water user group for Van Zandt (99%) and Smith (1%) counties. The system relies on three wells, which provide water from the Carrizo-Wilcox Aquifer with a total pumping capacity of 133 GPM or 214.5 ac-ft/yr on an annual average basis. The WSC is planning to drill one more well about 700 feet deep, which is expected to yield 250 GPM. The system is bordered by the City of Van to the North and Edom WSC to the South. Ben Wheeler WSC has a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	1417	1630	1842	2054	2267	2479
Projected Water Demand	183	203	221	237	252	264
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	214.5	214.5	214.5	214.5	214.5	214.5
Projected Supply Surplus (+) / Deficit (-)	+31.5	+11.5	**-6.5**	**-22.5**	**-37.5**	**-49.5**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Ben Wheeler WSC water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the WSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the WSC. A ground water worksheet is included as Attachment B.

Strategy	Firm Yield (ac-ft/yr)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water conservation					
Water Reuse					
Groundwater	**134**	**$ 326,871**	**$41,251**	**$ 307**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)			134	134	134	134

The recommended strategy for Ben Wheeler WSC to meet their projected deficit of 6.5 Acre-Feet in the year 2020 and 49.5 Acre-Feet in the year 2050 would be to construct one additional well. The recommended supply source will be the Carrizo-Wilcox aquifer in Van Zandt County. A well with a rated capacity of 250 GPM would provide approximately 134 Acre-Feet per year. This supply is more than enough to take care of the water shortage in Ben Wheeler WSC.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF CITY OF CANTON

Description of Water User Group:

City of Canton provides water service in Van Zandt County. In 1998, the City served 1,175 connections. The estimated population is 3,559 in the year 2000 and is projected to be 6,232 in the year 2050. The City relies on its ground water wells from Carrizo-Wilcox with a total pumping capacity of 69 GPM, or 112 ac-ft/yr and from Lake Canton with 706 ac-ft/yr. The existing City lake is not used due to inadequate treatment capacity for increased flow. The system is bordered by Myrtle Springs WSC to the Northwest and Mac Bee WSC to the Southwest. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	3559	4094	4628	5163	5698	6232
Projected Water Demand	694	757	814	891	951	1039
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	818	818	818	818	818	818
Projected Supply Surplus (+) / Deficit (-)	+124	+61	+4	**-73**	**133**	**-221**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet City of Canton water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the City does not have a demand for non-potable water at this time. Surface water alternatives were omitted since the City Lake is no longer being used since they need a treatment plant for using the water from the lake. The City has indicated a preference to use ground water wells. A ground water worksheet is included as Attachment B.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**108**	**$ 262,193**	**$ 33,052**	**$ 307**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)				108	216	216

The recommended strategy for the City of Canton to meet their projected water deficit of 73 ac-ft in the year 2030 and 221 ac-ft in the year 2050 would be to construct an additional well. The first additional well (which is in the works) will take care of the water shortage in the year 2030. The City will still have water shortages of 45 ac-ft in the year 2040 and 113 ac-ft in the year 2050. These shortages can be met by constructing an additional well similar to the other well. The recommended wells will be in the Carrizo-Wilcox aquifer in Van Zandt County.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF EAST MOUNTAIN

Description of Water User Group:

The City of East Mountain provides water service in the southern portion of Upshur County and the northern portion of Gregg County. The population is projected to increase from 1,237 persons in 2000 to 2,195 persons by 2050. Approximately 78 percent of the population is in Upshur County. The City of East Mountain is included in the County Other WUG for Upshur and Gregg. The City relies on one well with a capacity of 150 GPM, or 81 ac-ft/yr. The system is bounded on the west by Union Grove and Pritchett WSC; on the north and east by Glenwood WSC; and on the south by the City of Longview, Clarksville City, and the City of White Oak. The City does not have a water conservation plan nor a drought managment plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	1237	1453	1608	1805	2014	2195
Projected Water Demand	168	190	201	221	239	255
Current Water Supply	80.6	80.6	80.6	80.6	80.6	80.6
Projected Supply Surplus(+)/Deficit(-)	**-87.4**	**-109.4**	**-120.4**	**-140.4**	**-158.4**	**-174.4**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the City of East Mountain water supply shortages as summarized in the following table. Advanced water conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the Planning Group. Water reuse was not considered because the East Mountain area does not have a centralized wastewater collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the area, and surface water treatment is not economically feasible for a system of this size. Worksheets for the groundwater and interconnect alternatives are included as Attachments B and C respectively.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**187**	**$ 403,204**	**$ 51,569**	**$ 426**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr) (interconnect)	26	26	26	26	26	26
Groundwater (ac-ft/yr) (new wells)	81	161	161	161	161	161

East Mountain has contracted with Glenwood WSC for 50 GPM through an interconnect. The recommended strategy for East Mountain to meet their projected deficits in 2030 and 2050 would be to complete their planned interconnect with Glenwood WSC, and construct two water wells similar to their existing well. The first well should be constructed immediately and the second well before the year 2010. The recommended supply source is the Carrizo-Wilcox Aquifer in Upshur County. The interconnect will provide approximately 26 ac-ft/yr. Two wells at 150 GPM each would provide approximately 161 ac-ft/yr, for a total of 187 ac-ft/yr. The Carrizo-Wilcox in Upshur County is projected to have an ample supply availability for the City of East Mountain. Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF THE CITY OF MINEOLA

Description of Water User Group:

The City of Mineola is located in south western Wood County and serves the incorporated city limits and approximately 175 connections adjacent to the city. In 1999 the system had 2,109 connections. The population is projected to increase from 5,128 persons in 2000 to 8,223 persons in 2050. The City of Mineola is included in the City and County Other water user groups for Wood County. The system's current water supply consists of three water wells in the Carrizo-Wilcox Aquifer. The total rated capacity of these three wells is 1800 GPM which equates to 967 ac-ft/yr on an annual average basis. The system is bound on the north and west by Ramey WSC, on the east by New Hope WSC and on the south by the Sabine River. The City of Mineola does have a water conservation plan and a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	5128	5747	6366	6985	7604	8223
Projected Water Demand	908	967	1006	1092	1148	1243
Current Water Supply	967	967	967	967	967	967
Projected Supply Surplus (+)/Deficit(-)	+5.9	0	**-49**	**-125**	**-181**	**-276**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the City of Mineola water supply shortages as summarized in the following table. Water reuse was omitted from consideration because the City does not have a demand for non-potable water at this time. Surface water alternatives were omitted since surface water treatment is not economically feasible for a system when groundwater is readily available . A groundwater worksheet is included as Attachment B and an advanced water conservation worksheet is included as Attachment C.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation	**78**	**$168,840**	**$88,278**	**$1,129**	**Minimal**
Water Reuse					
Groundwater	**323**	**$ 224,805**	**$ 58,371**	**$ 181**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)			323	323	323	323

The recommended strategy for the City of Mineola to meet their projected deficit of 49 acre-feet in the year 2020 and 276 acre-feet in the year 2050 would be to construct one additional water well similar to their existing three wells. The recommended supply source will be the Carrizo-Wilcox aquifer in Wood County. A well with rated capacity of 600 gpm would provide approximately 323 acre-feet on an annualized basis. The Carrizo-Wilcox Aquifer in Wood County is projected to have a more than ample supply availability to meet the needs of the City of Mineola for the planning period. The City of Mineola is under construction of a new well at this time and it is expected to be complete in the year 2000.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF CORINTH WSC

Description of Water User Group:

Corinth WSC provides water service in Van Zandt County. In 1997, the WSC served 274 connections. The estimated population is 678 in the year 2000 and is projected to be 2,074 in year 2050. The system relies on one groundwater well, which provide water from the Carrizo-Wilcox Aquifer with a total rated pumping capacity of 86 GPM or 139 ac-ft/yr. Corinth WSC is included in the County Other water user group for Van Zandt County. The system is bordered by Pruitt-Sandflat WSC to the East, Fruitvale WSC to the West, City of Grand Saline to the North, and City of Van and Ben Wheeler WSC to the South. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	678	958	1237	1517	1796	2074
Projected Water Demand	87	119	148	175	199	221
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	139	139	139	139	139	139
Projected Supply Surplus (+) / Deficit (-)	+52	+20	**-9**	**-36**	**-60**	**-82**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Corinth WSC water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the WSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the WSC. A groundwater worksheet is included as Attachment B.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**108**	**$ 117,117**	**$ 22,519**	**$ 209**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)			108	108	108	108

The recommended strategy for Corinth WSC to meet their projected deficit of 9 ac-ft in the year 2020 and 82 ac-ft in the year 2050 would be to construct one additional well in the Carrizo-Wilcox aquifer about 200 ft deep. A well with a total pumping capacity of 108 ac-ft will suffice to meet their shortages through the year 2050.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF CROOKED CREEK WSC

Description of Water User Group:

Crooked Creek WSC provides water service in Van Zandt County. In 1998, the WSC served 231 connection. The estimated population is 541 in the year 2000 and is projected to be 1,653 in the year 2050. Crooked Creek WSC is included in the County Other water user group for Van Zandt County. The system relies on one well in the Carrizo-Wilcox aquifer with a total pumping capacity of 67 GPM, or 106 ac-ft/yr. The WSC is adjacent to rural roads between FM 859 and state highway 9. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	541	764	986	1208	1431	1653
Projected Water Demand	70	95	118	139	159	176
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	106	106	106	106	106	106
Projected Supply Surplus (+) / Deficit (-)	+36	+11	**-12**	**-33**	**-53**	**-70**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Crooked Creek WSC water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the WSC does not have a demand for non-potable water at this time. The WSC is considering hooking up with City of Canton for surface water. Surface water worksheet is included as Attachment B. A ground water worksheet is included as Attachment B.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**108**	**$ 177,565**	**$ 26,907**	**$ 250**	**Minimal**
Surface Water	**100**	**$ 106,723**	**$ 170,693**	**$ 1,706**	**Moderate**

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)			108	108	108	108

The recommended strategy for the Crooked Creek WSC would be to construct a groundwater well. The recommended supply source will be the Carrizo-Wilcox aquifer in Van Zandt County. A well with a rated capacity of 200 GPM would provide approximately 108 acre-feet on an annualized basis.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF DIANA WSC

Description of Water User Group:

Diana WSC is located in eastern Upshur County, north western Harrison County, and south western Marion County and serves an area around the communities of Diana, Graceton, Stamps, and Ashland. In 1999 the system had 1,380 members with 88% in Upshur County, 7% in Harrison County, and 5% in Marion County. The population is projected to increase from 3,061 persons in 2000 to 7,461 persons in 2050. The DWSC is included in the County Other WUG for Upshur, Harrison, and Marion Counties. The system's current water supply consists of seven water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these wells is 922 GPM, or 498 ac-ft/yr. The system is bound on the west by Bi-County WSC, on the north by Ore City, on the south by Glenwood WSC, and on the east by Harleton WSC. DWSC has a water conservation plan and a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	3061	3941	4821	5701	6581	7461
Projected Water Demand	396	492	579	660	733	797
Current Water Supply	498	498	498	498	498	498
Projected Supply Surplus(+)/Deficit(-)	+102	+6	**-81**	**-162**	**-235**	**-299**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the DWSC water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse was not considered because the DWSC does not have an identified demand for non-potable water. One surface water alternative was completed which included participation in a regional system sponsored by the Northeast Texas Municipal Water District and purchasing treated water from a proposed water plant on the south side of Lake O' The Pines. The regional system sponsored by NETMWD is proposed to be constructed in approximately 10 years. Worksheets for the groundwater and surface water alternatives are included as Attachments B and C respectively.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**71**	**$ 240,769**	**$ 26,730**	**$ 377**	**Minimal**
Surface Water	**248**	**$ 0**	**$ 216,182**	**$ 873**	**Moderate**

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)		71	71	71	71	71
Surface Water (ac-ft/yr)			248	248	248	248

The recommended strategy for the Diana WSC to meet their projected short term deficit of 81 ac-ft/yr in 2020 would be to construct one additional water well. The recommended supply source will be the Carrizo-Wilcox Aquifer in Upshur County. One well with rated capacity of 132 gpm would provide approximately 71 ac-ft/yr. The Carrizo-Wilcox Aquifer in Upshur County is projected to have a more than ample supply availability to meet the short term needs of DWSC for the planning period.

The recommended strategy for the Diana WSC to meet their projected long term deficit of 299 ac-ft/yr in 2050 would be to continue to participate in the planned NETMWD southside regional system. The recommended supply source will be the Lake O' The Pines Reservoir in Marion County. The proposed system will have a rated capacity of 460 gpm and would provide approximately 248 ac-ft/yr. The Lake O' The Pines Reservoir in Marion County, through NETMWD, is projected to have a more than ample supply availability to meet the long term needs of DWSC for the planning period.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF EDOM WSC

Description of Water User Group:

Edom WSC provides water service in Van Zandt and Henderson Counties. In 1998, the WSC served 435 connections. The estimated population is 795 in the year 2000 and is projected to be 2,433 in the year 2050. Edom WSC is included in the County Other water user group for Van Zandt County. The system relies on four wells with a total pumping capacity of 113 GPM, or 183 ac-ft/yr. Edom WSC is planning a future well with a total pumping capacity of 28 GPM, or 46 ac-ft/yr. The system is bordered by Ben Wheeler WSC to the Northwest and RPM WSC to the Northeast. A location map is included in Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	795	1122	1450	1777	2105	2433
Projected Water Demand	102	140	174	205	233	259
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	183	183	183	183	183	183
Projected Supply Surplus (+) / Deficit (-)	+81	+43	+9	**-22**	**-50**	**-76**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Edom WSC water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the WSC does not have a centralized sewerage collection system. Surface water alternatives were considered since Edom WSC is negotiating with City of Tyler, which is 16 miles away. The cost of this connection would be shared by five other WSC's. The approximate cost of hooking up Edom WSC with the City of Tyler is $ 253,440. A surface water worksheet is included as Attachment B. A ground water worksheet is included as Attachment B.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**46**	**$ 286,572**	**$ 26,762**	**$ 586**	**Minimal**
Surface Water	**30**	**$ 368,955**	**$ 66,732**	**$ 2,177**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)				46	92	92

The recommended strategy for Edom WSC to meet their projected deficit of 22 ac-ft in the year 2030 would be to construct one additional well similar to their existing wells. The recommended supply source will be the Carrizo-Wilcox aquifer in Van Zandt County. A well with a total rated capacity of 85 GPM would provide approximately 46 ac-ft/yr. This is enough to meet their projected shortages for the year 2030 but falls short of meeting their projected shortages for the year 2040 and 2050 by 4 ac-ft and 30 ac-ft respectively. To meet these additional shortages, it is our recommendation that they construct another well similar to the other wells.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF FOUKE WSC

Description of Water User Group:

Fouke WSC is located in south eastern Wood County and serves an area north of the Sabine River, east of Lake Fork Creek, and south of State Highway 154. In 1999 the system had 1,704 members. The population is projected to increase from 2,837 persons in 2000 to 5,487 persons in 2050. The FWSC is included in the County Other WUG for Wood and Upshur Counties. The system's current water supply consists of five water wells which provide water from the Carrizo-Wilcox Aquifer. The total rated capacity of these five wells is 1146 GPM, or 616 ac-ft/yr. The system is bound on the east by Pritchett WSC, on the south by the Sabine River, on the west by New Hope WSC, and on the north by Jones WSC and Sharon WSC. FWSC does not have a water conservation plan but does have a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	2837	3367	3897	4427	4957	5487
Projected Water Demand	402	445	484	535	574	643
Current Water Supply	616	616	616	616	616	616
Projected Supply Surplus(+)/Deficit(-)	+214	+171	+132	+81	+42	**-27**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the FWSC water supply shortages as summarized in the following table. Advanced conservation was omitted from consideration because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was omitted from consideration because the FWSC does not have a centralized sewerage collection system. Surface water alternatives were omitted since there is not a supply source within close proximity to the FWSC and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**108**	**$ 210,540**	**$ 29,302**	**$ 272**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)						108

The recommended strategy for Fouke WSC to meet their projected deficit of 27acre-feet in the year 2050 would be to construct one additional water well similar to their existing five wells. The recommended supply source will be the Carrizo-Wilcox aquifer in Wood County. A well with rated capacity of 200 gpm would provide approximately 108 acre-feet on an annualized basis. The Carrizo-Wilcox Aquifer in Wood County is projected to have a more than ample supply availability to meet the needs of the Fouke WSC for the planning period. Fouke WSC is nearing construction of a new well at this time and it is expected to be complete in the year 2000.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF FRUITVALE WSC

Description of Water User Group:

Fruitvale WSC provides water service in Van Zandt County. In 1998, the WSC served 994 connections. The estimated population is 2,324 in the year 2000 and is projected to be 7,111 in the year 2050. Fruitvale WSC is included in the County Other water user group for Van Zandt County. The system relies on eleven wells with a total pumping capacity of 222 GPM, or 358 ac-ft/yr. The system is bordered on the west by MacBee WSC, on the south by Corinth WSC and Crooked Creek WSC, and in the north by South Tawakoni WSC and Grand Saline WSC. A location map is included in Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	2324	3282	4239	5196	6153	7111
Projected Water Demand	299	408	508	599	682	757
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	358	358	358	358	358	358
Projected Supply Surplus (+) / Deficit (-)	+58.5	**-50.5**	**-150.5**	**-241.5**	**-324.5**	**-399.5**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Fruitvale WSC water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the WSC does not have a centralized sewer collection system. Surface water alternatives were omitted since there is no viable supply source within close proximity to the City. The system plans to continue adding water wells, which are 500 Feet deep and have an average capacity of 100 GPM to meet their requirements. A ground water worksheet is included as Attachment B.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**269**	**$ 1,052,253**	**$ 111,433**	**$ 414**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)		54	161	269	377	430

The recommended strategy for Fruitvale WSC to meet their projected water deficit of 50.5 ac-ft in the year 2010 and 399.5 ac-ft in the year 2050 would be to construct 8 additional wells. Five additional wells will take care of the water shortage till the year 2030. The other additional wells have to be drilled prior to the year 2040 to take care of the water shortages for year 2040 onwards. The five wells with a total rated capacity of 500 GPM would provide 269 ac-ft on an annualized basis. The recommended wells will be in the Carrizo-Wilcox aquifer in Van Zandt County.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF CITY OF GRAND SALINE

Description of Water User Group:

City of Grand Saline provides water service in Van Zandt County. In 1998, the City served 1,332 connections. The estimated population is 3,010 in the year 2000 and is projected to be 5,270 in the year 2050. The City relies on four wells in the Carrizo-Wilcox Aquifer with a total rated pumping capacity of 363 GPM, or 586 ac-ft/yr. The City is bounded by Golden WSC to the East, Pruitt Sandflat and Corinth WSC to the South, and Fruitvale WSC to the West. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	3010	3462	3914	4366	4818	5270
Projected Water Demand	583	636	684	749	804	880
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	586	586	586	586	586	586
Projected Supply Surplus (+) / Deficit (-)	+3	**-50**	**-98**	**-163**	**-218**	**-294**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet City of Grand Saline's water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the City does not have a centralized sewer collection system. Surface water alternatives were not considered because there was no viable supply source within close proximity to the City. A groundwater worksheet is included as Attachment B.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**323**	**$ 439,509**	**$ 73,959**	**$ 229**	**Minimal**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)		161	161	323	323	323

The recommended strategy for the City of Grand Saline to meet their projected water deficit of 50 ac-ft in the year 2010 and 294 ac-ft in the year 2050 would be to construct two wells. These two wells, 500 feet deep and with a total pumping capacity of 323 ac-ft will take care of the water shortage in the City of Grand Saline. The recommended wells will be in the Carrizo-Wilcox aquifer in Van Zandt County.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF HARMONY ISD

Description of Water User Group:

Harmony ISD is located in western Upshur County on State Highway 154 and serves the Harmony School Campus. In 1999 the system had an enrollment of 936 students. The population equivalent is projected to increase from 200 persons in 2000 to 850 persons in 2050. The HISD is included in the County Other WUG for Upshur County. The system's current water supply consists of one water well which provides water from the Carrizo-Wilcox Aquifer. The total rated capacity of the well is 30 GPM which equates to 24 ac-ft/yr on an annual average basis for a school district. The system is bound on the south by Pritchett WSC, on the north by Sharon WSC, and on the east and west by Texas Water Systems Rosewood and Rhonesboro Systems. HISD does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	200	330	460	590	720	850
Projected Water Demand	26	41	55	68	80	90
Current Water Supply	24.1	24.1	24.1	24.1	24.1	24.1
Projected Supply Surplus(+)/Deficit(-)	**-1.9**	**-16.9**	**-30.9**	**-43.9**	**-55.9**	**-65.9**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the HISD water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse was not considered because the HISD indicated the downstream landowner was already utilizing their discharge for irrigation on pastures. Surface water alternatives were omitted since there is not a supply source within close proximity to the HISD and surface water treatment is not economically feasible for a system of this size. A groundwater worksheet is included as Attachment B which includes additional water wells and water purchase from another entity.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater/Well	**73**	**$ 456,192**	**$ 42,680**	**$ 582**	**Minimal**
Groundwater/Contract	**81**	**$329,724**	**$155,337**	**$1,926**	**Moderate**
Surface Water					

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)	24	24	48	48	73	73

The recommended strategy for the Harmony ISD to meet their projected deficit of 1.9 ac-ft in the year 2000 and 65.9 ac-ft in the year 2050 would be to construct one additional water well similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo-Wilcox Aquifer in Upshur County. Three wells at 30 GPM each would provide approximately 24 ac-ft each or 73 ac-ft/yr total. The Carrizo-Wilcox Aquifer in Upshur County is projected to have a more than ample supply availability to meet the needs of HISD for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF LAKE FORK WSC

Description of Water User Group:

Lake Fork WSC is located in north western Wood County and serves an area north of Lake Fork and south of Hopkins County. In 1999 the system had 855 members. The population is projected to increase from 1,396 persons in 2000 to 4,996 persons in 2050. The LFWSC is included in the County Other WUG for Wood and Hopkins Counties. The system's current water supply consists of two water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these wells is 340 GPM, or 182 ac-ft/yr. The system is bound on the east, south, and west by Lake Fork, and on the north by Martin Springs WSC. The City of Yantis is completely surrounded by LFWSC. LFWSC does not have a water conservation plan, but does have a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	1396	2116	2836	3556	4276	4996
Projected Water Demand	198	280	352	430	495	587
Current Water Supply	182	182	182	182	182	182
Projected Supply Surplus(+)/Deficit(-)	**-16**	**-98**	**-170**	**-248**	**-313**	**-405**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the LFWSC water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse was not considered because the LFWSC does not have a centralized sewerage collection system. Surface water alternatives were not considered for the near term deficits since no supply source with the available capacity is within close proximity and surface water treatment is not economically feasible for a system of this size. In addition, LFWSC is constructing three new water wells with expected completion in 2000. A groundwater worksheet is included as Attachment B. The groundwater component was broken into two strategies to accommodate the groundwater development project in construction. Surface water alternatives should be considered for the long term deficits since LFWSC is located on Lake Fork, a surface water supply, and as the system grows it will become more feasible to operate a surface water treatment facility. If surface water becomes available from the Lake Fork Reservoir this study should be re-evaluated.

Strategy	**Firm Yield (AF)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater #1	**161**	**$ 569,662**	**$ 62,383**	**$ 387**	**Minimal**
Groundwater #2	**269**	**$ 935,003**	**$ 102,923**	**$ 383**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)	161	161	430	430	430	430

The recommended strategy for the Lake Fork WSC to meet their projected deficit of 16 acre-feet in the year 2000 and 405 acre-feet in the year 2050 would be to construct eight additional water wells similar to their existing two wells. The recommended supply source will be the Carrizo-Wilcox aquifer in Wood County. Eight wells with rated capacity of 800 gpm would provide approximately 430 acre-feet on an annualized basis. The Carrizo-Wilcox Aquifer in Wood County is projected to have a more than ample supply availability to meet the needs of the LFWSC for the planning period. The LFWSC is under construction of three new wells with a rated capacity of 300 gpm at this time and it is expected to be complete in the year 2000.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF LITTLE HOPE-MOORE WSC

Description of Water User Group:

Little Hope-Moore WSC provides water service in Van Zandt County. In 2000, the WSC served about 500 connections representing a population of approximately 1,282. The population is projected to increase to 3,922 in the year 2050. Little Hope-Moore WSC is included in the County Other water user group for Van Zandt County. The system relies on four ground water wells, which provide water from the Carrizo-Wilcox Aquifer. The four wells have a total rated pumping capacity of 115 GPM, or 186 ac-ft/yr. The WSC is bounded by City of Canton to the Southwest, MacBee WSC to the South, and Corinth WSC to the East. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	1282	1810	2338	2865	3394	3922
Projected Water Demand	165	225	280	331	376	417
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	186	186	186	186	186	186
Projected Supply Surplus (+) / Deficit (-)	+21	**-39**	**-94**	**-145**	**-190**	**-231**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet Little Hope-Moore WSC's water supply shortages as summarized in the Table below. Advanced conservation was not considered because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was not considered because the WSC does not have a centralized sewer collection system. Groundwater alternative was not considered because of high iron content in the water. Surface water alternative is included as Attachment B.

Strategy	Firm Yield (ac-ft)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**145**	**$ 281,655**	**$ 256,967**	**$ 1,770**	**Moderate**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water From City of Tyler (ac-ft/yr)		145	145	145		

The recommended strategy for Little Hope-Moore WSC to meet their projected water deficit of 39 ac-ft in the year 2010 and 231 ac-ft in the year 2050 would be to buy surface water from City of Tyler. A contract amounting to 145 ac-ft will take care of the water shortage in Little Hope-Moore WSC. The shortages in the year 2040 and the year 2050 can be taken care of by buying more water from the City of Tyler at a cost of $ 73,316 and $ 140,116 respectively.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF PRITCHETT WSC

Description of Water User Group:

Pritchett WSC is located in south western Upshur County and eastern Wood County and serves an area around the communities of Pritchett, Center Point, Latch, Shady Grove, and Wilkins. In 1999 the system had 2,124 members with 99% in Upshur County and 1% in Wood County. The population is projected to increase from 4,660 persons in 2000 to 9,702 persons in 2050. The PWSC is included in the County Other WUG for Upshur and Wood Counties. The system's current water supply consists of fourteen water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these wells is 934 GPM, or 504 ac-ft/yr. The system is bound on the west by Fouke WSC, on the north by Sharon WSC and the City of Gilmer, on the south by the cities of Gladewater and Big Sandy, and on the east by Union Grove WSC and Glenwood WSC. PWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	4660	5662	6672	7682	8692	9702
Projected Water Demand	599	704	800	886	964	1033
Current Water Supply	504.4	504.4	504.4	504.4	504.4	504.4
Projected Supply Surplus(+)/Deficit(-)	**-94.6**	**-199.6**	**-295.6**	**-381.6**	**-459.6**	**-528.6**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the PWSC water supply shortages as summarized in the following table. Advanced conservation was omitted because the per capita use per day was below the 115 gpcpd threshold set by the planning group. Water reuse was omitted because the PWSC does not have centralized sewerage collection system. One surface water alternative was completed which included participation in a regional system sponsored by the Northeast Texas Municipal Water District and purchasing treated water from a proposed water plant on the south side of Lake O' The Pines. The regional system sponsored by NETMWD is proposed to be constructed in approximately 10 years. Worksheets for the groundwater and surface water alternatives are included as Attachments B and C respectively. There are alternative sources of surface water available to PWSC such as the City of White Oak, the City of Gilmer and the City of Gladewater, all of which have been discussing potential contract arrangements with PWSC. All of these alternatives or combination of alternatives have merit and should be evaluated in more detail with council by the WSC engineer, financial advisor, and attorney.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**540**	**$ 2,895,836**	**$ 280,672**	**$ 519**	**Moderate**
Surface Water	**532**	**$ 0**	**$ 464,645**	**$ 873**	**Moderate**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)	532	532	532	532	532	532

The recommended strategy for the Pritchett WSC to meet their projected deficit of 94.6 ac-ft/yr in 2000 and 528.6 ac-ft/yr in 2050 would be to construct an emergency connection to either the City of Gilmer, White Oak, or Gladewater to meet the immediate deficits until the NETMWD Lake O' The Pines south side project can be developed. The long term recommended strategy would be to purchase treated water from the NETMWD. The recommended supply source will be the Lake O' The Pines Reservoir in Marion County. The system should provide the projected demand of approximately 532 ac-ft/yr. The NETMWD through the Lake O' The Pines in Marion County is projected to have a more than ample supply availability to meet the long term needs of PWSC for the planning period.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF UNION GROVE WSC

Description of Water User Group:

Union Grove WSC is located in southern Upshur County and serves an area around the communities of Union Grove and West Mountain along US Highway 271. In 1999 the system had 735 members. The population is projected to increase from 1,637 persons in 2000 to 3,337 persons in 2050. The UGWSC is included in the County Other WUG for Upshur County. The system's current water supply consists of three water wells from the Carrizo-Wilcox Aquifer. The total rated capacity of these three wells is 464 GPM, or 249 ac-ft/yr. The system is bound on the north and west by Pritchett WSC, on the south by the City of Gladewater, and on the east by the City of East Mountain. UGWSC does not have a water conservation plan nor a drought management plan. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Population	1637	1977	2317	2657	2997	3337
Projected Water Demand	211	246	278	307	332	355
Current Water Supply	249.5	249.5	249.5	249.5	249.5	249.5
Projected Supply Surplus(+)/Deficit(-)	+38.5	+3.5	**-28.5**	**-57.5**	**-82.5**	**-105.5**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet the UGWSC water supply shortages as summarized in the following table. Advanced conservation was not considered because the per capita use per day was below the 115 gpcpd threshold set by the water planning group. Water reuse was not considered because the UGWSC does not have a centralized sewerage collection system. Two surface water alternatives were considered including participation in a regional system sponsored by the Northeast Texas Municipal Water District and purchasing treated water from the City of Gladewater. The regional system sponsored by NETMWD was determined to be too costly at this time and was not evaluated further. A worksheet for purchasing surface water from Gladewater is included as Attachment C. A groundwater worksheet is included as Attachment B.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater	**167**	**$ 411,212**	**$ 51,580**	**$ 309**	**Minimal**
Surface Water	**107.5**	**$562,361**	**$110,907**	**$1,031**	**Moderate**

Recommendations:

	2000	2010	2020	2030	2040	2050
Groundwater (ac-ft/yr)			83.5	83.5	83.5	167

The recommended strategy for the Union Grove WSC to meet their projected deficit of 28.5 ac-ft in the year 2020 and 105.5 ac-ft in the year 2050 would be to construct one additional water well similar to their existing wells just prior to each decade as the deficits occur. The recommended supply source will be the Carrizo-Wilcox Aquifer in Upshur County. Two wells with rated capacity of 155 gpm each would provide approximately 83 ac-ft each or 167 ac-ft/yr. The Carrizo-Wilcox Aquifer in Upshur County is projected to have a more than ample supply availability to meet the needs of UGWSC for the planning period.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendations previously discussed should be disregarded and a re-evaluation completed.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF STEAM ELECTRIC IN UPSHUR COUNTY

Description of Water User Group:

The Steam Electric WUG in Upshur County has a demand that is projected to grow from a current demand of 0 ac-ft/yr in 2000 to 5601 ac-ft/yr in 2050. The projected demand is the result of an expected steam electric generating facility near the City of Gilmer. There are not any existing steam electric facilities in Upshur County. A steam electric utility is currently in negotiations

Water Supply and Demand Analysis:

	2000	2010	2020	2030	2040	2050
Projected Water Demand	0	5601	5601	5601	5601	5601
Current Water Supply	0	0	0	0	0	0
Projected Supply Surplus (+)/Deficit(-)	0	**-5601**	**-5601**	**-5601**	**-5601**	**-5601**

Evaluation of Potentially Feasible Water Management Strategies:

Four alternative strategies were considered to meet the Upshur County Manufacturing WUG's water supply shortages as summarized in the preceding table. Advanced water conservation was not considered because it is not applicable for steam electric utilities. Water reuse was not considered because there would be no net change in demand required by an entity if reuse were implemented, and the entities are projected entities only, and cannot be construed to benefit from reuse. Groundwater was not considered due to questionable reliability and the large quantity required for a steam electric facility. Surface water was considered because the City of Gilmer recently completed construction of Lake Gilmer and has the available supply. A worksheet for the surface water alternative is included as Attachment A.

Strategy	Firm Yield (AF)	Total Capital Cost	Total Annualized Cost	Unit Cost	Environmental Impact
Advanced Water Conservation					
Water Reuse					
Groundwater					
Surface Water	**5601**	**$ 0**	**$ 876,000**	**$ 135**	**Minimal**

Recommendations:

	2000	2010	2020	2030	2040	2050
Surface Water (ac-ft/yr)	0	5,601	5,601	5,601	5,601	5,601

The recommended strategy for the Upshur County steam electric WUG to meet projected demands during the planning period is to purchase raw water from the City of Gilmer. The City of Gilmer will have an ample supply of water to meet the needs of steam electric in Upshur County once Lake Gilmer is fully operational.

EVALUATION OF WATER MANAGEMENT STRATEGIES FOR MEETING THE PROJECTED WATER SUPPLY NEEDS OF CITY OF VAN

Description of Water User Group:

City of Van provides water service to Van and surrounding area located in Van Zandt (98%) and Smith (2%) Counties. In 1998, they served 1161 connections. The estimated population is 2,255 in the year 2000 and is projected to be 3,949 in the year 2050. The City relies on three wells with a total pumping capacity of 357 GPM, or 575 ac-ft/yr on an average annual basis. Surface water is available from an abandoned supply lake but the City has not used the treatment plant since 1970 and the plant would require reconstruction and 2 miles of supply pipeline. The City is bordered on the South by Ben Wheeler WSC and Corinth WSC in the Northwest. A location map is included as Attachment A.

Water Supply and Demand Analysis:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Population	2255	2594	2932	3271	3610	3949
Projected Water Demand	511	560	605	663	715	782
Water Demand from other entities	0	0	0	0	0	0
Current Water Supply	575	575	575	575	575	575
Projected Supply Surplus (+) / Deficit (-)	+64	+15	**-30**	**-88**	**-140**	**-207**

Evaluation of Potentially Feasible Water Management Strategies:

There were four alternative strategies considered to meet City of Van water supply shortages as summarized in the Table below. Advanced conservation was omitted from consideration because the per capita use per day was below 115 gpcd threshold set by the water planning group. Water reuse was omitted from consideration because the City has no identified use for reuse water. Surface water alternative was omitted as it was cost prohibitive to utilize existing lake and there were no other supply sources in close proximity. A ground water worksheet is included as Attachment B.

Strategy	**Firm Yield (ac-ft)**	**Total Capital Cost**	**Total Annualized Cost**	**Unit Cost**	**Environmental Impact**
Advanced Water Conservation					
Water Reuse					
Groundwater	**269**	**$ 447,768**	**$ 67,548**	**$ 251**	**Minimal**
Surface Water					

Recommendations:

	2000	**2010**	**2020**	**2030**	**2040**	**2050**
Groundwater (ac-ft/yr)			269	269	269	269

The recommended strategy for the City of Van to meet their projected water deficit of 30 ac-ft in 2020 and 207 ac-ft in 2050 would be to construct one additional well. The recommended supply source will be the Carrizo-Wilcox aquifer in Van Zandt County. A well with a rated capacity of 500 GPM would provide approximately 269 ac-ft on an annualized basis.

Given the increasing costs to comply with more stringent regulations and decreasing reliability of groundwater as a future supply source due to quality issues in this region, it is recommended that groundwater supply systems consider combining resources and/or soliciting future water supply from neighboring systems and/or major water providers in the region. If a feasible alternative becomes available, then the recommendation previously discussed should be disregarded and a re-evaluation completed.

MUNICIPAL WATER DEMAND PROJECTIONS
REGION D

		Water Demand (Acre-Feet)					
County	**Scenario**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Bowie	TWDB	14,056	13,899	13,739	13,685	13,554	13,677
	New Proposed	15,657	16,128	16,606	17,313	18,005	18,907
	Proposed % Increase	11	16	21	27	33	38
Camp	TWDB	1,625	1,607	1,575	1,550	1,548	1,757
	New Proposed	1,747	2,048	2,086	2,139	2,191	2,250
	Proposed % Increase	8	27	32	38	42	28
Cass	TWDB	4,634	4,571	4,419	4,384	4,274	4,273
	New Proposed	5,014	5,120	5,201	5,321	5,413	5,530
	Proposed % Increase	8	12	18	21	27	29
Delta	TWDB	717	683	648	622	590	568
	New Proposed	926	898	866	838	810	790
	Proposed % Increase	29	31	34	35	37	39
Franklin	TWDB	2,005	2,216	2,413	2,689	2,830	3,002
	New Proposed	2,005	2,216	2,413	2,689	2,830	3,002
	Proposed % Increase	0	0	0	0	0	0
Gregg	TWDB	21,629	21,928	22,391	23,181	23,886	24,953
	New Proposed	21,682	22,487	23,315	24,628	25,874	27,493
	Proposed % Increase	0	3	4	6	8	10
Harrison	TWDB	9,225	9,296	9,167	8,826	8,183	7,896
	New Proposed	9,877	10,384	10,588	10,976	11,361	11,855
	Proposed % Increase	7	12	16	24	39	50
Hopkins	TWDB	5,142	5,054	4,900	4,793	4,612	4,509
	New Proposed	5,531	5,835	6,078	6,455	6,782	7,238
	Proposed % Increase	8	15	24	35	47	61
Hunt	TWDB	12,594	12,796	12,759	13,008	12,906	13,174
	New Proposed	13,475	14,394	15,185	16,178	17,127	18,163
	Proposed % Increase	7	12	19	24	33	38
Lamar	TWDB	10,001	9,869	9,783	9,954	10,144	10,472
	New Proposed	10,609	10,947	11,150	11,607	12,018	12,569
	Proposed % Increase	6	11	14	17	18	20

MUNICIPAL WATER DEMAND PROJECTIONS
REGION D

		Water Demand (Acre-Feet)					
County	**Scenario**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Marion	TWDB	1,318	1,212	1,112	991	918	850
	New Proposed	1,696	1,737	1,774	1,813	1,854	1,896
	Proposed % Increase	29	43	60	83	102	123
Morris	TWDB	1,609	1,524	1,395	1,291	1,198	1,138
	New Proposed	1,937	1,880	1,807	1,746	1,681	1,638
	Proposed % Increase	20	23	30	35	40	44
Rains	TWDB	1,317	1,377	1,415	1,463	1,487	1,579
	New Proposed	1,374	1,513	1,637	1,787	1,940	2,111
	Proposed % Increase	4	10	16	22	30	34
Red River	TWDB	1,796	1,657	1,506	1,334	1,224	1,112
	New Proposed	2,018	1,941	1,863	1,795	1,744	1,691
	Proposed % Increase	12	17	24	35	42	52
Smith	TWDB	3,920	4,042	3,976	3,846	3,680	3,469
	New Proposed	3,759	3,992	4,206	4,489	4,786	5,154
	Proposed % Increase	-4	-1	6	17	30	49
Titus	TWDB	4,312	4,355	4,406	4,440	4,454	4,516
	New Proposed	4,727	4,994	5,240	5,529	5,816	6,129
	Proposed % Increase	10	15	19	25	31	36
Upshur	TWDB	5,230	5,352	5,433	5,551	5,608	5,724
	New Proposed	5,067	5,365	5,354	5,583	5,846	6,001
	Proposed % Increase	-3	0	-1	1	4	5
Van Zandt	TWDB	5,874	5,962	5,891	5,613	5,190	4,970
	New Proposed	6,513	7,179	7,779	8,403	8,946	9,548
	Proposed % Increase	11	20	32	50	72	92
Wood	TWDB	5,124	5,197	5,128	4,950	4,487	4,044
	New Proposed	5,188	5,503	5,780	6,209	6,524	7,143
	Proposed % Increase	1	6	13	25	45	77
Total	**TWDB**	**112,128**	**112,597**	**112,056**	**112,171**	**110,773**	**111,683**
	New Proposed	**118,804**	**124,561**	**128,929**	**135,498**	**141,548**	**149,108**
	Proposed % Increase	6	11	15	21	28	34

Bowie County Summary - Population and Water Demand Projections

MUNICIPAL

City	Scenario	POPULATION								PER CAPITA USE		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
		1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Report	2000 TWDB Projecte	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
DeKalb	TWDB	1,976		2,065	2,168	2,261	2,326	2,372	2,422	133	125	118.0	111.2	103.8	99.8	97.1	95.8	273	270	263	260	258	260
	SDC	1,976	1,865	1,837	1,929	2,012	2,069	2,110	2,155			118.0	111.2	103.8	99.8	97.1	95.8	243	240	234	231	230	231
	Survey	1,976	2,122	2,159	2,266	2,363	2,431	2,479	2,532			88.8	82.6	75.7	71.9	69.0	67.8	215	210	200	196	192	192
	Forecas	1,976		1,863	2,026	2,190	2,353	2,516	2,680			118.0	111.2	103.8	99.8	97.1	95.8	246	252	255	263	274	288
	Propose	1,976		1,863	2,026	2,190	2,353	2,516	2,680			118.0	111.2	103.8	99.8	97.1	95.8	246	252	255	263	274	288
Hooks	TWDB	2,684		2,855	2,885	2,869	2,830	2,765	2,701	88	146	139.1	132.1	125.1	121.1	115.9	116.0	445	427	402	384	359	351
	SDC	2,684	2,826	2,862	2,892	2,876	2,836	2,771	2,707			139.1	132.1	125.1	121.1	115.9	116.0	446	428	403	385	360	352
	Survey	2,684	3,309	3,465	3,502	3,482	3,435	3,356	3,278			121.5	114.8	108.3	104.2	99.2	99.0	471	450	422	401	373	364
	Forecas	2,684		2,822	3,070	3,318	3,565	3,813	4,061			139.1	132.1	125.1	121.1	115.9	116.0	440	454	465	484	495	528
	Propose	2,684		2,822	3,070	3,318	3,565	3,813	4,061			139.1	132.1	125.1	121.1	115.9	116.0	440	454	465	484	495	528
Maud	TWDB	1,049		1,085	1,097	1,091	1,077	1,053	1,030	113	99	93.0	87.1	81.0	77.1	72.9	72.8	113	107	99	93	86	84
	SDC	1,049	1,024	1,018	1,029	1,023	1,010	988	966			93.0	87.1	81.0	77.1	72.9	72.8	106	100	93	87	81	79
	Survey	1,049	1,050	1,050	1,062	1,056	1,043	1,019	997			135.5	128.0	121.5	117.9	113.2	113.7	159	152	144	138	129	127
	Forecas	1,049		1,023	1,112	1,202	1,292	1,382	1,471			93.0	87.1	81.0	77.1	72.9	72.8	107	109	109	112	113	120
	Propose	1,049		1,023	1,112	1,202	1,292	1,382	1,471			115.0	111.0	107.0	103.0	99.0	95.0	132	138	144	149	153	157
Nash	TWDB	2,162		2,395	2,514	2,621	2,695	2,747	2,800	74	102	96.2	89.8	85.2	82.2	78.0	77.2	258	253	250	248	240	242
	SDC	2,162	2,316	2,355	2,471	2,577	2,649	2,701	2,753			96.2	89.8	85.2	82.2	78.0	77.2	254	249	246	244	236	238
	Survey	2,162	2,332	2,375	2,492	2,599	2,672	2,723	2,776			85.1	79.3	74.7	71.6	67.4	66.5	226	221	217	214	205	207
	Forecas	2,162		2,313	2,516	2,719	2,922	3,125	3,328			96.2	89.8	85.2	82.2	78.0	77.2	249	253	259	269	273	288
	Propose	2,162		2,313	2,516	2,719	2,922	3,125	3,328			115.0	111.0	107.0	103.0	99.0	95.0	298	313	326	337	347	354
New Boston	TWDB	5,057		5,320	5,639	5,926	6,133	6,290	6,451	110	118	110.9	104.0	97.9	94.0	91.0	90.0	661	657	650	646	641	650
	SDC	5,057	5,049	5,047	5,350	5,622	5,818	5,967	6,120			110.9	104.0	97.9	94.0	91.0	90.0	627	623	617	613	608	617
	Survey	5,057	5,873	6,077	6,441	6,769	7,006	7,185	7,369			91.3	84.9	79.0	75.5	72.2	71.1	621	613	599	592	581	587
	Forecas	5,057		5,043	5,485	5,928	6,370	6,813	7,255		(a)	196.3	189.4	183.3	179.4	176.4	175.3	1,109	1,164	1,217	1,280	1,346	1,425
	Propose	5,057		5,043	5,485	5,928	6,370	6,813	7,255		(a)	196.3	189.4	183.3	179.4	176.4	175.3	1,109	1,164	1,217	1,280	1,346	1,425
Redwater	TWDB	824		899	925	956	974	1,049	1,123		115	109.2	102.3	96.2	91.7	87.7	86.7	110	106	103	100	103	109
	SDC	824	844	849	874	903	920	991	1,061			109.2	102.3	96.2	91.7	87.7	86.7	104	100	97	94	97	103
	Survey	824	909	930	957	989	1,008	1,085	1,162			89.0	82.5	76.3	72.1	67.8	66.4	93	88	85	81	82	86
	Forecas	824		843	917	991	1,065	1,139	1,213			109.2	102.3	96.2	91.7	87.7	86.7	103	105	107	109	112	118
	Propose	824		843	917	991	1,065	1,139	1,213			115.0	111.0	107.0	103.0	99.0	95.0	109	114	119	123	126	129
Texarkana	TWDB	31,656		33,507	33,521	33,529	33,308	32,883	32,463	126	165	157.0	149.0	142.0	138.0	134.0	132.0	5,893	5,595	5,333	5,149	4,936	4,800
	SDC	31,656	#####	33,629	33,643	33,651	33,429	33,002	32,581			157.0	149.0	142.0	138.0	134.0	132.0	5,914	5,615	5,352	5,168	4,954	4,817
	Survey	31,656	#####	37,086	37,101	37,110	36,866	36,395	35,930			132.0	124.0	117.0	113.0	109.0	107.0	5,484	5,153	4,863	4,667	4,444	4,306
	Forecas	31,656		42,193	45,896	49,599	53,301	57,004	60,707			157.0	149.0	142.0	138.0	134.0	132.0	7,421	7,660	7,889	8,240	8,557	8,976
	Propose	31,656		42,193	45,896	49,599	53,301	57,004	60,707			157.0	149.0	142.0	138.0	134.0	132.0	7,421	7,660	7,889	8,240	8,557	8,976
Wake Village	TWDB	4,757		5,167	5,425	5,657	5,819	5,935	6,060	93	117	110.1	103.0	95.9	93.0	89.0	87.9	637	626	608	606	592	597
	SDC	4,757	5,105	5,192	5,451	5,684	5,847	5,964	6,089			110.1	103.0	95.9	93.0	89.0	87.9	640	629	611	609	595	600
	Survey	4,757	5,916	6,206	6,516	6,794	6,989	7,128	7,278			92.1	85.0	78.0	74.9	71.0	70.0	640	620	594	586	567	570
	Forecas	4,757		5,098	5,546	5,993	6,441	6,888	7,336			110.1	103.0	95.9	93.0	89.0	87.9	628	640	644	671	687	723
	Propose	4,757		5,098	5,546	5,993	6,441	6,888	7,336			115.0	111.0	107.0	103.0	99.0	95.0	657	690	718	743	764	781
County Other	TWDB	31,500		33,002	36,433	39,576	42,022	44,028	46,168		160	153.3	143.5	136.0	131.7	128.5	127.3	5,666	5,858	6,031	6,199	6,339	6,584
	SDC	31,500	#####	30,364	33,520	36,412	38,663	40,508	42,477			153.3	143.5	136.0	131.7	128.5	127.3	5,213	5,390	5,549	5,703	5,832	6,058
	Survey	31,500	#####	33,399	36,871	40,052	42,527	44,557	46,723			91.6	84.1	78.2	74.2	71.2	70.2	3,426	3,473	3,510	3,536	3,554	3,673
	Forecas	31,500		30,551	33,233	35,913	38,596	41,277	43,958			153.3	143.5	136.0	131.7	128.5	127.3	5,245	5,343	5,473	5,694	5,943	6,269
	Propose	31,500		30,551	33,233	35,913	38,596	41,277	43,958			153.3	143.5	136.0	131.7	128.5	127.3	5,245	5,343	5,473	5,694	5,943	6,269
Municipal Total	TWDB	81,665		86,295	90,607	94,486	97,184	99,122	101,218									####	####	####	####	####	####
	Forecas	81,665	#####	91,749	99,801	107,853	115,905	123,957	132,009									####	####	####	####	####	####
	Propose	**81,665**		**91,749**	**99,801**	**107,853**	**115,905**	**123,957**	**132,009**									**####**	**####**	**####**	**####**	**####**	**####**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

(a) Projected PerCapita adjusted for recorded water use from prison

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Bowie	TWDB	1,288	1,288	1,288	1,288	1,288	1,288
	Modified	3,671	3,850	3,850	3,850	3,500	3,000
	Propose	3,671	3,850	3,850	3,850	3,500	3,000

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Bowie	TWDB	3,709	3,668	3,628	3,588	3,548	3,509
	Modified	4,400	4,620	4,620	4,620	4,500	4,200
	Propose	4,400	4,620	4,620	4,620	4,500	4,200

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Bowie	TWDB	1,944	2,152	2,366	2,590	2,826	3,071
	Modified						
	Propose	1,944	2,152	2,366	2,590	2,826	3,071

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Bowie	TWDB	53	52	53	56	61	66
	Modified						
	Proposed	53	52	53	56	61	66

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Bowie	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Camp County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Pittsburg	TWDB	4,007		4,274	4,484	4,641	4,720	5,147	5,574	181	193	185.1	176.0	167.9	164.0	161.0	160.0	886	884	873	867	928	999
	SDC	4,007	4,454	4,566	4,790	4,958	5,042	5,498	5,954			185.1	176.0	167.9	164.0	161.0	160.0	947	944	933	926	991	1,067
	Survey	4,007	3,838	3,796	3,982	4,122	4,192	4,571	4,950			182.1	173.2	165.2	161.3	158.1	157.2	774	773	763	757	810	872
	Forecast	4,007		4,454	4,790	5,126	5,463	5,799	6,135			185.1	176.0	167.9	164.0	161.0	160.0	923	944	964	1,003	1,046	1,100
	Proposed	4,007		4,454	4,790	5,126	5,463	5,799	6,135			185.1	176.0	167.9	164.0	161.0	160.0	923	944	964	1,003	1,046	1,100
County Other (a)	TWDB	5,897		6,278	6,586	6,816	6,931	6,586	8,186		111	105.1	98.0	91.9	88.0	84.0	82.7	739	723	702	683	620	758
	SDC	5,897	6,396	6,521	6,841	7,080	7,199	6,841	8,503			105.1	98.0	91.9	88.0	84.0	82.7	768	751	729	709	644	787
	Survey	5,897	6,122	6,178	6,481	6,708	6,821	6,481	8,056			76.4	70.0	64.6	60.9	56.6	55.6	529	509	485	465	411	502
	Forecast	5,897		6,395	8,878	9,362	9,844	10,328	10,811			105.1	98.0	91.9	88.0	84.0	82.7	753	975	964	970	972	1,001
	Proposed	5,897		6,395	8,878	9,362	9,844	10,328	10,811			115.0	111.0	107.0	103.0	99.0	95.0	824	1,104	1,122	1,136	1,145	1,150
Municipal Total	TWDB	9,904		10,552	11,070	11,457	11,651	11,733	13,760									1,625	1,607	1,575	1,550	1,548	1,757
	Forecast	9,904	10,850	10,849	13,668	14,488	15,307	16,127	16,946									1,676	1,919	1,928	1,974	2,018	2,101
	Proposed	**9,904**		**10,849**	**13,668**	**14,488**	**15,307**	**16,127**	**16,946**									**1,747**	**2,048**	**2,086**	**2,139**	**2,191**	**2,250**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.
(a) Population of County-Other was increased by 2,000 in the year 2010 in view of the proposed Chicken feed industry

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Camp	TWDB	800	800	800	800	800	800
	Modified						
	Proposed	800	800	800	800	800	800

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Camp	TWDB	132	131	131	131	131	131
	Modified						
	Proposed	132	131	131	131	131	131

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Camp	TWDB	87	87	87	87	87	87
	Modified						
	Proposed	87	87	87	87	87	87

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Camp	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Camp	TWDB	0	0	0	0	0	0
	Modified	10	2,242	2,242	2,242	2,242	2,242
	Proposed	10	2,242	2,242	2,242	2,242	2,242

Increase in Manufacturing water demand for the year 2010 reflects the water demand from Pilgrims Plant

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Cass County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Atlanta	TWDB	6,118		6,342	6,637	6,857	7,038	7,133	7,229	161	209	200.0	191.0	183.1	179.0	176.0	175.0	1,421	1,420	1,406	1,411	1,406	1,417
	SDC	6,118	6,219	6,244	6,535	6,751	6,930	7,023	7,118			200.0	191.0	183.1	179.0	176.0	175.0	1,399	1,398	1,384	1,389	1,384	1,395
	Survey	6,118	5,336	5,141	5,380	5,558	5,705	5,782	5,859			195.1	186.3	178.3	174.3	171.3	170.2	1,124	1,123	1,110	1,114	1,109	1,117
	Forecast	6,118		6,342	6,637	6,857	7,038	7,133	7,229			200.0	191.0	183.1	179.0	176.0	175.0	1,421	1,420	1,406	1,411	1,406	1,417
	Proposed	6,118		6,342	6,637	6,857	7,038	7,133	7,229			200.0	191.0	183.1	179.0	176.0	175.0	1,421	1,420	1,406	1,411	1,406	1,417
Hughes Springs	TWDB	1,927		2,148	2,281	2,308	2,354	2,354	2,354	155	212	202.8	194.1	184.9	182.0	177.9	177.1	488	496	478	480	469	467
	SDC	1,927	2,092	2,133	2,265	2,292	2,338	2,338	2,338			202.8	194.1	184.9	182.0	177.9	177.1	485	493	475	477	466	464
	Survey	1,927	1,958	1,966	2,087	2,112	2,154	2,154	2,154			109.7	103.0	96.2	93.3	89.2	88.4	242	241	227	225	215	213
	Forecast	1,927		2,148	2,281	2,308	2,354	2,354	2,354			202.8	194.1	184.9	182.0	177.9	177.1	488	496	478	480	469	467
	Proposed	1,927		2,148	2,281	2,308	2,354	2,354	2,354			202.8	194.1	184.9	182.0	177.9	177.1	488	496	478	480	469	467
Linden	TWDB	2,375		2,459	2,719	2,753	2,807	2,808	2,809	115	125	118.0	110.0	104.1	101.1	97.0	96.0	325	335	321	318	305	302
	SDC	2,375	2,389	2,393	2,645	2,649	2,731	2,732	2,733			118.0	110.0	104.1	101.1	97.0	96.0	316	326	309	309	297	294
	Survey	2,375	2,553	2,598	2,872	2,908	2,965	2,966	2,967			116.1	108.0	102.4	99.3	95.1	94.2	338	347	333	330	316	313
	Forecast	2,375		2,465	2,635	2,806	2,976	3,146	3,317			118.0	110.0	104.1	101.1	97.0	96.0	326	325	327	337	342	357
	Proposed	2,375		2,465	2,635	2,806	2,976	3,146	3,317			118.0	110.0	104.1	101.1	97.0	96.0	326	325	327	337	342	357
Queen City	TWDB	1,748		1,918	2,036	2,061	2,102	2,103	2,104	101	141	134.1	126.3	120.0	115.9	112.9	112.0	288	288	277	273	266	264
	SDC	1,748	1,995	2,057	2,183	2,210	2,254	2,255	2,256			134.1	126.3	120.0	115.9	112.9	112.0	309	309	297	293	285	283
	Survey	1,748	2,176	2,283	2,423	2,453	2,502	2,503	2,504			65.9	59.9	55.0	51.5	47.9	46.9	169	163	151	144	134	131
	Forecast	1,748		2,058	2,201	2,343	2,485	2,627	2,770			134.1	126.3	120.0	115.9	112.9	112.0	309	311	315	323	332	348
	Proposed	1,748		2,058	2,201	2,343	2,485	2,627	2,770			134.1	126.3	120.0	115.9	112.9	112.0	309	311	315	323	332	348
County Other	TWDB	17,814		18,115	18,490	18,982	19,276	19,408	19,595		110	104.1	98.1	91.1	88.1	84.1	83.1	2,112	2,032	1,937	1,902	1,828	1,823
	SDC	17,814	18,499	18,670	19,057	19,564	19,867	20,003	20,196			104.1	98.1	91.1	88.1	84.1	83.1	2,177	2,094	1,996	1,960	1,884	1,879
	Survey	17,814	21,194	22,039	22,495	23,094	23,451	23,612	23,840			94.2	88.4	81.6	78.6	74.6	73.5	2,325	2,227	2,112	2,063	1,972	1,964
	Forecast	17,814		19,172	20,655	22,320	24,005	25,822	27,637			104.1	98.1	91.1	88.1	84.1	83.1	2,235	2,270	2,278	2,369	2,432	2,571
	Proposed	17,814		19,172	20,655	22,320	24,005	25,822	27,637			115.0	111.0	107.0	103.0	99.0	95.0	2,470	2,568	2,675	2,770	2,864	2,941
Municipal Total	TWDB	29,982		30,982	32,163	32,961	33,577	33,806	34,091									4,634	4,571	4,419	4,384	4,274	4,273
	Forecast	29,982	31,194	32,185	34,409	36,634	38,858	41,082	43,307									4,779	4,822	4,804	4,920	4,981	5,159
	Proposed	**29,982**		**32,185**	**34,409**	**36,634**	**38,858**	**41,082**	**43,307**									**5,014**	**5,120**	**5,201**	**5,321**	**5,413**	**5,530**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Cass	TWDB	851	851	851	851	851	851
	Modified						
	Proposed	851	851	851	851	851	851

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Cass	TWDB	1,254	990	942	902	872	496
	Modified						
	Proposed	1,254	990	942	902	872	496

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Cass	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Cass	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Cass	TWDB	80,129	76,867	76,871	74,569	77,555	80,664
	Modified						
	Proposed	80,129	76,867	76,871	74,569	77,555	80,664

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Delta County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Cooper	TWDB	2,153		2,346	2,382	2,403	2,392	2,344	2,297	136	169	161.0	154.0	147.1	142.9	139.0	138.0	423	411	396	383	365	355
	SDC	2,153	2,227	2,246	2,280	2,300	2,290	2,244	2,199			161.0	154.0	147.1	142.9	139.0	138.0	405	393	379	367	349	340
	Survey	2,153	2,386	2,444	2,482	2,504	2,492	2,442	2,393			137.6	131.0	124.5	120.3	116.3	115.2	377	364	349	336	318	309
	Forecast	2,153		2,076	2,005	1,933	1,862	1,790	1,719			161.0	154.0	147.1	142.9	139.0	138.0	374	346	319	298	279	266
	Proposed	2,153		2,346	2,382	2,403	2,403	2,403	2,403			161.0	154.0	147.1	142.9	139.0	138.0	423	411	396	385	374	371
County Other	TWDB	2,704		2,499	2,450	2,445	2,420	2,366	2,263		112	105.0	99.1	92.0	88.2	84.9	84.0	294	272	252	239	225	213
	SDC	2,704	2,910	2,962	2,903	2,898	2,868	2,804	2,682			105.0	99.1	92.0	88.2	84.9	84.0	348	322	299	283	267	252
	Survey	2,704	3,537	3,745	3,672	3,664	3,627	3,546	3,392			85.4	80.0	73.2	69.3	66.1	65.3	358	329	300	281	263	248
	Forecast	2,704		2,712	2,619	2,526	2,433	2,340	2,247			105.0	99.1	92.0	88.2	84.9	84.0	319	291	260	240	222	211
	Proposed	2,704	3,537	3,745	3,745	3,745	3,745	3,745	3,745			120.0	116.0	112.0	108.0	104.0	100.0	503	487	470	453	436	419
Municipal Total	TWDB	4,857		4,845	4,832	4,848	4,812	4,710	4,560									717	683	648	622	590	568
	Forecast	4,857	5,137	4,788	4,624	4,459	4,295	4,130	3,966									693	637	579	538	501	477
	Proposed	**4,857**		**6,091**	**6,127**	**6,148**	**6,148**	**6,148**	**6,148**									**926**	**898**	**866**	**838**	**810**	**790**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Delta	TWDB	577	577	577	577	577	577
	Modified	770	770	770	770	770	770
	Proposed	770	770	770	770	770	770

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Delta	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Delta	TWDB	1,978	1,956	1,934	1,913	1,891	1,870
	Modified						
	Proposed	1,978	1,956	1,934	1,913	1,891	1,870

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Delta	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Delta	TWDB	0	0	0	0	0	0
	Modified	8	8	8	8	8	8
	Proposed	8	8	8	8	8	8

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Franklin County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Mount Vernon	TWDB	2,219		2,631	3,031	3,428	3,874	4,120	4,382	124	195	184.9	175.0	165.9	162.9	159.9	158.9	545	594	637	707	738	780
	SDC	2,219	2,417	2,467	2,841	3,214	3,632	3,862	4,108			184.9	175.0	165.9	162.9	159.9	158.9	511	557	597	663	692	731
	Survey	2,219	2,722	2,848	3,281	3,710	4,193	4,459	4,743			103.0	95.3	88.3	85.0	82.4	81.4	329	350	367	399	412	433
	Forecast	2,219		2,831	3,033	3,236	3,438	3,641	3,843			184.9	175.0	165.9	162.9	159.9	158.9	586	594	601	627	652	684
	Proposed	2,219		2,631	3,031	3,428	3,874	4,120	4,382			184.9	175.0	165.9	162.9	159.9	158.9	545	594	637	707	738	780
Winnsboro	TWDB	671		776	903	1,030	1,171	1,250	1,334	155	176	168.0	160.2	152.5	149.4	146.4	145.2	146	162	176	196	205	217
	SDC	671	745	764	888	1,013	1,152	1,230	1,313			168.0	160.2	152.5	149.4	146.4	145.2	144	159	173	193	202	214
	Survey	671	709	719	836	954	1,084	1,157	1,235			203.2	195.0	186.5	183.5	180.1	179.2	164	183	199	223	233	248
	Forecast	671		873	935	997	1,060	1,122	1,185			168.0	160.2	152.5	149.4	146.4	145.2	164	168	170	177	184	193
	Proposed	671		776	903	1,030	1,171	1,250	1,334			168.0	160.2	152.5	149.4	146.4	145.2	146	162	176	196	205	217
County Other	TWDB	4,912		5,835	6,826	7,805	8,905	9,516	10,169		211	201.0	190.9	183.0	179.0	177.0	176.0	1,314	1,460	1,600	1,786	1,887	2,005
	SDC	4,912	3,107	2,656	3,107	3,552	4,053	4,331	4,628			201.0	190.9	183.0	179.0	177.0	176.0	598	665	728	813	859	912
	Survey	4,912	6,627	7,056	8,254	9,438	10,768	11,507	12,296			143.5	134.5	127.7	123.9	121.9	120.9	1,134	1,244	1,350	1,495	1,572	1,665
	Forecast	4,912		3,639	3,899	4,159	4,420	4,680	4,940			201.0	190.9	183.0	179.0	177.0	176.0	819	834	853	886	928	974
	Proposed	4,912		5,835	6,826	7,805	8,905	9,516	10,169			201.0	190.9	183.0	179.0	177.0	176.0	1,314	1,460	1,600	1,786	1,887	2,005
Municipal Total	TWDB	7,802		9,242	10,760	12,263	13,950	14,886	15,885									2,005	2,216	2,413	2,689	2,830	3,002
	Forecast	7,802	6,269	7,342	7,867	8,392	8,918	9,443	9,968									1,570	1,596	1,624	1,691	1,764	1,851
	Proposed	**7,802**		**9,242**	**10,760**	**12,263**	**13,950**	**14,886**	**15,885**									**2,005**	**2,216**	**2,413**	**2,689**	**2,830**	**3,002**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Franklin	TWDB	1,595	1,595	1,595	1,595	1,595	1,595
	Modified						
	Proposed	1,595	1,595	1,595	1,595	1,595	1,595

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Franklin	TWDB	1,479	1,384	1,338	1,278	1,297	1,359
	Modified						
	Proposed	1,479	1,384	1,338	1,278	1,297	1,359

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Franklin	TWDB	33	33	33	33	33	33
	Modified						
	Proposed	33	33	33	33	33	33

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Franklin	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Franklin	TWDB	0	0	0	0	0	0
	Modified	6	6	6	6	6	6
	Proposed	6	6	6	6	6	6

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Gregg County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

City	Scenario	POPULATION 1990	1998	2000	2010	2020	2030	2040	2050	PER CAPITA USE (gal/per/day) 1996 TWDB Reported	2000 TWDB Projected	PROJECTED PER CAPITA USE (Expected Case Conservation) 2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	MUNICIPAL WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Clarksville City	TWDB	720		836	876	900	959	1,019	1,103		77	70.5	66.2	59.5	55.9	51.7	51.0	66	65	60	60	59	63
	SDC	720	909	956	1,002	1,029	1,097	1,166	1,262			70.5	66.2	59.5	55.9	51.7	51.0	75	74	69	69	68	72
	Survey	720	889	931	976	1,003	1,068	1,135	1,229			84.6	79.8	73.1	69.6	65.6	65.1	88	87	82	83	83	90
	Forecast	720		964	1,057	1,151	1,244	1,337	1,431			70.5	66.2	59.5	55.9	51.7	51.0	76	78	77	78	77	82
	Proposed	720		964	1,057	1,151	1,244	1,337	1,431			115.0	111.0	107.0	103.0	99.0	95.0	124	131	138	144	148	152
Gladewater	TWDB	3,747		4,288	4,697	5,135	5,550	5,942	6,362	131	164	155.9	146.9	139.1	135.9	133.0	132.0	749	773	800	845	885	941
	SDC	3,747	3,891	3,927	4,302	4,703	5,083	5,442	5,826			155.9	146.9	139.1	135.9	133.0	132.0	686	708	733	774	811	862
	Survey	3,747	3,088	2,923	3,202	3,501	3,784	4,051	4,337			134.3	125.8	118.6	115.3	112.4	111.5	440	451	465	489	510	542
	Forecast	3,747		4,126	4,525	4,925	5,325	5,724	6,124			155.9	146.9	139.1	135.9	133.0	132.0	721	745	767	811	853	906
	Proposed	3,747		4,126	4,525	4,925	5,325	5,724	6,124			155.9	146.9	139.1	135.9	133.0	132.0	721	745	767	811	853	906
Kilgore	TWDB	8,258		9,560	10,297	11,125	11,819	12,500	13,220	180	200	191.0	182.0	174.0	170.0	167.0	166.0	2,045	2,099	2,168	2,251	2,338	2,458
	SDC	8,258	8,748	8,871	9,554	10,323	10,967	11,598	12,267			191.0	182.0	174.0	170.0	167.0	166.0	1,898	1,948	2,012	2,089	2,169	2,281
	Survey	8,258	6,793	6,427	6,922	7,479	7,945	8,403	8,887			259.5	248.8	239.4	235.5	232.5	231.4	1,868	1,929	2,006	2,096	2,188	2,304
	Forecast	8,258		9,276	10,174	11,073	11,971	12,870	13,769			191.0	182.0	174.0	170.0	167.0	166.0	1,984	2,074	2,158	2,280	2,407	2,560
	Proposed	8,258		9,276	10,174	11,073	11,971	12,870	13,769			191.0	182.0	174.0	170.0	167.0	166.0	1,984	2,074	2,158	2,280	2,407	2,560
Lakeport	TWDB	710		786	803	804	818	868	917	119.5		112.5	106.7	99.9	96.0	92.6	90.5	99	96	90	88	90	93
	SDC	710	891	936	956	958	974	1,034	1,092			112.5	106.7	99.9	96.0	92.6	90.5	118	114	107	105	107	111
	Survey	710																					
	Forecast	710		945	1,036	1,128	1,219	1,311	1,402	119.5		112.5	106.7	99.9	96.0	92.6	90.5	119	124	126	131	136	142
	Proposed	710		945	1,036	1,128	1,219	1,311	1,402			115.0	111.0	107.0	103.0	99.0	95.0	122	129	135	141	145	149
Liberty City	TWDB	1,607		2,177	2,565	2,863	3,073	3,200	3,332	142	178	168.1	158.0	150.0	147.0	145.1	143.9	410	454	481	506	520	537
	SDC	1,607	1,730	1,761	2,075	2,316	2,485	2,588	2,695			168.1	158.0	150.0	147.0	145.1	143.9	332	367	389	409	421	434
	Survey	1,607	2,778	3,071	3,618	4,038	4,335	4,514	4,700			119.2	110.7	103.6	100.6	98.7	97.7	410	449	469	488	499	514
	Forecast	1,607		1,834	2,012	2,190	2,367	2,545	2,723			168.1	158.0	150.0	147.0	145.1	143.9	345	356	368	390	414	439
	Proposed	1,607		1,834	2,012	2,190	2,367	2,545	2,723			168.1	158.0	150.0	147.0	145.1	143.9	345	356	368	390	414	439
Longview	TWDB	68,655		76,438	82,596	89,188	95,336	101,080	107,170	123	189	181.0	172.0	165.0	161.0	158.0	157.0	15,498	15,913	16,484	17,193	17,889	18,847
	SDC	68,655	74,184	75,566	81,654	88,171	94,249	99,927	115,658			181.0	172.0	165.0	161.0	158.0	157.0	15,321	15,732	16,296	16,997	17,685	20,340
	Survey	68,655	69,281	69,438	75,032	81,020	86,605	91,823	106,278			156.4	148.1	141.5	137.5	134.5	133.5	12,165	12,444	12,837	13,335	13,829	15,887
	Forecast	68,655		76,438	82,596	89,188	95,336	101,080	107,170			181.0	172.0	165.0	161.0	158.0	157.0	15,498	15,913	16,484	17,193	17,889	18,847
	Proposed	68,655		76,438	82,596	89,188	95,336	101,080	107,170			181.0	172.0	165.0	161.0	158.0	157.0	15,498	15,913	16,484	17,193	17,889	18,847
White Oak	TWDB	5,136		5,882	6,466	7,089	7,682	8,246	8,851	141	133	125.1	116.9	109.9	106.0	103.0	102.0	824	847	873	912	951	1,011
	SDC	5,136	5,712	5,856	6,437	7,058	7,648	8,210	8,963			125.1	116.9	109.9	106.0	103.0	102.0	820	843	869	908	947	1,024
	Survey	5,136	4,984	4,929	5,418	5,940	6,437	6,910	7,544			184.1	176.0	169.0	165.0	162.0	160.9	1,016	1,068	1,124	1,190	1,254	1,360
	Forecast	5,136		6,056	6,643	7,230	7,817	8,403	8,990			125.1	116.9	109.9	106.0	103.0	102.0	848	870	890	928	969	1,027
	Proposed	5,136		6,056	6,643	7,230	7,817	8,403	8,990			125.1	116.9	109.9	106.0	103.0	102.0	848	870	890	928	969	1,027
County Other	TWDB	16,115		13,632	12,586	11,595	10,567	9,422	8,110		130	126.9	119.2	110.5	112.0	109.3	110.4	1,938	1,681	1,435	1,326	1,154	1,003
	SDC	16,115	11,441	10,273	9,484	8,738	7,963	7,100	6,111			126.9	119.2	110.5	112.0	109.3	110.4	1,460	1,267	1,081	999	870	756
	Survey	16,115	18,719	19,370	17,884	16,476	15,015	13,388	11,524			123.0	115.1	106.1	106.0	102.1	101.1	2,668	2,305	1,957	1,783	1,531	1,305
	Forecast	16,115		14,350	16,989	19,190	21,840	24,892	27,596			126.9	119.2	110.5	112.0	109.3	110.4	2,040	2,269	2,375	2,741	3,049	3,413
	Proposed	16,115		14,350	16,989	19,190	21,840	24,892	27,596			126.9	119.2	110.5	112.0	109.3	110.4	2,040	2,269	2,375	2,741	3,049	3,413
Municipal Total	TWDB	104,948		113,599	120,886	128,699	135,804	142,277	149,065									21,629	21,928	22,391	23,181	23,886	24,953
	Forecast	104,948	107,506	113,989	125,032	136,075	147,118	158,162	169,205									21,632	22,429	23,245	24,551	25,794	27,415
	Proposed	**104,948**		**113,989**	**125,032**	**136,075**	**147,118**	**158,162**	**169,205**									**21,682**	**22,487**	**23,315**	**24,628**	**25,874**	**27,493**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

D:\98506\county population\Gregg\Gregg2(mun dmd).xls, 6/14/2012

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Gregg	TWDB	265	265	265	265	265	265
	Modified						
	Proposed	265	265	265	265	265	265

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Gregg	TWDB	96	67	46	37	29	27
	Modified						
	Proposed	96	67	46	37	29	27

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Gregg	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Gregg	TWDB	2,500	3,000	3,000	3,000	3,000	4,000
	Modified	1,251	1,251	1,251	1,251	1,251	1,251
	Proposed	1,251	1,251	1,251	1,251	1,251	1,251

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Gregg	TWDB	16,538	18,576	20,934	23,507	26,515	29,716
	Modified						
	Proposed	16,538	18,576	20,934	23,507	26,515	29,716

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Harrison County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Hallsville	TWDB	2,288		3,081	3,901	4,514	4,859	4,919	4,980	100	130	121.1	111.9	106.0	103.1	101.1	100.0	418	489	536	561	557	558
	SDC	2,288	2,821	2,954	3,741	4,328	4,659	4,717	4,775			121.1	111.9	106.0	103.1	101.1	100.0	401	469	514	538	534	535
	Survey	2,288	3,073	3,269	4,139	4,790	5,156	5,220	5,284			107.3	98.6	93.0	90.0	88.1	87.0	393	457	499	520	515	515
	Forecast	2,288		2,849	3,133	3,335	3,565	3,808	4,042			121.1	111.9	106.0	103.1	101.1	100.0	387	393	396	412	431	453
	Proposed	2,288		2,849	3,133	3,335	3,565	3,808	4,042			120.0	116.0	112.0	108.0	104.0	100.0	383	407	418	431	444	453
Marshall	TWDB	23,682		25,555	27,486	29,199	29,519	28,161	26,865	159	181	173.0	164.0	156.0	152.0	148.0	148.0	4,952	5,049	5,102	5,026	4,669	4,454
	SDC	23,682	25,066	25,412	27,332	29,036	29,354	28,003	26,715			173.0	164.0	156.0	152.0	148.0	148.0	4,924	5,021	5,074	4,998	4,643	4,429
	Survey	23,682	25,875	26,423	28,420	30,191	30,522	29,117	27,777			105.5	98.0	91.6	87.6	83.6	83.6	3,123	3,121	3,097	2,994	2,727	2,600
	Forecast	23,682		25,316	27,835	29,631	31,674	33,832	35,918			173.0	164.0	156.0	152.0	148.0	148.0	4,906	5,113	5,177	5,393	5,609	5,955
	Proposed	23,682		25,316	27,835	29,631	31,674	33,832	35,918			173.0	164.0	156.0	152.0	148.0	148.0	4,906	5,113	5,177	5,393	5,609	5,955
Waskom	TWDB	1,812		1,938	2,071	2,143	2,118	2,042	1,969	107	138	130.8	124.1	117.9	113.8	110.2	110.2	284	288	283	270	252	243
	SDC	1,812	1,871	1,886	2,015	2,085	2,061	1,987	1,916			130.8	124.1	117.9	113.8	110.2	110.2	276	280	275	263	245	236
	Survey	1,812	2,331	2,461	2,630	2,721	2,689	2,593	2,500			95.5	89.4	83.8	80.1	75.9	76.1	263	263	256	241	220	213
	Forecast	1,812		1,890	2,078	2,212	2,364	2,525	2,681			130.8	124.1	117.9	113.8	110.2	110.2	277	289	292	301	312	331
	Proposed	1,812		1,890	2,078	2,212	2,364	2,525	2,681			130.8	124.1	117.9	113.8	110.2	110.2	277	289	292	301	312	331
Longview	TWDB	1,656		1,780	1,902	1,969	1,945	1,876	1,809	123	189	181.1	171.8	165.0	161.1	158.0	156.9	361	366	364	351	332	318
	SDC	1,656	1,789	1,822	1,947	2,016	1,991	1,921	1,852			181.1	171.8	165.0	161.1	158.0	156.9	370	375	373	359	340	326
	Survey	1,656	3,282	3,689	3,942	4,081	4,031	3,888	3,749			136.7	128.5	122.6	118.6	115.7	114.5	565	568	560	536	504	481
	Forecast	1,656		1,807	1,987	2,115	2,261	2,415	2,564			181.1	171.8	165.0	161.1	158.0	156.9	366	382	391	408	427	451
	Proposed	1,656		1,807	1,987	2,115	2,261	2,415	2,564			181.1	171.8	165.0	161.1	158.0	156.9	366	382	391	408	427	451
County Other	TWDB	28,045		29,528	30,771	30,618	29,193	28,219	27,263		103	97.1	90.1	84.0	80.1	75.1	76.1	3,210	3,104	2,882	2,618	2,373	2,323
	SDC	28,045	29,062	29,316	30,550	30,398	28,984	28,017	27,067			97.1	90.1	84.0	80.1	75.1	76.1	3,187	3,082	2,861	2,599	2,356	2,306
	Survey	28,045	37,703	40,118	41,806	41,599	39,663	38,339	37,040			90.2	83.3	77.4	73.4	68.5	69.4	4,051	3,900	3,609	3,262	2,941	2,879
	Forecast	28,045		29,352	32,272	34,353	36,723	39,224	41,645			97.1	90.1	84.0	80.1	75.1	76.1	3,191	3,255	3,234	3,293	3,298	3,548
	Proposed	28,045		29,352	32,272	34,353	36,723	39,224	41,645			120.0	116.0	112.0	108.0	104.0	100.0	3,945	4,193	4,310	4,443	4,569	4,665
Municipal Total	TWDB	57,483	60,609	61,882	66,131	68,443	67,634	65,217	62,886									9,225	9,296	9,167	8,826	8,183	7,896
	Forecast	57,483	60,609	61,214	67,305	71,646	76,587	81,804	86,850									9,127	9,433	9,490	9,807	10,078	10,738
	Proposed	**57,483**		**61,214**	**67,305**	**71,646**	**76,587**	**81,804**	**86,850**									**9,877**	**10,384**	**10,588**	**10,976**	**11,361**	**11,855**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.
Note: Forecasted Population was determined considering the historical population from 1960 through 1998 SDC data.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Harrison	TWDB	768	768	768	768	768	768
	Modified	991	1,040	1,092	1,147	1,205	1,264
	Proposed	991	1,040	1,092	1,147	1,205	1,264

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Harrison	TWDB	362	185	107	56	40	35
	Modified	370	370	370	370	370	370
	Proposed	370	370	370	370	370	370

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Harrison	TWDB	100	100	100	100	100	100
	Modified						
	Proposed	100	100	100	100	100	100

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Harrison	TWDB	5,000	5,000	5,000	10,000	10,000	15,000
	Modified	5,760	5,760	5,760	5,760	5,760	5,760
	Proposed	5,760	5,760	5,760	5,760	5,760	5,760

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Harrison	TWDB	110,588	135,166	141,913	147,949	161,370	176,471
	Modified						
	Proposed	110,588	135,166	141,913	147,949	161,370	176,471

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Hopkins County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Como	TWDB	563		638	660	689	724	765	792		146	138.5	131.2	124.4	120.8	116.7	116.1	99	97	96	98	100	103
	SDC	563	627	643	665	694	730	771	798			138.5	131.2	124.4	120.8	116.7	116.1	100	98	97	99	101	104
	Survey	563	666	692	716	747	785	829	859			117.0	110.5	103.3	99.3	96.0	94.7	91	89	86	87	89	91
	Forecast	563		643	713	783	853	923	992			138.5	131.2	124.4	120.8	116.7	116.1	100	105	109	115	121	129
	Proposed	563		643	713	783	853	923	992			138.5	131.2	124.4	120.8	116.7	116.1	100	105	109	115	121	129
Cumby	TWDB	584		697	734	759	784	823	845		140	133.2	126.5	118.8	115.0	110.6	109.9	104	104	101	101	102	104
	SDC	584	683	708	745	771	796	836	858			133.2	126.5	118.8	115.0	110.6	109.9	106	106	103	103	104	106
	Survey	584	751	793	835	863	892	939	961			93.6	86.6	78.8	74.9	70.7	69.4	83	81	76	75	74	75
	Forecast	584		701	777	853	929	1,005	1,081			133.2	126.5	118.8	115.0	110.6	109.9	105	110	113	120	125	133
	Proposed	584		701	777	853	929	1,005	1,081			133.2	126.5	118.8	115.0	110.6	109.9	105	110	113	120	125	133
Sulphur Springs	TWDB	14,062		14,516	14,994	15,320	15,373	15,240	15,016	167	169	161.0	153.0	145.0	142.0	138.0	137.0	2,618	2,570	2,488	2,445	2,356	2,304
	SDC	14,062	14,977	15,206	15,706	16,048	16,103	15,964	15,730			161.0	153.0	145.0	142.0	138.0	137.0	2,742	2,692	2,606	2,561	2,468	2,414
	Survey	14,062	15,160	15,435	15,943	16,289	16,346	16,204	15,966			133.7	126.4	119.0	115.8	111.8	110.8	2,311	2,257	2,171	2,121	2,030	1,981
	Forecast	14,062		15,367	17,034	18,701	20,369	22,036	23,703			161.0	153.0	145.0	142.0	138.0	137.0	2,771	2,920	3,037	3,240	3,407	3,637
	Proposed	14,062		15,367	17,034	18,701	20,369	22,036	23,703			161.0	153.0	145.0	142.0	138.0	137.0	2,771	2,920	3,037	3,240	3,407	3,637
County Other	TWDB	13,624		13,883	14,326	14,614	14,609	14,389	14,106		155	149.3	142.3	135.3	131.3	127.4	126.4	2,321	2,283	2,215	2,149	2,054	1,998
	SDC	13,624	14,897	15,215	15,701	16,016	16,011	15,770	15,460			149.3	142.3	135.3	131.3	127.4	126.4	2,544	2,502	2,427	2,355	2,251	2,190
	Survey	13,624	16,377	17,065	17,610	17,964	17,958	17,687	17,339			142.1	135.3	128.4	124.4	120.3	119.4	2,717	2,668	2,584	2,502	2,384	2,318
	Forecast	13,624		15,284	16,943	18,601	20,259	21,917	23,577			149.3	142.3	135.3	131.3	127.4	126.4	2,555	2,700	2,819	2,980	3,129	3,339
	Proposed	13,624		15,284	16,943	18,601	20,259	21,917	23,577			149.3	142.3	135.3	131.3	127.4	126.4	2,555	2,700	2,819	2,980	3,129	3,339
Municipal Total	TWDB	28,833		29,734	30,714	31,382	31,490	31,217	30,759									5,142	5,054	4,900	4,793	4,612	4,509
	Forecast	28,833	31,184	31,995	35,467	38,938	42,410	45,881	49,353									5,531	5,835	6,079	6,455	6,782	7,238
	Proposed	**28,833**		**31,995**	**35,467**	**38,938**	**42,410**	**45,881**	**49,353**									**5,531**	**5,835**	**6,078**	**6,455**	**6,782**	**7,238**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hopkins	TWDB	7,100	7,100	7,100	7,100	7,100	7,100
	Modified						
	Proposed	7,100	7,100	7,100	7,100	7,100	7,100

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hopkins	TWDB	125	122	120	117	116	116
	Modified						
	Proposed	125	122	120	117	116	116

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hopkins	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hopkins	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hopkins	TWDB	637	685	724	756	819	881
	Modified	2,654	2,853	3,016	3,148	3,410	3,669
	Proposed	2,654	2,853	3,016	3,148	3,410	3,669

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Hunt County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Caddo Mills	TWDB	1,068		1,305	1,540	1,742	1,859	1,912	1,967	120	121	112.9	98.0	90.2	88.8	86.8	85.8	165	169	176	185	186	189
	SDC	1,068	1,156	1,178	1,390	1,572	1,678	1,726	1,776			112.9	98.0	90.2	88.8	86.8	85.8	149	153	159	167	168	171
	Survey	1,068	1,280	1,333	1,573	1,779	1,899	1,953	2,009			114.7	106.7	100.8	97.9	95.8	94.8	171	188	201	208	210	213
	Forecast	1,068		1,180	1,315	1,450	1,585	1,720	1,855			112.9	98.0	90.2	88.8	86.8	85.8	149	144	146	158	167	178
	Proposed	1,068	1,280	1,180	1,315	1,450	1,585	1,720	1,855			115.0	111.0	107.0	103.0	99.0	95.0	152	164	174	183	191	197
Campbell	TWDB	683		813	855	882	909	935	967		80	73.6	67.9	62.8	58.9	55.4	53.5	67	65	62	60	58	58
	SDC	683	819	853	897	925	954	981	1,015			73.6	67.9	62.8	58.9	55.4	53.5	70	68	65	63	61	61
	Survey	683	1,161	1,281	1,347	1,389	1,432	1,473	1,523			95.4	89.5	84.8	81.4	77.2	75.2	137	135	132	131	127	128
	Forecast	683		836	932	1,027	1,123	1,219	1,314			73.6	67.9	62.8	58.9	55.4	53.5	69	71	72	74	76	79
	Proposed	683	819	836	932	1,027	1,123	1,219	1,314			120.0	116.0	112.0	108.0	104.0	100.0	112	121	129	136	142	147
Celeste	TWDB	733		909	972	1,020	1,050	1,063	1,076		122	114.9	108.4	102.4	97.8	94.1	92.9	117	118	117	115	112	112
	SDC	733	896	937	1,002	1,051	1,082	1,095	1,109			114.9	108.4	102.4	97.8	94.1	92.9	121	122	121	119	115	115
	Survey	733	968	1,027	1,098	1,152	1,186	1,201	1,215			78.1	71.2	65.7	61.2	57.3	56.0	90	88	85	81	77	76
	Forecast	733		915	1,019	1,124	1,229	1,333	1,438			114.9	108.4	102.4	97.8	94.1	92.9	118	124	129	135	140	150
	Proposed	733	896	915	1,019	1,124	1,229	1,333	1,438			115.0	111.0	107.0	103.0	99.0	95.0	118	127	135	142	148	153
Commerce	TWDB	6,825		7,309	7,961	8,363	8,972	9,189	9,411	171	260	250.0	240.0	230.0	227.0	223.0	223.0	2,047	2,140	2,155	2,281	2,295	2,351
	SDC	6,825	7,123	7,198	7,840	8,235	8,835	9,049	9,267			250.0	240.0	230.0	227.0	223.0	223.0	2,016	2,107	2,122	2,246	2,260	2,315
	Survey	6,825	7,655	7,863	8,564	8,996	9,651	9,885	10,124			175.7	167.1	159.0	155.6	152.0	151.7	1,548	1,603	1,602	1,683	1,683	1,720
	Forecast	6,825		7,271	8,103	8,935	9,767	10,599	11,430			250.0	240.0	230.0	227.0	223.0	223.0	2,036	2,178	2,302	2,483	2,647	2,855
	Proposed	6,825		7,271	8,103	8,935	9,767	10,599	11,430			250.0	240.0	230.0	227.0	223.0	223.0	2,036	2,178	2,302	2,483	2,647	2,855
Greenville	TWDB	23,071		24,137	25,075	25,565	26,276	26,476	26,678	157	228	218.0	208.0	198.0	194.0	191.0	190.0	5,894	5,842	5,670	5,710	5,664	5,678
	SDC	23,071	25,238	25,780	26,782	27,305	28,064	28,278	28,494			218.0	208.0	198.0	194.0	191.0	190.0	6,295	6,240	6,056	6,099	6,050	6,065
	Survey	23,071	19,442	18,535	19,255	19,631	20,177	20,331	20,486			191.7	182.3	173.1	169.1	166.0	165.0	3,981	3,932	3,807	3,822	3,780	3,787
	Forecast	23,071		25,764	28,711	31,658	34,605	37,553	40,500			218.0	208.0	198.0	194.0	191.0	190.0	6,291	6,689	7,021	7,520	8,034	8,620
	Proposed	23,071	25,238	25,764	28,711	31,658	34,605	37,553	40,500			218.0	208.0	198.0	194.0	191.0	190.0	6,291	6,689	7,021	7,520	8,034	8,620
Lone Oak	TWDB	521		605	628	639	651	688	735		93	87.1	81.0	75.4	71.3	67.5	65.6	59	57	54	52	52	54
	SDC	521	614	637	661	673	686	725	774			87.1	81.0	75.4	71.3	67.5	65.6	62	60	57	55	55	57
	Survey	521	543	549	569	579	590	624	666			76.1	70.6	63.8	60.1	56.0	54.1	47	45	41	40	39	40
	Forecast	521		627	698	770	842	914	985			87.1	81.0	75.4	71.3	67.5	65.6	61	63	65	67	69	72
	Proposed	521	614	627	698	770	842	914	985			115.0	111.0	107.0	103.0	99.0	95.0	81	87	92	97	101	105
Quinlan	TWDB	1,360		1,841	2,322	2,752	2,982	3,089	3,200	192	115	107.2	91.1	84.0	82.9	80.9	80.9	221	237	259	277	280	290
	SDC	1,360	1,616	1,680	2,119	2,511	2,721	2,819	2,920			107.2	91.1	84.0	82.9	80.9	80.9	202	216	236	253	256	265
	Survey	1,360	1,645	1,716	2,165	2,566	2,780	2,880	2,983			97.4	88.5	82.6	80.7	77.7	77.7	187	215	237	251	251	260
	Forecast	1,360		1,650	1,838	2,027	2,216	2,405	2,593			107.2	91.1	84.0	82.9	80.9	80.9	198	188	191	206	218	235
	Proposed	1,360		1,650	1,838	2,027	2,216	2,405	2,593			115.0	111.0	107.0	103.0	99.0	95.0	213	229	243	256	267	276
West Tawakoni	TWDB	932		1,067	1,098	1,133	1,194	1,255	1,323		162	154.8	147.2	138.7	136.1	132.3	130.9	185	181	176	182	186	194
	SDC	932	1,168	1,227	1,263	1,303	1,373	1,443	1,356			154.8	147.2	138.7	136.1	132.3	130.9	213	208	202	209	214	199
	Survey	932	2,226	2,550	2,624	2,708	2,853	2,999	2,818			141.5	134.4	125.4	122.8	119.1	118.0	404	395	380	393	400	372
	Forecast	932		1,192	1,329	1,465	1,602	1,738	1,874			154.8	147.2	138.7	136.1	132.3	130.9	207	219	228	244	258	275
	Proposed	932	1,168	1,192	1,329	1,465	1,602	1,738	1,874			154.8	147.2	138.7	136.1	132.3	130.9	207	219	228	244	258	275
Wolfe City	TWDB	1,505		1,610	1,753	1,842	1,976	2,024	2,073	131	124	117.0	109.0	101.8	98.9	96.2	95.2	211	214	210	219	218	221
	SDC	1,505	1,600	1,624	1,768	1,858	1,993	2,041	2,091			117.0	109.0	101.8	98.9	96.2	95.2	213	216	212	221	220	223
	Survey	1,505	1,934	2,041	2,223	2,335	2,505	2,566	2,628			74.8	67.2	59.7	57.2	54.2	53.1	171	167	156	160	156	156
	Forecast	1,505		1,633	1,820	2,007	2,194	2,381	2,568			117.0	109.0	101.8	98.9	96.2	95.2	214	222	229	243	256	274
	Proposed	1,505	1,600	1,633	1,820	2,007	2,194	2,381	2,568			117.0	109.0	101.8	98.9	96.2	95.2	214	222	229	243	256	274
County Other	TWDB	27,645		31,737	35,831	39,314	41,165	41,888	44,263		110	102.1	94.0	88.1	85.2	82.2	81.2	3,628	3,773	3,880	3,927	3,855	4,027
	SDC	27,645	30,809	31,600	35,676	39,144	40,987	41,707	44,072			102.1	94.0	88.1	85.2	82.2	81.2	3,612	3,757	3,863	3,910	3,838	4,010
	Survey	27,645	35,035	36,883	41,640	45,688	47,839	48,679	51,439			101.0	93.1	87.2	84.1	81.1	80.1	4,174	4,342	4,460	4,509	4,423	4,616
	Forecast	27,645		31,451	35,049	38,647	42,243	45,840	49,440			102.1	94.0	88.1	85.2	82.2	81.2	3,595	3,691	3,814	4,030	4,219	4,498
	Proposed	27,645	35,035	31,451	35,049	38,647	42,243	45,840	49,440			115.0	111.0	107.0	103.0	99.0	95.0	4,051	4,358	4,632	4,874	5,083	5,261
Municipal Total	TWDB	64,343		71,333	78,035	83,252	87,034	88,519	91,693									12,594	12,796	12,759	13,008	12,906	13,174
	Forecast	64,343	71,039	72,519	80,814	89,110	97,406	105,702	113,997									12,939	13,589	14,198	15,160	16,084	17,236
	Proposed	**64,343**		**72,519**	**80,814**	**89,110**	**97,406**	**105,702**	**113,997**									**13,475**	**14,394**	**15,185**	**16,178**	**17,127**	**18,163**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hunt	TWDB	1,237	1,237	1,237	1,237	1,237	1,237
	Modified						
	Proposed	1,237	1,237	1,237	1,237	1,237	1,237

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hunt	TWDB	70	71	73	75	77	79
	Modified						
	Proposed	70	71	73	75	77	79

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hunt	TWDB	271	271	271	271	271	271
	Modified						
	Proposed	271	271	271	271	271	271

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hunt	TWDB	800	0	0	0	0	0
	Modified	516	516	516	516	516	516
	Proposed	516	516	516	516	516	516

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Hunt	TWDB	573	634	699	773	874	988
	Modified	740	818	903	998	1,129	1,276
	Proposed	740	818	903	998	1,129	1,276

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Lamar County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

City	Scenario	POPULATION 1990	1998	2000	2010	2020	2030	2040	2050	PER CAPITA USE (gal/per/day) 1996 TWDB Reported	2000 TWDB Projected	PROJECTED PER CAPITA USE (Expected Case Conservation) 2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	MUNICIPAL WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Blossom	TWDB	1,440		1,798	2,170	2,566	3,002	3,348	3,734	63	78	71.0	64.2	58.1	55.0	53.1	51.9	143	156	167	185	199	217
	SDC	1,440	1,687	1,749	2,111	2,496	2,920	3,256	3,632			71.0	64.2	58.1	55.0	53.1	51.9	139	152	162	180	194	211
	Survey	1,440	1,537	1,561	1,884	2,228	2,607	2,907	3,242			63.3	56.3	50.7	47.6	45.5	44.5	111	119	126	139	148	161
	Forecast	1,440		1,734	1,853	1,972	2,092	2,211	2,330			71.0	64.2	58.1	55.0	53.1	51.9	138	133	128	129	131	135
	Proposed	1,440		1,734	1,853	1,972	2,092	2,211	2,330			115.0	111.0	107.0	103.0	99.0	95.0	223	230	236	241	245	248
Deport	TWDB	746		796	807	801	779	742	712		96	89.7	84.1	78.0	74.5	69.8	69.0	80	76	70	65	58	55
	SDC	746	852	879	891	884	860	819	786			89.7	84.1	78.0	74.5	69.8	69.0	88	84	77	72	64	61
	Survey	746	932	979	992	985	958	912	875			64.3	58.8	53.2	49.2	44.5	43.4	70	65	59	53	45	43
	Forecast	746		876	936	996	1,056	1,117	1,177			89.7	84.1	78.0	74.5	69.8	69.0	88	88	87	88	87	91
	Proposed	746	852	876	936	996	1,056	1,117	1,177			115.0	111.0	107.0	103.0	99.0	95.0	113	116	119	122	124	125
Paris	TWDB	24,699		25,035	25,464	26,047	26,507	27,218	27,948	160	261	251.0	240.0	230.0	226.0	222.0	221.0	7,039	6,846	6,710	6,710	6,768	6,918
	SDC	24,699	26,241	26,627	27,083	27,703	28,192	28,948	29,725			251.0	240.0	230.0	226.0	222.0	221.0	7,487	7,281	7,137	7,137	7,198	7,358
	Survey	24,699	26,656	27,145	27,610	28,243	28,741	29,512	30,304			152.3	144.1	136.3	132.3	128.3	127.4	4,632	4,455	4,313	4,260	4,242	4,324
	Forecast	24,699		26,970	28,826	30,682	32,538	34,394	36,250			251.0	240.0	230.0	226.0	222.0	221.0	7,583	7,750	7,904	8,237	8,552	8,973
	Proposed	24,699	26,241	26,970	28,826	30,682	32,538	34,394	36,250			251.0	240.0	230.0	226.0	222.0	221.0	7,583	7,750	7,904	8,237	8,552	8,973
Reno	TWDB	1,784		2,201	2,465	2,774	3,090	3,334	3,597	81	110	101.8	94.9	87.9	84.9	81.9	80.9	251	262	273	294	306	326
	SDC	1,784	2,491	2,668	2,988	3,362	3,745	4,041	4,360			101.8	94.9	87.9	84.9	81.9	80.9	304	318	331	356	371	395
	Survey	1,784	2,560	2,754	3,084	3,471	3,866	4,172	4,501			96.1	89.1	82.2	79.2	76.3	75.4	296	308	320	343	357	380
	Forecast	1,784		2,560	2,736	2,913	3,089	3,265	3,441			101.8	94.9	87.9	84.9	81.9	80.9	292	291	287	294	300	312
	* Proposed	1,784	2,491	3,059	4,327	4,869	5,424	5,852	6,314			120.0	116.0	112.0	108.0	104.0	100.0	411	562	611	656	682	707
Roxton	TWDB	639		618	590	551	522	517	513		103	96.8	90.8	84.3	80.4	77.7	74.8	67	60	52	47	45	43
	SDC	639	704	720	688	642	608	603	598			96.8	90.8	84.3	80.4	77.7	74.8	78	70	61	55	52	50
	Survey	639	809	852	813	759	719	712	707			81.2	74.9	67.6	64.8	61.1	59.2	78	68	57	52	49	47
	Forecast	639		724	773	823	873	923	973			96.8	90.8	84.3	80.4	77.7	74.8	78	79	78	79	80	82
	Proposed	639	704	724	773	823	873	923	973			115.0	111.0	107.0	103.0	99.0	95.0	93	96	99	101	102	103
County Other	TWDB	14,641		15,700	17,057	18,564	20,161	21,633	22,995		141	137.7	129.2	120.8	117.5	114.2	113.1	2,421	2,469	2,511	2,653	2,768	2,913
	SDC	14,641	13,791	13,579	14,752	16,055	17,437	18,710	19,888			137.7	129.2	120.8	117.5	114.2	113.1	2,094	2,135	2,172	2,295	2,394	2,519
	Survey	14,641	16,931	17,504	19,016	20,696	22,477	24,118	25,636			114.4	106.9	99.4	96.3	93.2	92.3	2,244	2,276	2,305	2,424	2,519	2,650
	Forecast	14,641		14,173	15,150	16,125	17,100	18,075	19,051			137.7	129.2	120.8	117.5	114.2	113.1	2,186	2,193	2,181	2,250	2,313	2,413
	Proposed	14,641		14,173	15,150	16,125	17,100	18,075	19,051			137.7	129.2	120.8	117.5	114.2	113.1	2,186	2,193	2,181	2,250	2,313	2,413
Municipal Total	TWDB	43,949		46,148	48,553	51,303	54,061	56,792	59,499									10,001	9,869	9,783	9,954	10,144	10,472
	Forecast	43,949	45,766	47,037	50,274	53,511	56,748	59,985	63,222									10,365	10,534	10,665	11,076	11,464	12,006
	Proposed	**43,949**		**47,536**	**51,865**	**55,467**	**59,083**	**62,572**	**66,095**									**10,609**	**10,947**	**11,150**	**11,607**	**12,018**	**12,569**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

* Reno County proposed population is based on the data provided by the comprehensive plan.

LIVESTOCK

County	Scenario	LIVESTOCK WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Lamar	TWDB	1,523	1,523	1,523	1,523	1,523	1,523
	Modified						
	Proposed	1,523	1,523	1,523	1,523	1,523	1,523

MINING

County	Scenario	MINING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Lamar	TWDB	25	24	24	25	25	25
	Modified						
	Proposed	25	24	24	25	25	25

IRRIGATION

County	Scenario	IRRIGATION WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Lamar	TWDB	4,368	4,319	4,271	4,223	4,176	4,129
	Modified						
	Proposed	4,368	4,319	4,271	4,223	4,176	4,129

STEAM ELECTRIC

County	Scenario	STEAM ELECTRIC WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Lamar	TWDB	0	0	0	0	0	0
	Modified	12,209	12,209	12,209	12,209	12,209	12,209
	Proposed	12,209	12,209	12,209	12,209	12,209	12,209

MANUFACTURING

County	Scenario	MANUFACTURING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Lamar	TWDB	5,348	6,128	6,837	7,472	8,473	9,477
	Modified	5,422	6,213	6,932	7,575	8,590	9,608
	Proposed	5,422	6,213	6,932	7,575	8,590	9,608

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Marion County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Jefferson	TWDB	2,199		2,286	2,307	2,273	2,156	2,034	1,919	160	220	210.9	202.0	194.0	188.8	186.1	185.2	540	522	494	456	424	398
	SDC	2,199	2,578	2,673	2,697	2,697	2,697	2,697	2,697			210.9	202.0	194.0	188.8	186.1	185.2	631	610	586	570	562	559
	Survey	2,199	2,729	2,862	2,888	2,888	2,888	2,888	2,888			151.4	143.6	137.0	131.8	129.1	128.0	485	465	443	427	418	414
	Forecast	2,199		2,642	2,813	2,983	3,154	3,324	3,494			210.9	202.0	194.0	188.8	186.1	185.2	624	636	648	667	693	725
	Proposed	2,199	2,578	2,642	2,813	2,983	3,154	3,324	3,494			210.9	202.0	194.0	188.8	186.1	185.2	624	636	648	667	693	725
County Other	TWDB	7,785		7,416	7,115	6,838	6,391	5,984	5,537		100	93.7	86.6	80.7	74.7	73.7	72.9	778	690	618	535	494	452
	SDC	7,785	8,119	8,203	8,203	8,203	8,203	8,203	8,203			93.7	86.6	80.7	74.7	73.7	72.9	861	796	741	687	677	670
	Survey	7,785	11,178	12,028	12,028	12,028	12,028	12,028	12,028			75.5	68.7	63.2	57.1	56.0	55.2	1,017	926	851	770	755	744
	Forecast	7,785		8,322	8,858	9,395	9,931	10,468	11,005			93.7	86.6	80.7	74.7	73.7	72.9	873	859	849	831	864	898
	Proposed	7,785	8,119	8,322	8,858	9,395	9,931	10,468	11,005			115.0	111.0	107.0	103.0	99.0	95.0	1,072	1,101	1,126	1,146	1,161	1,171
Municipal Total	TWDB	9,984		9,702	9,422	9,111	8,547	8,018	7,456									1,318	1,212	1,112	991	918	850
	Forecast	9,984	10,697	10,964	11,671	12,378	13,085	13,792	14,499									1,497	1,495	1,497	1,498	1,557	1,623
	Proposed	**9,984**	**10,697**	**10,964**	**11,671**	**12,378**	**13,085**	**13,792**	**14,499**									**1,696**	**1,737**	**1,774**	**1,813**	**1,854**	**1,896**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Marion	TWDB	182	182	182	182	182	182
	Modified						
	Proposed	182	182	182	182	182	182

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Marion	TWDB	71	43	30	24	20	34
	Modified						
	Proposed	71	43	30	24	20	34

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Marion	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Marion	TWDB	2,000	5,000	5,000	5,000	10,000	10,000
	Modified	2,868	2,868	2,868	2,868	2,868	2,868
	Proposed	2,868	2,868	2,868	2,868	2,868	2,868

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Marion	TWDB	0	0	0	0	0	0
	Modified	20	20	20	20	20	20
	Proposed	20	20	20	20	20	20

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Morris County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

City	Scenario	POPULATION 1990	1998	2000	2010	2020	2030	2040	2050	PER CAPITA USE (gal/per/day) 1996 TWDB Reported	2000 TWDB Projected	PROJECTED PER CAPITA USE (Expected Case Conservation) 2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	MUNICIPAL WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Daingerfield	TWDB	2,572		2,758	2,769	2,717	2,636	2,526	2,415	147	131	124.0	117.0	110.1	105.0	101.1	100.9	383	363	335	310	286	273
	SDC	2,572	2,764	2,812	2,823	2,770	2,688	2,575	2,462			124.0	117.0	110.1	105.0	101.1	100.9	390	370	342	316	292	278
	Survey	2,572	2,819	2,881	2,892	2,838	2,753	2,638	2,522			146.4	139.1	131.4	126.3	122.4	122.4	472	450	418	390	362	346
	Forecast	2,572		3,049	3,017	2,985	2,952	2,920	2,888			124.0	117.0	110.1	105.0	101.1	100.9	423	395	368	347	331	326
	Proposed	2,572		2,881	2,892	2,892	2,892	2,892	2,892			124.0	117.0	110.1	105.0	101.1	100.9	400	379	357	340	327	327
Hughes Springs	TWDB	11		12	12	12	11	11	10	155	223	223.2	223.2	148.8	162.3	162.3	178.5	3	3	2	2	2	2
	SDC	11	12	12	12	12	11	11	10			223.2	223.2	148.8	162.3	162.3	178.5	3	3	2	2	2	2
	Survey	11	12	12	12	12	11	11	10			117.0	117.0	78.0	35.8	35.8	117.0	2	2	1	0	0	1
	Forecast	11		13	13	13	13	13	13			223.2	223.2	148.8	162.3	162.3	178.5	3	3	2	2	2	3
	Proposed	11		12	12	12	11	11	10			223.2	223.2	148.8	162.3	162.3	178.5	3	3	2	2	2	2
Lone Star	TWDB	1,615		1,668	1,675	1,643	1,595	1,528	1,461	85	113	106.0	100.2	92.9	89.0	84.1	84.9	198	188	171	159	144	139
	SDC	1,615	1,646	1,654	1,661	1,629	1,581	1,515	1,449			106.0	100.2	92.9	89.0	84.1	84.9	196	186	170	158	143	138
	Survey	1,615	1,978	2,069	2,077	2,038	1,978	1,895	1,812			122.6	116.5	108.7	104.8	100.2	100.8	284	271	248	232	213	205
	Forecast	1,615		1,816	1,796	1,777	1,758	1,739	1,720			106.0	100.2	92.9	89.0	84.1	84.9	216	202	185	175	164	164
	Proposed	1,615		2,069	2,077	2,077	2,077	2,077	2,077			115.0	111.0	107.0	103.0	99.0	95.0	267	258	249	240	230	221
Naples	TWDB	1,508		1,660	1,790	1,852	1,883	1,839	1,796	115	140	132.3	124.2	117.1	113.3	110.2	108.9	246	249	243	239	227	219
	SDC	1,508	1,464	1,453	1,567	1,621	1,648	1,610	1,572			132.3	124.2	117.1	113.3	110.2	108.9	215	218	213	209	199	192
	Survey	1,508	1,917	2,019	2,177	2,253	2,291	2,237	2,185			94.2	87.5	81.0	76.9	73.6	72.6	213	213	204	197	184	178
	Forecast	1,508		1,615	1,598	1,581	1,564	1,547	1,530			132.3	124.2	117.1	113.3	110.2	108.9	239	222	207	198	191	187
	Proposed	1,508		1,660	1,790	1,852	1,883	1,883	1,883			132.3	124.2	117.1	113.3	110.2	108.9	246	249	243	239	232	230
Omaha	TWDB	833		1,007	1,062	1,099	1,116	1,110	1,082		116	109.9	103.4	96.7	92.8	89.3	88.3	124	123	119	116	111	107
	SDC	833	979	1,016	1,071	1,108	1,125	1,119	1,091			109.9	103.4	96.7	92.8	89.3	88.3	125	124	120	117	112	108
	Survey	833	1,097	1,163	1,227	1,269	1,289	1,282	1,250			124.8	118.4	111.5	107.8	104.5	102.9	163	163	158	156	150	144
	Forecast	833		1,080	1,069	1,057	1,046	1,034	1,023			109.9	103.4	96.7	92.8	89.3	88.3	133	124	114	109	103	101
	Proposed	833		1,163	1,227	1,269	1,289	1,289	1,289			124.8	118.4	111.5	107.8	104.5	102.9	163	163	158	156	151	149
County Other	TWDB	6,661		6,160	6,011	5,745	5,440	5,136	4,853		103	94.9	88.8	81.6	76.3	74.4	73.2	655	598	525	465	428	398
	SDC	6,661	4,510	3,972	3,876	3,705	3,508	3,312	3,129			94.9	88.8	81.6	76.3	74.4	73.2	422	386	339	300	276	257
	Survey	6,661	7,543	7,763	7,576	7,240	6,856	6,473	6,116			95.1	89.1	82.2	77.2	75.1	74.0	827	756	667	592	545	507
	Forecast	6,661		4,975	4,922	4,870	4,817	4,765	4,712			94.9	88.8	81.6	76.3	74.4	73.2	529	490	445	412	397	386
	Proposed	6,661		6,661	6,661	6,661	6,661	6,661	6,661			115.0	111.0	107.0	103.0	99.0	95.0	858	828	798	769	739	709
Municipal Total	TWDB	13,200		13,265	13,319	13,068	12,681	12,150	11,617									1,609	1,524	1,395	1,291	1,198	1,138
	Forecast	13,200	11,375	12,548	12,415	12,283	12,150	12,018	11,885									1,544	1,436	1,322	1,244	1,188	1,167
	Proposed	**13,200**		**14,446**	**14,659**	**14,763**	**14,813**	**14,813**	**14,812**									**1,937**	**1,880**	**1,807**	**1,746**	**1,681**	**1,638**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

County	Scenario	LIVESTOCK WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Morris	TWDB	624	624	624	624	624	624
	Modified						
	Proposed	624	624	624	624	624	624

MINING

County	Scenario	MINING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Morris	TWDB	31	16	12	10	10	11
	Modified						
	Proposed	31	16	12	10	10	11

IRRIGATION

County	Scenario	IRRIGATION WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Morris	TWDB	190	188	186	184	182	180
	Modified						
	Proposed	190	188	186	184	182	180

STEAM ELECTRIC

County	Scenario	STEAM ELECTRIC WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Morris	TWDB	0	0	0	0	0	0
	Modified	48	48	48	48	48	48
	Proposed	48	48	48	48	48	48

MANUFACTURING

County	Scenario	MANUFACTURING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Morris	TWDB	132,451	135,264	129,869	124,443	119,127	113,929
	Modified						
	Proposed	132,451	135,264	129,869	124,443	119,127	113,929

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Rains County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
East Tawakoni	TWDB	642		779	827	861	897	936	976		131	124.9	117.7	110.9	108.5	104.0	103.4	109	109	107	109	109	113
	SDC	642	746	772	777	853	889	928	967			124.9	117.7	110.9	108.5	104.0	103.4	108	102	106	108	108	112
	Survey	642	1,323	1,493	1,502	1,650	1,719	1,794	1,871			100.3	93.0	86.3	83.1	79.3	78.6	168	157	160	160	159	165
	Forecast	642		762	886	1,011	1,135	1,259	1,384			124.9	117.7	110.9	108.5	104.0	103.4	107	117	126	138	147	160
	Proposed	642		762	886	1,011	1,135	1,259	1,384			124.9	117.7	110.9	108.5	104.0	103.4	107	117	126	138	147	160
Emory	TWDB	963		979	994	1,005	1,014	1,029	1,044	202	184	176.9	168.8	160.8	157.6	154.4	153.1	194	188	181	179	178	179
	SDC	963	1,034	1,052	1,053	1,080	1,089	1,105	1,122			176.9	168.8	160.8	157.6	154.4	153.1	208	199	195	192	191	192
	Survey	963	1,590	1,747	1,749	1,793	1,809	1,836	1,863			76.2	70.7	65.3	61.4	57.8	56.9	149	139	131	125	119	119
	Forecast	963		1,056	1,228	1,401	1,573	1,745	1,918			176.9	168.8	160.8	157.6	154.4	153.1	209	232	252	278	302	329
	Proposed	963	1,034	1,056	1,228	1,401	1,573	1,745	1,918			176.9	168.8	160.8	157.6	154.4	153.1	209	232	252	278	302	329
Point	TWDB	645		726	749	758	793	840	888		128	120.5	114.4	108.4	103.6	99.9	98.5	98	96	92	92	94	98
	SDC	645	799	838	840	874	915	969	1,024			120.5	114.4	108.4	103.6	99.9	98.5	113	108	106	106	108	113
	Survey	645	1,384	1,569	1,574	1,638	1,714	1,815	1,919			95.6	89.9	83.0	78.2	75.4	73.8	168	158	152	150	153	159
	Forecast	645		816	949	1,082	1,216	1,349	1,482			120.5	114.4	108.4	103.6	99.9	98.5	110	122	131	141	151	164
	Proposed	645	799	816	949	1,082	1,216	1,349	1,482			120.5	114.4	108.4	103.6	99.9	98.5	110	122	131	141	151	164
County Other	TWDB	4,465		4,960	5,640	6,246	6,732	7,002	7,598		163	164.9	155.8	147.9	143.6	141.0	139.7	916	984	1,035	1,083	1,106	1,189
	SDC	4,465	5,024	5,164	5,235	6,503	7,009	7,290	7,910			164.9	155.8	147.9	143.6	141.0	139.7	954	913	1,078	1,128	1,151	1,238
	Survey	4,465	6,519	7,033	7,129	8,856	9,545	9,928	10,773			105.9	98.8	92.7	89.0	86.1	85.0	834	789	920	952	957	1,026
	Forecast	4,465		5,131	5,970	6,806	7,643	8,481	9,317			164.9	155.8	147.9	143.6	141.0	139.7	948	1,042	1,128	1,230	1,340	1,458
	Proposed	4,465	5,024	5,131	5,970	6,806	7,643	8,481	9,317			164.9	155.8	147.9	143.6	141.0	139.7	948	1,042	1,128	1,230	1,340	1,458
Municipal Total	TWDB	6,715		7,444	8,210	8,870	9,436	9,807	10,506									1,317	1,377	1,415	1,463	1,487	1,579
	Forecast	6,715	7,603	7,765	9,033	10,300	11,567	12,834	14,101									1,374	1,512	1,637	1,787	1,940	2,111
	Proposed	**6,715**		**7,765**	**9,033**	**10,300**	**11,567**	**12,834**	**14,101**									**1,374**	**1,513**	**1,637**	**1,787**	**1,940**	**2,111**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Rains	TWDB	700	700	700	700	700	700
	Modified						
	Proposed	700	700	700	700	700	700

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Rains	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Rains	TWDB	20	20	20	20	20	20
	Modified						
	Proposed	20	20	20	20	20	20

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Rains	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Rains	TWDB	0	0	0	0	0	0
	Modified	2	2	2	2	2	2
	Proposed	2	2	2	2	2	2

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Red River County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Bogata	TWDB	1,421		1,400	1,331	1,263	1,156	1,054	961	84	121	114.1	107.3	99.7	94.2	94.0	92.9	179	160	141	122	111	100
	SDC	1,421	1,307	1,279	1,215	1,153	1,056	963	878			114.1	107.3	99.7	94.2	94.0	92.9	164	146	129	111	101	91
	Survey	1,421	1,480	1,495	1,421	1,348	1,234	1,125	1,026			118.9	112.4	104.4	98.7	98.6	97.8	199	179	158	136	124	112
	Forecast	1,421		1,305	1,283	1,261	1,240	1,218	1,196			114.1	107.3	99.7	94.2	94.0	92.9	167	154	141	131	128	124
	Proposed	1,421	1,480	1,495	1,495	1,495	1,495	1,495	1,495			115.0	111.0	107.0	103.0	99.0	95.0	193	186	179	172	166	159
Clarksville	TWDB	4,311		4,162	4,135	4,068	3,865	3,628	3,406	148	146	139.0	131.9	125.1	120.1	118.1	116.1	648	611	570	520	480	443
	SDC	4,311	4,326	4,330	4,302	4,232	4,021	3,774	3,543			139.0	131.9	125.1	120.1	118.1	116.1	674	636	593	541	499	461
	Survey	4,311	4,374	4,390	4,361	4,291	4,076	3,827	3,592			130.1	123.3	116.7	111.7	109.7	107.7	640	602	561	510	470	433
	Forecast	4,311		4,321	4,248	4,175	4,103	4,030	3,957			139.0	131.9	125.1	120.1	118.1	116.1	673	628	585	552	533	515
	Proposed	4,311	4,326	4,330	4,330	4,330	4,330	4,330	4,330			139.0	131.9	125.1	120.1	118.1	116.1	674	640	607	583	573	563
Detroit	TWDB	706		820	851	866	899	947	995		86	80.6	74.5	69.1	65.5	62.2	61.0	74	71	67	66	66	68
	SDC	706	799	822	853	868	901	950	998			80.6	74.5	69.1	65.5	62.2	61.0	74	71	67	66	66	68
	Survey	706	824	854	886	901	936	986	1,036			68.6	62.5	57.5	53.1	50.4	48.9	66	62	58	56	56	57
	Forecast	706		798	785	771	758	744	731			80.6	74.5	69.1	65.5	62.2	61.0	72	65	60	56	52	50
	Proposed	706	799	822	853	868	901	950	998			115.0	111.0	107.0	103.0	99.0	95.0	106	106	104	104	105	106
County Other	TWDB	7,879		7,489	7,212	6,916	6,357	5,766	5,121		113	106.7	100.9	94.0	87.9	87.8	87.3	895	815	728	626	567	501
	SDC	7,879	8,067	8,114	7,814	7,493	6,888	6,247	5,548			106.7	100.9	94.0	87.9	87.8	87.3	970	883	789	678	614	543
	Survey	7,879	7,987	8,014	7,718	7,401	6,803	6,170	5,480			75.3	70.1	63.5	57.8	57.1	56.6	676	606	527	441	395	348
	Forecast	7,879		8,058	7,922	7,786	7,651	7,515	7,379			106.7	100.9	94.0	87.9	87.8	87.3	963	895	820	753	739	722
	Proposed	7,879	8,067	8,114	8,114	8,114	8,114	8,114	8,114			115.0	111.0	107.0	103.0	99.0	95.0	1,045	1,009	973	936	900	863
Municipal Total	TWDB	14,317		13,871	13,529	13,113	12,277	11,395	10,483									1,796	1,657	1,506	1,334	1,224	1,112
	Forecast	14,317	14,499	14,482	14,238	13,994	13,751	13,507	13,263									1,875	1,743	1,605	1,492	1,452	1,411
	Proposed	**14,317**	**14,672**	**14,761**	**14,792**	**14,807**	**14,840**	**14,889**	**14,937**									**2,018**	**1,941**	**1,863**	**1,795**	**1,744**	**1,691**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Red River	TWDB	1,180	1,180	1,180	1,180	1,180	1,180
	Modified						
	Proposed	1,180	1,180	1,180	1,180	1,180	1,180

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Red River	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Red River	TWDB	99	98	97	96	95	94
	Modified						
	Proposed	99	98	97	96	95	94

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Red River	TWDB	1,500	1,500	2,000	2,000	5,000	5,000
	Modified	1,500	5,000	7,000	10,000	10,000	10,000
	Proposed	1,500	5,000	7,000	10,000	10,000	10,000

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Red River	TWDB	5	7	8	9	10	12
	Modified	11	15	17	19	21	25
	Proposed	11	15	17	19	21	25

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

MUNICIPAL WATER DEMAND PROJECTIONS
REGION D

		Water Demand (Acre-Feet)					
County	**Scenario**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Bowie	TWDB	14,056	13,899	13,739	13,685	13,554	13,677
	New Proposed	15,657	16,128	16,606	17,313	18,005	18,907
	Proposed % Increase	11	16	21	27	33	38
Camp	TWDB	1,625	1,607	1,575	1,550	1,548	1,757
	New Proposed	1,747	2,048	2,086	2,139	2,191	2,250
	Proposed % Increase	8	27	32	38	42	28
Cass	TWDB	4,634	4,571	4,419	4,384	4,274	4,273
	New Proposed	5,014	5,120	5,201	5,321	5,413	5,530
	Proposed % Increase	8	12	18	21	27	29
Delta	TWDB	717	683	648	622	590	568
	New Proposed	926	898	866	838	810	790
	Proposed % Increase	29	31	34	35	37	39
Franklin	TWDB	2,005	2,216	2,413	2,689	2,830	3,002
	New Proposed	2,005	2,216	2,413	2,689	2,830	3,002
	Proposed % Increase	0	0	0	0	0	0
Gregg	TWDB	21,629	21,928	22,391	23,181	23,886	24,953
	New Proposed	21,682	22,487	23,315	24,628	25,874	27,493
	Proposed % Increase	0	3	4	6	8	10
Harrison	TWDB	9,225	9,296	9,167	8,826	8,183	7,896
	New Proposed	9,877	10,384	10,588	10,976	11,361	11,855
	Proposed % Increase	7	12	16	24	39	50
Hopkins	TWDB	5,142	5,054	4,900	4,793	4,612	4,509
	New Proposed	5,531	5,835	6,078	6,455	6,782	7,238
	Proposed % Increase	8	15	24	35	47	61
Hunt	TWDB	12,594	12,796	12,759	13,008	12,906	13,174
	New Proposed	13,475	14,394	15,185	16,178	17,127	18,163
	Proposed % Increase	7	12	19	24	33	38
Lamar	TWDB	10,001	9,869	9,783	9,954	10,144	10,472
	New Proposed	10,609	10,947	11,150	11,607	12,018	12,569
	Proposed % Increase	6	11	14	17	18	20

MUNICIPAL WATER DEMAND PROJECTIONS
REGION D

		Water Demand (Acre-Feet)					
County	**Scenario**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Marion	TWDB	1,318	1,212	1,112	991	918	850
	New Proposed	1,696	1,737	1,774	1,813	1,854	1,896
	Proposed % Increase	29	43	60	83	102	123
Morris	TWDB	1,609	1,524	1,395	1,291	1,198	1,138
	New Proposed	1,937	1,880	1,807	1,746	1,681	1,638
	Proposed % Increase	20	23	30	35	40	44
Rains	TWDB	1,317	1,377	1,415	1,463	1,487	1,579
	New Proposed	1,374	1,513	1,637	1,787	1,940	2,111
	Proposed % Increase	4	10	16	22	30	34
Red River	TWDB	1,796	1,657	1,506	1,334	1,224	1,112
	New Proposed	2,018	1,941	1,863	1,795	1,744	1,691
	Proposed % Increase	12	17	24	35	42	52
Smith	TWDB	3,920	4,042	3,976	3,846	3,680	3,469
	New Proposed	3,759	3,992	4,206	4,489	4,786	5,154
	Proposed % Increase	-4	-1	6	17	30	49
Titus	TWDB	4,312	4,355	4,406	4,440	4,454	4,516
	New Proposed	4,727	4,994	5,240	5,529	5,816	6,129
	Proposed % Increase	10	15	19	25	31	36
Upshur	TWDB	5,230	5,352	5,433	5,551	5,608	5,724
	New Proposed	5,067	5,365	5,354	5,583	5,846	6,001
	Proposed % Increase	-3	0	-1	1	4	5
Van Zandt	TWDB	5,874	5,962	5,891	5,613	5,190	4,970
	New Proposed	6,513	7,179	7,779	8,403	8,946	9,548
	Proposed % Increase	11	20	32	50	72	92
Wood	TWDB	5,124	5,197	5,128	4,950	4,487	4,044
	New Proposed	5,188	5,503	5,780	6,209	6,524	7,143
	Proposed % Increase	1	6	13	25	45	77
Total	**TWDB**	**112,128**	**112,597**	**112,056**	**112,171**	**110,773**	**111,683**
	New Proposed	**118,804**	**124,561**	**128,929**	**135,498**	**141,548**	**149,108**
	Proposed % Increase	6	11	15	21	28	34

Smith County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Lindale	TWDB	1,214		1,372	1,491	1,566	1,626	1,677	1,709	121	179	169.8	159.9	152.0	148.8	145.9	145.2	261	267	267	271	274	278
	SDC	1,214	1,339	1,370	1,488	1,563	1,623	1,674	1,706			169.8	159.9	152.0	148.8	145.9	145.2	261	267	266	271	274	278
	Survey	1,214	1,588	1,681	1,826	1,918	1,991	2,054	2,094			233.5	221.1	211.8	209.0	206.1	205.5	440	452	455	466	474	482
	Forecast	1,214		1,377	1,556	1,735	1,913	2,092	2,271			169.8	159.9	152.0	148.8	145.9	145.2	262	279	295	319	342	369
	Proposed	1,214		1,377	1,556	1,735	1,913	2,092	2,271			169.8	159.9	152.0	148.8	145.9	145.2	262	279	295	319	342	369
Overton	TWDB	71		78	85	90	93	96	98			183.1	178.5	168.6	163.2	158.1	154.9	16	17	17	17	17	17
	SDC	71	76																				
	Survey	71																					
	Forecast	71		78	88	98	109	119	129			183.1	178.5	168.6	163.2	158.1	154.9	16	18	19	20	21	22
	Proposed	71		78	88	98	109	119	129			183.1	178.5	168.6	163.2	158.1	154.9	16	18	19	20	21	22
Tyler	TWDB	8		8	8	9	9	10	11			223.2	223.2	198.4	198.4	178.5	162.3	2	2	2	2	2	2
	SDC	8	8																				
	Survey	8																					
	Forecast	8		8	9	10	11	13	14			223.2	223.2	198.4	198.4	178.5	162.3	2	2	2	2	3	3
	Proposed	8		8	9	10	11	13	14			223.2	223.2	198.4	198.4	178.5	162.3	2	2	2	2	3	3
County Other	TWDB	20,261		23,963	26,303	27,353	27,267	26,648	25,155		144	135.6	127.5	120.4	116.4	113.5	112.6	3,641	3,756	3,690	3,556	3,387	3,172
	SDC	20,261	22,248	22,670	24,883	25,877	25,795	25,210	23,797			135.6	127.5	120.4	116.4	113.5	112.6	3,445	3,553	3,491	3,364	3,204	3,001
	Survey	20,261	25,324	26,590	29,186	30,351	30,256	29,569	27,912			229.0	218.8	209.1	205.1	202.1	201.3	6,820	7,152	7,109	6,950	6,695	6,294
	Forecast	20,261		22,894	25,864	28,835	31,805	34,775	37,745			135.6	127.5	120.4	116.4	113.5	112.6	3,479	3,693	3,890	4,148	4,420	4,760
	Proposed	20,261		22,894	25,864	28,835	31,805	34,775	37,745			135.6	127.5	120.4	116.4	113.5	112.6	3,479	3,693	3,890	4,148	4,420	4,760
Municipal Total	TWDB	21,554		25,421	27,887	29,018	28,995	28,431	26,973									3,920	4,042	3,976	3,846	3,680	3,469
	Forecast	21,554	23,671	24,357	27,517	30,678	33,838	36,999	40,159									3,759	3,992	4,206	4,489	4,786	5,154
	Proposed	**21,554**		**24,357**	**27,517**	**30,678**	**33,838**	**36,999**	**40,159**									**3,759**	**3,992**	**4,206**	**4,489**	**4,786**	**5,154**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Smith	TWDB	453	453	453	453	453	453
	Modified						
	Proposed	453	453	453	453	453	453

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Smith	TWDB	425	178	91	32	18	6
	Modified						
	Proposed	425	178	91	32	18	6

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Smith	TWDB	63	63	63	63	63	63
	Modified	446	468	491	516	542	569
	Proposed	446	468	491	516	542	569

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Smith	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Smith	TWDB	262	298	325	346	377	403
	Modified						
	Proposed	262	298	325	346	377	403

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Titus County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

City	Scenario	POPULATION 1990	1998	2000	2010	2020	2030	2040	2050	PER CAPITA USE (gal/per/day) 1996 TWDB Reported	2000 TWDB Projected	PROJECTED PER CAPITA USE (Expected Case Conservation) 2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	MUNICIPAL WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Mount Pleasant	TWDB	12,291		12,859	13,627	14,438	14,895	15,246	15,605	241	203	195.0	186.0	178.0	174.0	171.0	170.0	2,809	2,839	2,879	2,903	2,920	2,972
	SDC	12,291	13,595	13,921	14,752	15,630	16,125	16,505	16,894			195.0	186.0	178.0	174.0	171.0	170.0	3,041	3,073	3,117	3,143	3,161	3,217
	Survey	12,291	12,661	12,754	13,515	14,320	14,773	15,121	15,477			200.9	191.7	183.7	179.6	176.6	175.7	2,870	2,903	2,946	2,972	2,991	3,046
	Forecast	12,291		13,790	15,201	16,611	18,022	19,433	20,844			195.0	186.0	178.0	174.0	171.0	170.0	3,012	3,167	3,312	3,512	3,722	3,970
	Proposed	12,291	13,595	13,790	15,201	16,611	18,022	19,433	20,844			195.0	186.0	178.0	174.0	171.0	170.0	3,012	3,167	3,312	3,512	3,722	3,970
Talco	TWDB	592		494	482	449	445	420	408		94	88.6	81.5	75.6	72.2	68.0	67.8	49	44	38	36	32	31
	SDC	592	597	598	584	544	539	509	494			88.6	81.5	75.6	72.2	68.0	67.8	59	53	46	44	39	38
	Survey	592	701	728	711	662	656	619	601			63.6	56.0	51.1	46.9	43.5	42.7	52	45	38	34	30	29
	Forecast	592		606	668	729	791	853	915			88.6	81.5	75.6	72.2	68.0	67.8	60	61	62	64	65	70
	Proposed	592	597	606	668	729	791	853	915			115.0	111.0	107.0	103.0	99.0	95.0	78	83	87	91	95	97
County Other	TWDB	11,126		12,259	13,303	14,504	15,298	15,851	16,173		112	105.9	98.8	91.7	87.6	84.6	83.5	1,454	1,472	1,489	1,501	1,502	1,513
	SDC	11,126	12,007	12,227	13,269	14,466	15,258	15,810	16,131			105.9	98.8	91.7	87.6	84.6	83.5	1,450	1,468	1,485	1,497	1,498	1,509
	Survey	11,126	15,453	16,535	17,943	19,563	20,634	21,380	21,814			96.2	89.4	82.6	78.6	75.7	74.6	1,783	1,797	1,811	1,817	1,812	1,822
	Forecast	11,126		12,178	13,424	14,672	15,918	17,163	18,409			105.9	98.8	91.7	87.6	84.6	83.5	1,444	1,485	1,506	1,562	1,626	1,722
	Proposed	11,126	15,453	12,178	13,424	14,672	15,918	17,163	18,409			120.0	116.0	112.0	108.0	104.0	100.0	1,637	1,744	1,841	1,926	1,999	2,062
Municipal Total	TWDB	24,009		25,612	27,412	29,391	30,638	31,517	32,186									4,312	4,355	4,406	4,440	4,454	4,516
	Forecast	24,009	26,199	26,574	29,293	32,012	34,731	37,449	40,168									4,517	4,713	4,880	5,138	5,413	5,761
	Proposed	**24,009**		**26,574**	**29,293**	**32,012**	**34,731**	**37,449**	**40,168**									**4,727**	**4,994**	**5,240**	**5,529**	**5,816**	**6,129**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

County	Scenario	LIVESTOCK WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Titus	TWDB	858	858	858	858	858	858
	Modified						
	Proposed	858	858	858	858	858	858

MINING

County	Scenario	MINING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Titus	TWDB	2,772	1,991	1,796	1,722	1,705	1,744
	Modified						
	Proposed	2,772	1,991	1,796	1,722	1,705	1,744

IRRIGATION

County	Scenario	IRRIGATION WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Titus	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

STEAM ELECTRIC

County	Scenario	STEAM ELECTRIC WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Titus	TWDB	36,000	36,000	36,000	36,000	40,000	45,000
	Modified	28,280	31,280	31,280	36,280	36,280	36,280
	Proposed	28,280	31,280	31,280	36,280	36,280	36,280

MANUFACTURING

County	Scenario	MANUFACTURING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Titus	TWDB	2,427	2,598	2,729	2,832	3,069	3,301
	Modified	3,734	3,997	4,199	4,357	4,722	5,079
	Proposed	3,734	3,997	4,199	4,357	4,722	5,079

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Upshur County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Big Sandy	TWDB	1,185		1,334	1,455	1,566	1,657	1,722	1,776	133	155	147.2	138.1	131.1	127.1	123.9	123.2	220	225	230	236	239	245
	SDC	1,185	1,294	1,321	1,441	1,551	1,641	1,706	1,759			147.2	138.1	131.1	127.1	123.9	123.2	218	223	228	234	237	243
	Survey	1,185	1,763	1,908	2,081	2,239	2,369	2,462	2,540			105.7	98.0	92.0	87.9	84.8	84.3	226	228	231	233	234	240
	Forecast	1,185		1,400	1,548	1,611	1,732	1,870	1,970			147.2	138.1	131.1	127.1	123.9	123.2	231	239	237	247	260	272
	Proposed	1,185		1,400	1,548	1,611	1,732	1,870	1,970			147.2	138.1	131.1	127.1	123.9	123.2	231	239	237	247	260	272
East Mountain	TWDB	762		939	1,000	1,045	1,071	1,077	1,061		92	85.6	80.3	74.3	70.0	66.3	64.8	90	90	87	84	80	77
	SDC	762	927	968	1,031	1,078	1,104	1,111	1,094			85.6	80.3	74.3	70.0	66.3	64.8	93	93	90	87	83	79
	Survey	762	1,137	1,231	1,311	1,370	1,404	1,412	1,391			82.3	77.4	71.1	67.3	63.3	62.1	114	114	109	106	100	97
	Forecast	762		1,003	1,109	1,154	1,241	1,340	1,411			85.6	80.3	74.3	70.0	66.3	64.8	96	100	96	97	100	102
	Proposed	762		1,003	1,109	1,154	1,241	1,340	1,411			120.0	116.0	112.0	108.0	104.0	100.0	135	144	145	150	156	158
Gilmer	TWDB	4,822		5,444	5,938	6,390	6,763	7,029	7,248	145	218	207.9	198.0	189.0	186.0	183.0	182.0	1,268	1,317	1,353	1,409	1,441	1,478
	SDC	4,822	5,376	5,515	6,015	6,473	6,851	7,120	7,342			207.9	198.0	189.0	186.0	183.0	182.0	1,285	1,334	1,371	1,427	1,460	1,497
	Survey	4,822	6,300	6,670	7,275	7,828	8,285	8,611	8,880			142.6	134.4	127.0	123.7	120.7	119.6	1,065	1,095	1,113	1,148	1,164	1,190
	Forecast	4,822		5,815	6,430	6,693	7,195	7,769	8,183			207.9	198.0	189.0	186.0	183.0	182.0	1,354	1,426	1,417	1,499	1,593	1,669
	Proposed	4,822		5,815	6,430	6,693	7,195	7,769	8,183			207.9	198.0	189.0	186.0	183.0	182.0	1,354	1,426	1,417	1,499	1,593	1,669
Gladewater	TWDB	2,280		2,544	2,774	2,986	3,160	3,284	3,387	131	164	156.2	147.1	139.0	135.9	132.9	132.1	445	457	465	481	489	501
	SDC	2,280	2,367	2,389	2,605	2,804	2,967	3,084	3,180			156.2	147.1	139.0	135.9	132.9	132.1	418	429	437	452	459	470
	Survey	2,280	3,008	3,190	3,478	3,744	3,962	4,118	4,247			134.7	125.9	118.4	115.2	112.5	111.6	481	490	496	511	519	531
	Forecast	2,280		2,560	2,831	2,947	3,168	3,421	3,603			156.2	147.1	139.0	135.9	132.9	132.1	448	466	459	482	509	533
	Proposed	2,280		2,560	2,831	2,947	3,168	3,421	3,603			156.2	147.1	139.0	135.9	132.9	132.1	448	466	459	482	509	533
Ore City	TWDB	898		1,017	1,109	1,194	1,263	1,313	1,354	113	130	122.0	114.3	106.9	103.9	101.3	100.2	139	142	143	147	149	152
	SDC	898	1,039	1,074	1,171	1,261	1,334	1,387	1,430			122.0	114.3	106.9	103.9	101.3	100.2	147	150	151	155	157	161
	Survey	898	1,317	1,422	1,550	1,669	1,766	1,836	1,893			112.1	104.7	96.8	93.8	91.4	90.3	179	182	181	186	188	192
	Forecast	898		1,124	1,243	1,294	1,391	1,501	1,581			122.0	114.3	106.9	103.9	101.3	100.2	154	159	155	162	170	177
	Proposed	898		1,124	1,243	1,294	1,391	1,501	1,581			122.0	114.3	106.9	103.9	101.3	100.2	154	159	155	162	170	177
County Other	TWDB	21,423		23,882	26,072	28,090	29,766	30,969	31,984		121	114.7	106.9	100.3	95.8	92.5	91.3	3,068	3,121	3,155	3,194	3,210	3,271
	SDC	21,423	19,707	19,278	21,046	22,675	24,028	24,999	25,818			114.7	106.9	100.3	95.8	92.5	91.3	2,477	2,519	2,547	2,578	2,591	2,640
	Survey	21,423	25,741	26,821	29,280	31,546	33,428	34,780	35,919			81.5	75.3	69.9	65.8	62.8	61.8	2,449	2,470	2,468	2,465	2,446	2,486
	Forecast	21,423		21,313	23,572	24,537	26,375	28,478	29,994			114.7	106.9	100.3	95.8	92.5	91.3	2,738	2,822	2,756	2,830	2,952	3,067
	Proposed	21,423		21,313	23,572	24,537	26,375	28,478	29,994			115.0	111.0	107.0	103.0	99.0	95.0	2,745	2,931	2,941	3,043	3,158	3,192
Municipal Total	TWDB	31,370		35,160	38,348	41,271	43,680	45,394	46,810									5,230	5,352	5,433	5,551	5,608	5,724
	Forecast	31,370	30,710	33,215	36,733	38,236	41,102	44,379	46,742									5,021	5,213	5,120	5,317	5,583	5,821
	Proposed	**31,370**		**33,215**	**36,733**	**38,236**	**41,102**	**44,379**	**46,742**									**5,067**	**5,365**	**5,354**	**5,583**	**5,846**	**6,001**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Upshur	TWDB	1,928	1,928	1,928	1,928	1,928	1,928
	Modified						
	Proposed	1,928	1,928	1,928	1,928	1,928	1,928

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Upshur	TWDB	1	1	1	1	1	0
	Modified						
	Proposed	1	1	1	1	1	0

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Upshur	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Upshur	TWDB	0	0	0	0	0	0
	Modified		5,601	5,601	5,601	5,601	5,601
	Proposed	0	5,601	5,601	5,601	5,601	5,601

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Upshur	TWDB	215	232	241	243	277	314
	Modified						
	Proposed	215	232	241	243	277	314

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Van Zandt County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

		POPULATION								PER CAPITA USE (gal/per/day)		PROJECTED PER CAPITA USE (Expected Case Conservation)						MUNICIPAL WATER DEMAND (AF)					
City	Scenario	1990	1998	2000	2010	2020	2030	2040	2050	1996 TWDB Reported	2000 TWDB Projected	2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	2000	2010	2020	2030	2040	2050
Canton	TWDB	2,949		3,406	3,685	3,861	3,813	3,666	3,508	169	183	174.0	165.0	157.0	154.1	149.0	148.9	664	681	679	658	612	585
	SDC	2,949	3,466	3,595	3,890	4,076	4,025	3,870	3,703			174.0	165.0	157.0	154.1	149.0	148.9	701	719	717	695	646	618
	Survey	2,949	3,820	4,038	4,368	4,577	4,520	4,346	4,159			233.8	223.1	213.8	211.0	205.8	205.5	1,057	1,091	1,096	1,068	1,002	957
	Forecast	2,949		3,559	4,094	4,628	5,163	5,698	6,232			174.0	165.0	157.0	154.1	149.0	148.9	694	757	814	891	951	1,039
	Proposed	2,949		3,559	4,094	4,628	5,163	5,698	6,232			174.0	165.0	157.0	154.1	149.0	148.9	694	757	814	891	951	1,039
Edgewood	TWDB	1,284		1,477	1,597	1,674	1,653	1,589	1,520	103	128	120.9	112.9	107.2	103.2	98.9	99.3	200	202	201	191	176	169
	SDC	1,284	1,546	1,612	1,742	1,826	1,804	1,734	1,658			120.9	112.9	107.2	103.2	98.9	99.3	218	220	219	208	192	184
	Survey	1,284	1,669	1,765	1,909	2,001	1,976	1,899	1,817			145.4	136.7	130.6	126.6	122.3	122.7	287	292	293	280	260	250
	Forecast	1,284		1,588	1,826	2,064	2,303	2,541	2,780			120.9	112.9	107.2	103.2	98.9	99.3	215	231	248	266	281	309
	Proposed	1,284		1,588	1,826	2,064	2,303	2,541	2,780			120.9	112.9	107.2	103.2	98.9	99.3	215	231	248	266	281	309
Grand Saline	TWDB	2,630		2,907	3,145	3,296	3,254	3,129	2,994	141	182	172.9	164.1	156.0	153.1	148.9	149.1	563	578	576	558	522	500
	SDC	2,630	2,931	3,006	3,252	3,409	3,365	3,236	3,096			172.9	164.1	156.0	153.1	148.9	149.1	582	598	596	577	540	517
	Survey	2,630	2,673	2,684	2,903	3,043	3,004	2,889	2,764			189.4	180.3	171.8	169.1	164.8	165.1	569	586	586	569	533	511
	Forecast	2,630		3,010	3,462	3,914	4,366	4,818	5,270			172.9	164.1	156.0	153.1	148.9	149.1	583	636	684	749	804	880
	Proposed	2,630		3,010	3,462	3,914	4,366	4,818	5,270			172.9	164.1	156.0	153.1	148.9	149.1	583	636	684	749	804	880
Van	TWDB	1,854		2,124	2,298	2,408	2,378	2,286	2,187	215	212	202.2	192.7	184.3	181.0	176.9	176.8	481	496	497	482	453	433
	SDC	1,854	2,196	2,282	2,468	2,587	2,554	2,456	2,282			202.2	192.7	184.3	181.0	176.9	176.8	517	533	534	518	487	452
	Survey	1,854	2,809	3,048	3,297	3,456	3,412	3,280	3,139			203.3	193.5	185.1	181.8	177.8	177.4	694	715	717	695	653	624
	Forecast	1,854		2,255	2,594	2,932	3,271	3,610	3,949			202.2	192.7	184.3	181.0	176.9	176.8	511	560	605	663	715	782
	Proposed	1,854		2,255	2,594	2,932	3,271	3,610	3,949			202.2	192.7	184.3	181.0	176.9	176.8	511	560	605	663	715	782
Wills Point	TWDB	2,986		3,347	3,624	3,802	3,757	3,614	3,476	110	159	150.2	142.1	134.1	130.0	126.0	126.1	563	577	571	547	510	491
	SDC	2,986	3,412	3,519	3,807	3,989	3,939	3,787	3,623			150.2	142.1	134.1	130.0	126.0	126.1	592	606	599	573	534	512
	Survey	2,986	4,609	5,015	5,426	5,685	5,614	5,397	5,015			93.9	86.2	78.1	74.0	70.1	70.1	528	524	497	465	424	394
	Forecast	2,986		3,504	4,030	4,556	5,083	5,609	6,135			150.2	142.1	134.1	130.0	126.0	126.1	589	642	684	740	792	867
	Proposed	2,986		3,504	4,030	4,556	5,083	5,609	6,135			150.2	142.1	134.1	130.0	126.0	126.1	589	642	684	740	792	867
County Other	TWDB	26,241		29,190	31,573	33,082	32,665	31,400	30,028		111	104.1	96.9	90.9	86.8	82.9	83.0	3,403	3,428	3,367	3,177	2,917	2,792
	SDC	26,241	29,640	30,490	33,013	34,635	34,225	32,922	31,665			104.1	96.9	90.9	86.8	82.9	83.0	3,555	3,584	3,525	3,329	3,058	2,944
	Survey	26,241	33,841	35,741	38,699	40,600	40,119	38,592	37,119			85.3	78.9	73.2	69.2	65.2	65.2	3,416	3,418	3,330	3,108	2,817	2,710
	Forecast	26,241		30,436	35,008	39,582	44,152	48,724	53,295			104.1	96.9	90.9	86.8	82.9	83.0	3,548	3,801	4,029	4,294	4,526	4,955
	Proposed	26,241		30,436	35,008	39,582	44,152	48,724	53,295			115.0	111.0	107.0	103.0	99.0	95.0	3,921	4,353	4,744	5,094	5,403	5,671
Municipal Total	TWDB	37,944		42,451	45,922	48,123	47,520	45,684	43,713									5,874	5,962	5,891	5,613	5,190	4,970
	Forecast	37,944	43,191	44,352	51,014	57,676	64,338	71,000	77,661									6,140	6,626	7,064	7,603	8,070	8,832
	Proposed	**37,944**		**44,352**	**51,014**	**57,676**	**64,338**	**71,000**	**77,661**									**6,513**	**7,179**	**7,779**	**8,403**	**8,946**	**9,548**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

		LIVESTOCK WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Van Zandt	TWDB	2,381	2,381	2,381	2,381	2,381	2,381
	Modified						
	Proposed	2,381	2,381	2,381	2,381	2,381	2,381

MINING

		MINING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Van Zandt	TWDB	1,359	1,167	1,099	1,077	1,084	1,115
	Modified						
	Proposed	1,359	1,167	1,099	1,077	1,084	1,115

IRRIGATION

		IRRIGATION WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Van Zandt	TWDB	50	50	50	50	50	50
	Modified	220	220	220	220	220	220
	Proposed	220	220	220	220	220	220

STEAM ELECTRIC

		STEAM ELECTRIC WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Van Zandt	TWDB	0	0	0	0	0	0
	Modified						
	Proposed	0	0	0	0	0	0

MANUFACTURING

		MANUFACTURING WATER DEMAND (AF)					
County	Scenario	2000	2010	2020	2030	2040	2050
Van Zandt	TWDB	280	344	396	451	508	566
	Modified						
	Proposed	280	344	396	451	508	566

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

Wood County Summary - Population and Municipal Water Demand Projections

MUNICIPAL

City	Scenario	POPULATION 1990	1998	2000	2010	2020	2030	2040	2050	PER CAPITA USE (gal/per/day) 1996 TWDB Reported	2000 TWDB Projected	PROJECTED PER CAPITA USE (Expected Case Conservation) 2000 Proj.	2010 Proj.	2020 Proj.	2030 Proj.	2040 Proj.	2050 Proj.	MUNICIPAL WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Hawkins	TWDB	1,309		1,474	1,590	1,663	1,647	1,552	1,386	101	160	150.8	142.1	134.2	131.2	126.0	126.9	249	253	250	242	219	197
	SDC	1,309	1,422	1,450	1,564	1,636	1,620	1,527	1,364			150.8	142.1	134.2	131.2	126.0	126.9	245	249	246	238	215	194
	Survey	1,309	1,477	1,519	1,639	1,714	1,697	1,599	1,428			76.0	69.4	63.4	60.0	55.4	56.0	129	127	122	114	99	90
	Forecast	1,309		1,447	1,632	1,817	2,002	2,187	2,372			150.8	142.1	134.2	131.2	126.0	126.9	244	260	273	294	309	337
	Proposed	1,309		1,447	1,632	1,817	2,002	2,187	2,372			150.8	142.1	134.2	131.2	126.0	126.9	244	260	273	294	309	337
Mineola	TWDB	4,321		4,858	5,239	5,480	5,426	5,115	4,566	176	169	160.1	152.0	144.0	141.0	136.0	136.1	871	892	884	857	779	696
	SDC	4,321	4,756	4,865	5,246	5,488	5,434	5,122	4,572			160.1	152.0	144.0	141.0	136.0	136.1	872	893	885	858	780	697
	Survey	4,321	4,923	5,074	5,471	5,723	5,667	5,342	4,769			155.1	147.2	139.4	136.4	131.4	131.5	882	902	894	866	786	702
	Forecast	4,321		4,838	5,457	6,076	6,695	7,314	7,933			160.1	152.0	144.0	141.0	136.0	136.1	867	929	980	1,057	1,114	1,209
	Proposed	4,321		4,838	5,457	6,076	6,695	7,314	7,933			160.1	152.0	144.0	141.0	136.0	136.1	867	929	980	1,057	1,114	1,209
Quitman	TWDB	1,684		1,897	2,046	2,140	2,119	1,998	1,783	160	195	185.9	178.0	170.2	166.0	162.2	162.2	395	408	408	394	363	324
	SDC	1,684	1,849	1,890	2,039	2,132	2,111	1,991	1,777			185.9	178.0	170.2	166.0	162.2	162.2	394	407	406	393	362	323
	Survey	1,684	2,258	2,402	2,590	2,709	2,683	2,529	2,257			162.6	155.0	147.8	143.4	139.8	139.9	437	450	449	431	396	354
	Forecast	1,684		1,881	2,122	2,362	2,603	2,844	3,084			185.9	178.0	170.2	166.0	162.2	162.2	392	423	450	484	517	560
	Proposed	1,684		1,881	2,122	2,362	2,603	2,844	3,084			185.9	178.0	170.2	166.0	162.2	162.2	392	423	450	484	517	560
Winnsboro	TWDB	2,233		2,483	2,677	2,801	2,773	2,614	2,333	155	176	167.9	160.1	153.0	149.1	145.8	145.0	467	480	480	463	427	379
	SDC	2,233	2,578	2,664	2,872	3,005	2,975	2,805	2,503			167.9	160.1	153.0	149.1	145.8	145.0	501	515	515	497	458	407
	Survey	2,233	2,837	2,988	3,221	3,371	3,337	3,146	2,807			203.4	195.1	186.7	183.2	179.5	179.0	681	704	705	685	633	563
	Forecast	2,233		2,623	2,958	3,294	3,629	3,965	4,300			167.9	160.1	153.0	149.1	145.8	145.0	493	530	564	606	648	699
	Proposed	2,233		2,623	2,958	3,294	3,629	3,965	4,300			167.9	160.1	153.0	149.1	145.8	145.0	493	530	564	606	648	699
County Other	TWDB	19,833		22,163	23,902	25,001	24,755	23,334	20,830		135	126.6	118.2	110.9	108.0	103.3	104.9	3,142	3,164	3,106	2,994	2,699	2,448
	SDC	19,833	22,130	22,704	24,486	25,612	25,360	23,904	21,339			126.6	118.2	110.9	108.0	103.3	104.9	3,219	3,241	3,182	3,067	2,765	2,508
	Survey	19,833	33,793	37,283	40,208	42,057	41,643	39,253	35,041			88.8	82.0	75.8	72.6	67.8	68.6	3,710	3,693	3,571	3,384	2,982	2,694
	Forecast	19,833		22,513	25,393	28,273	31,153	34,032	36,914			126.6	118.2	110.9	108.0	103.3	104.9	3,192	3,361	3,513	3,768	3,936	4,338
	Proposed	19,833		22,513	25,393	28,273	31,153	34,032	36,914			126.6	118.2	110.9	108.0	103.3	104.9	3,192	3,361	3,513	3,768	3,936	4,338
Municipal Total	TWDB	29,380		32,875	35,454	37,085	36,720	34,613	30,898									5,124	5,197	5,128	4,950	4,487	4,044
	Forecast	29,380	32,735	33,302	37,562	41,822	46,082	50,342	54,603									5,188	5,503	5,780	6,209	6,524	7,143
	Proposed	**29,380**		**33,302**	**37,562**	**41,822**	**46,082**	**50,342**	**54,603**									**5,188**	**5,503**	**5,780**	**6,209**	**6,524**	**7,143**

TWDB scenario refers to the State's default projections; Proposed scenario includes expected case conservation savings.

LIVESTOCK

County	Scenario	LIVESTOCK WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Wood	TWDB	2,562	2,562	2,562	2,562	2,562	2,562
	Modified						
	Proposed	2,562	2,562	2,562	2,562	2,562	2,562

MINING

County	Scenario	MINING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Wood	TWDB	2,102	17,584	17,344	17,107	16,107	4,641
	Modified						
	Proposed	2,102	17,584	17,344	17,107	16,107	4,641

IRRIGATION

County	Scenario	IRRIGATION WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Wood	TWDB	354	354	354	354	354	354
	Modified						
	Proposed	354	354	354	354	354	354

STEAM ELECTRIC

County	Scenario	STEAM ELECTRIC WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Wood	TWDB	0	7,500	7,500	7,500	7,500	15,000
	Modified						
	Proposed	0	7,500	7,500	7,500	7,500	15,000

MANUFACTURING

County	Scenario	MANUFACTURING WATER DEMAND (AF) 2000	2010	2020	2030	2040	2050
Wood	TWDB	48	57	67	77	92	107
	Modified	244	290	341	391	468	544
	Proposed	244	290	341	391	468	544

Notes: - For population projections - TWDB scenario refers to projections provided by the TWDB;
Modified scenario uses a year 2000 population extrapolated based on observed growth from 1990 to 1998 (SDC) and TWDB furnished decade growth rates;
Proposed scenario chooses the higher of the two population projections.

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
	BOWIE																			
1	Burns-Redbank WSC	1243	1150	1751	1952	2153	2354	2555	153.3	143.5	136	131.7	128.5	127.3	197	281	297	318	339	364
2	Central Bowie WSC	4792	4434	4823	7212	7601	8990	12379	153.3	143.5	136	131.7	128.5	127.3	761	775	1099	1121	1294	1765
3	Cody's Mobile Home Park	78	72	79	80	80	80	80	153.3	143.5	136	131.7	128.5	127.3	12	13	12	12	12	11
4	El Chaparral Mobile Home Park	158	146	159	160	160	160	160	153.3	143.5	136	131.7	128.5	127.3	25	26	24	24	23	23
5	Federal Correction Institute	1450	1342	1459	1577	1695	1813	1930	153.3	143.5	136	131.7	128.5	127.3	230	235	240	250	261	275
6	Macedonia-Eylau M.U.D. #1	4043	3741	5392	6597	7804	9114	9900	153.3	143.5	136	131.7	128.5	127.3	642	867	1005	1151	1312	1412
7	Oak Grove WSC (P-Red River)	566	524	664	804	944	1084	1224	153.3	143.5	136	131.7	128.5	127.3	90	107	122	139	156	175
8	Park Terrace Mobile Home Park	10	9	10	11	12	13	13	153.3	143.5	136	131.7	128.5	127.3	2	2	2	2	2	2
9	Plattners Mobile Home Park	251	232	253	260	260	260	260	153.3	143.5	136	131.7	128.5	127.3	40	41	40	38	37	37
10	Woodland Estates	65	60	65	71	76	81	87	153.3	143.5	136	131.7	128.5	127.3	10	10	11	11	12	12
11	DeKalb, City of	192	178	300	500	700	800	900	153.3	143.5	136	131.7	128.5	127.3	31	48	76	103	115	128
12	Redwater, City of	1363	1261	1372	1482	2593	3204	3814	153.3	143.5	136	131.7	128.5	127.3	217	221	226	383	461	544
13	Self Supplied	18809	17402	16906	15207	14518	13324	10656	153.3	143.5	136	131.7	128.5	127.3	2988	2717	2319	2142	1919	1521
14	**TOTAL COUNTY OTHER**	**33020**	**30551**	**33233**	**35913**	**38596**	**41277**	**43958**							**5245**	**5343**	**5473**	**5694**	**5943**	**6269**
15																				
16	**CAMP**																			
17	Bi-County WSC (P-Titus, Upshur, Morris)	4240	4442	6247	6583	6917	7251	7585	115	111	107	103	99	95	572	777	790	797	803	806
18	Cherokee Point Water Company	78	81	113	119	125	132	138	115	111	107	103	99	95	10	14	14	14	15	15
19	HAB WSC	101	105	146	154	162	170	178	115	111	107	103	99	95	14	18	18	19	19	19
20	Newsome WSC	324	338	487	533	561	596	672	115	111	107	103	99	95	44	61	64	65	66	72
21	Thunderbird Water Services	521	544	755	796	858	899	920	115	111	107	103	99	95	70	94	95	99	100	98
22	Woodland Harbor	203	120	120	120	120	120	120	115	111	107	103	99	95	15	15	14	14	13	13
23	Sharon WSC (P-Wood, Upshur)	53	55	94	101	105	124	130	115	111	107	103	99	95	7	12	12	12	14	14
24	Pittsburg, City of	306	320	444	468	492	516	540	115	111	107	103	99	95	41	55	56	57	57	57
25	Self Supplied (1990)	298	390	472	488	504	520	528	115	111	107	103	99	95	51	58	58	59	58	56
26	**TOTAL COUNTY OTHER**	**6124**	**6395**	**8878**	**9362**	**9844**	**10328**	**10811**							**824**	**1104**	**1121**	**1136**	**1145**	**1150**
27																				
28	**CASS**																			
29	Avinger, City of	744	673	863	1053	1243	1433	1623	115	111	107	103	99	95	87	107	126	143	159	173
30	Bloomberg WSC	600	543	703	863	1023	1183	1343	115	111	107	103	99	95	70	87	103	118	131	143
31	Domino, City of	224	203	323	443	563	683	803	115	111	107	103	99	95	26	40	53	65	76	85
32	Douglassville, City of	185	167	170	173	176	179	182	115	111	107	103	99	95	22	21	21	20	20	19
33	Green Hills Subdivision	84	76	76	76	76	76	76	115	111	107	103	99	95	10	9	9	9	8	8
34	Holly Springs WSC (P-Morris)	635	574	854	1134	1414	1694	1974	115	111	107	103	99	95	74	106	136	163	188	210
35	Linden-Kildare High School	70	63	73	83	93	103	113	115	111	107	103	99	95	8	9	10	11	11	12
36	Linden-Kildare Junior High School	70	63	73	83	93	103	113	115	111	107	103	99	95	8	9	10	11	11	12
37	Marietta WSC	329	298	378	458	538	618	698	115	111	107	103	99	95	38	47	55	62	69	74
38	McLeod WSC	243	220	270	320	370	420	470	115	111	107	103	99	95	28	34	38	43	47	50
39	McLeod Independent School Dist.	97	88	98	108	118	128	138	115	111	107	103	99	95	11	12	13	14	14	15
40	Sherwood Addition	39	35	35	35	35	35	35	115	111	107	103	99	95	5	4	4	4	4	4
41	Spring Valley Subdivision	39	35	35	35	35	35	35	115	111	107	103	99	95	5	4	4	4	4	4
42	Atlanta State Recreation Area	37	33	33	33	33	33	33	115	111	107	103	99	95	4	4	4	4	4	4
43	Whispering Pines Mobile Home Park	91	82	82	82	82	82	82	115	111	107	103	99	95	11	10	10	9	9	9
44	Whispering Pines Subdivision	55	50	50	50	50	50	50	115	111	107	103	99	95	6	6	6	6	6	5
45	East Marion County WSC (P-Marion)	271	245	265	285	305	325	345	115	111	107	103	99	95	32	33	34	35	36	37
46	Mims WSC (P-Marion, Morris)	232	210	290	370	450	530	610	115	111	107	103	99	95	27	36	44	52	59	65

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	2000	2010	2020	2030	2040	2050	2000	2010	2020	2030	2040	2050	2000	2010	2020	2030	2040	2050
47	Atlanta, City of	52	47	47	47	47	47	47	115	111	107	103	99	95	6	6	6	5	5	5
48	Hughes Springs, City of (P-Morris)	39	35	55	75	95	115	135	115	111	107	103	99	95	5	7	9	11	13	14
49	Queen City, City of	94	85	135	185	235	285	335	115	111	107	103	99	95	11	17	22	27	32	36
50	Self Supplied (1990)	16962	15347	15747	16329	16931	17665	18397	115	111	107	103	99	95	1976	1960	1958	1954	1958	1957
51	**TOTAL COUNTY OTHER**	**21192**	**19172**	**20655**	**22320**	**24005**	**25822**	**27637**							**2470**	**2568**	**2675**	**2770**	**2864**	**2941**
52																				
53	**DELTA**																			
54	Ben Franklin WSC	228	241	241	241	241	241	241	120	116	112	108	104	100	32	31	30	29	28	27
55	Charleston WSC	992	1051	1075	1078	1082	1085	1094	120	116	112	108	104	100	141	140	135	131	126	123
56	Enloe-Lake Creek WSC	434	460	480	480	480	480	480	120	116	112	108	104	100	62	62	60	58	56	54
57	Lone Star WSC (P-Hunt)	190	201	201	201	201	201	201	120	116	112	108	104	100	27	26	25	24	23	23
58	Pecan Gap, City of	270	286	286	286	286	286	286	120	116	112	108	104	100	38	37	36	35	33	32
59	West Delta WSC	1076	1139	1158	1158	1158	1158	1158	120	116	112	108	104	100	154	150	145	140	135	128
60	North Hunt WSC (P-Hunt)	269	285	285	285	285	285	285	120	116	112	108	104	100	38	37	36	34	33	32
61	Self Supplied	77	82	19	16	12	9	0	120	116	112	108	104	100	11	4	3	2	2	0
62	**TOTAL COUNTY OTHER**	**3536**	**3745**	**3745**	**3745**	**3745**	**3745**	**3745**							**503**	**487**	**470**	**453**	**436**	**419**
63																				
64	**FRANKLIN**																			
65	Deer Cove POA WS	33	29	34	34	34	34	34	201	190.9	183	179	177	176	7	7	7	7	7	7
66	Pelican Bay	368	324	379	379	379	379	379	201	190.9	183	179	177	176	73	81	78	76	75	75
67	Cypress Springs WSC (P-Titus, Hopkins, Wood)	5133	4520	5790	7060	8188	8759	9372	201	190.9	183	179	177	176	1018	1238	1447	1642	1737	1847
68	Tri WSC (P-Titus, Morris)	209	184	224	264	304	344	384	201	190.9	183	179	177	176	41	48	54	61	68	76
69	Self Supplied	884	778	399	68	0	0	0	201	190.9	183	179	177	176	175	86	14	0	0	0
70	**TOTAL COUNTY OTHER**	**6627**	**5835**	**6826**	**7805**	**8905**	**9516**	**10169**							**1314**	**1460**	**1600**	**1786**	**1887**	**2005**
71																				
72	**GREGG**																			
73	C & C Mobile Home Park	84	64	64	64	64	64	64	126.9	119.2	110.5	112	109.3	110.4	9	9	8	8	8	8
74	E-J Water Company	384	294	294	294	294	294	294	126.9	119.2	110.5	112	109.3	110.4	42	39	36	37	36	36
75	Elderville WSC	4037	3096	3846	4596	5346	6096	6846	126.9	119.2	110.5	112	109.3	110.4	439	512	567	672	748	846
76	Forest Lake Estates of Longview	271	208	208	208	208	208	208	126.9	119.2	110.5	112	109.3	110.4	30	28	26	26	25	26
77	Garden Acres Subdivision	123	94	94	94	94	94	94	126.9	119.2	110.5	112	109.3	110.4	13	13	12	12	12	12
78	Gregg County Airport	0	0	0	0	0	0	0	126.9	119.2	110.5	112	109.3	110.4	0	0	0	0	0	0
79	Liberty-Danville FWSD 2	486	373	493	613	733	853	973	126.9	119.2	110.5	112	109.3	110.4	53	66	76	92	104	120
80	Sabine ISD	271	208	208	208	208	208	208	126.9	119.2	110.5	112	109.3	110.4	30	28	26	26	25	26
81	Sun Acres Mobile Home Park	123	94	94	94	94	94	94	126.9	119.2	110.5	112	109.3	110.4	13	13	12	12	12	12
82	Tyron Road WSC (P-Harrison)	3548	2720	3720	4720	5720	6720	7720	126.9	119.2	110.5	112	109.3	110.4	387	497	584	718	823	955
83	Warren City, City of	287	220	270	320	370	420	470	126.9	119.2	110.5	112	109.3	110.4	31	36	40	46	51	58
84	West Gregg WSC (P-Smith, Rusk)	1988	1524	1924	2324	2724	3124	3524	126.9	119.2	110.5	112	109.3	110.4	217	257	288	342	382	436
85	Starrville-Friendship WSC (P-Smith)	443	340	440	540	640	740	840	126.9	119.2	110.5	112	109.3	110.4	48	59	67	80	91	104
86	Glenwood WSC (P-Upshur)	100	77	107	137	167	197	227	126.9	119.2	110.5	112	109.3	110.4	11	14	17	21	24	28
87	East Mountain, City of (P-Upshur)	305	234	344	454	564	674	784	126.9	119.2	110.5	112	109.3	110.4	33	46	56	71	83	97
88	Clarksville City, City of	26	20	30	40	50	60	70	126.9	119.2	110.5	112	109.3	110.4	3	4	5	6	7	9
89	Gladewater, City of (P-Upshur)	128	98	108	118	128	138	148	126.9	119.2	110.5	112	109.3	110.4	14	14	15	16	17	18
90	Kilgore, City of (P-Rusk)	256	196	246	296	346	396	446	126.9	119.2	110.5	112	109.3	110.4	28	33	37	43	48	55
91	Liberty City WSC (P-Smith)	2304	1766	2196	2626	3056	3486	3916	126.9	119.2	110.5	112	109.3	110.4	251	293	325	383	427	484
92	White Oak, City of (P-Upshur)	51	39	49	59	69	79	89	126.9	119.2	110.5	112	109.3	110.4	6	7	7	9	10	11
93	Self Supplied	3502	2685	2254	1385	965	947	581	126.9	119.2	110.5	112	109.3	110.4	382	301	171	121	116	72

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
94	**TOTAL COUNTY OTHER**	**18717**	**14350**	**16989**	**19190**	**21840**	**24892**	**27596**							**2040**	**2269**	**2375**	**2741**	**3049**	**3413**
95																				
96	**HARRISON**																			
97	Big Oaks Mobile Home Park	610	475	475	475	475	475	475	120	116	112	108	104	100	64	62	60	57	55	53
98	Blocker-Crossroads WSC	870	677	877	1077	1277	1477	1677	120	116	112	108	104	100	91	114	135	154	172	188
99	Caddo Lake WSC	1076	838	998	1158	1318	1478	1638	120	116	112	108	104	100	113	130	145	159	172	183
100	Cypress Valley WSC	976	760	1030	1300	1570	1840	2110	120	116	112	108	104	100	102	134	163	190	214	236
101	Elysian Fields WSC (P-Panola)	580	452	532	612	692	772	852	120	116	112	108	104	100	61	69	77	84	90	95
102	Gill WSC (P-Panola)	1642	1278	1438	1598	1758	1918	2078	120	116	112	108	104	100	172	187	200	213	223	233
103	Gum Springs WSC	6444	5016	6546	8076	9606	11136	12666	120	116	112	108	104	100	673	849	1012	1164	1299	1419
104	Harleton WSC (P-Marion)	2054	1599	2249	2899	3549	4199	4849	120	116	112	108	104	100	215	292	364	429	489	543
105	Holiday Springs Mobile Home Park	87	68	68	68	68	68	68	120	116	112	108	104	100	9	9	9	8	8	8
106	Karnack WSC	596	464	464	464	464	464	464	120	116	112	108	104	100	62	60	58	56	54	52
107	Leigh WSC	3138	1610	1790	1970	2150	2330	2510	120	116	112	108	104	100	216	233	247	260	271	281
108	North Harrison WSC	894	696	906	1116	1326	1536	1746	120	116	112	108	104	100	94	118	140	160	179	196
109	Pinehill Mobile Home Park	190	148	148	148	148	148	148	120	116	112	108	104	100	20	19	19	18	17	17
110	Rolling Acres MHP and Subdivision	89	69	69	69	69	69	69	120	116	112	108	104	100	9	9	9	8	8	8
111	Scottsville, City of	751	585	585	585	585	585	585	120	116	112	108	104	100	79	76	73	71	68	66
112	Shadowood Water Company	203	158	158	158	158	158	158	120	116	112	108	104	100	21	21	20	19	18	18
113	Talley WSC	1434	1116	1286	1456	1626	1796	1966	120	116	112	108	104	100	150	167	183	197	209	220
114	Caddo Lake State Park	201	156	156	156	156	156	156	120	116	112	108	104	100	21	20	20	19	18	17
115	Waskom Rural WSC #1	650	506	746	986	1226	1466	1706	120	116	112	108	104	100	68	97	124	148	171	191
116	West Harrison WSC	1184	922	1132	1342	1552	1762	1972	120	116	112	108	104	100	124	147	168	188	205	221
117	Tyron Road WSC (P-Gregg)	417	325	465	605	745	885	1025	120	116	112	108	104	100	44	60	76	90	103	115
118	Diana WSC (P-Upshur, Marion)	264	206	276	346	416	486	556	120	116	112	108	104	100	28	36	43	50	57	62
119	Waskom, City of	528	411	451	491	531	571	611	120	116	112	108	104	100	55	59	62	64	67	68
120	Self Supplied	12824	10817	9427	7198	5258	3449	1560	120	116	112	108	104	100	1454	1225	903	636	402	175
121	**TOTAL COUNTY OTHER**	**37702**	**29352**	**32272**	**34353**	**36723**	**39224**	**41645**							**3945**	**4193**	**4310**	**4442**	**4569**	**4665**
122																				
123	**HOPKINS**																			
124	Brashear WSC	808	754	774	794	814	834	854	149.3	142.3	135.3	131.3	127.4	126.4	126	123	120	120	119	121
125	Brinker WSC	1684	1572	1672	1772	1872	1972	2077	149.3	142.3	135.3	131.3	127.4	126.4	263	267	269	275	281	294
126	Cornersville WSC	813	759	809	859	909	959	1009	149.3	142.3	135.3	131.3	127.4	126.4	127	129	130	134	137	143
127	Gafford Chapel WSC	1018	950	1155	1398	1590	1783	1976	149.3	142.3	135.3	131.3	127.4	126.4	159	184	212	234	254	280
128	Martin Springs WSC	2486	2320	2570	2820	3070	3244	3395	149.3	142.3	135.3	131.3	127.4	126.4	388	410	427	452	463	481
129	Miller Grove WSC (P-Rains, Hunt)	952	888	988	1088	1188	1288	1388	149.3	142.3	135.3	131.3	127.4	126.4	149	157	165	175	184	197
130	North Hopkins WSC	4584	4278	4878	5478	6078	6678	7278	149.3	142.3	135.3	131.3	127.4	126.4	713	778	831	893	954	1030
131	Pickton WSC	539	503	558	612	667	721	776	149.3	142.3	135.3	131.3	127.4	126.4	84	89	93	98	103	110
132	Pleasant Hill WSC #2	181	169	187	206	224	242	261	149.3	142.3	135.3	131.3	127.4	126.4	28	30	31	33	35	37
133	Shady Grove #2 WSC	461	430	477	524	570	617	664	149.3	142.3	135.3	131.3	127.4	126.4	72	76	79	84	88	94
134	Shirley WSC (P-Rains)	1104	1030	1150	1270	1390	1510	1630	149.3	142.3	135.3	131.3	127.4	126.4	172	183	192	204	215	231
135	Jones WSC (P-Wood)	36	34	37	41	45	48	52	149.3	142.3	135.3	131.3	127.4	126.4	6	6	6	7	7	7
136	Cypress Springs WSC (P-Franklin, Titus, Wood)	925	863	1013	1163	1313	1463	1613	149.3	142.3	135.3	131.3	127.4	126.4	144	161	176	193	209	228
137	Cash WSC (P-Rains, Hunt, Rockwall)	330	308	348	388	428	468	508	149.3	142.3	135.3	131.3	127.4	126.4	52	55	59	63	67	72
138	Lake Fork WSC (P-Wood)	67	63	69	76	83	90	96	149.3	142.3	135.3	131.3	127.4	126.4	11	11	12	12	13	14
139	Self Supplied	389	363	258	112	18	0	0	149.3	142.3	135.3	131.3	127.4	126.4	61	41	17	3	0	0
140	**TOTAL COUNTY OTHER**	**16377**	**15284**	**16943**	**18601**	**20259**	**21917**	**23577**							**2555**	**2700**	**2819**	**2980**	**3129**	**3339**

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
141																				
142	**HUNT**																			
143	BHP WSC (P-Rockwall)	1734	1614	1926	2282	2612	3031	2978	115	111	107	103	99	95	208	239	274	301	336	317
144	Cash WSC (P-Hopkins, Rains, Rockwall)	9967	9275	10466	11699	12905	13935	15025	115	111	107	103	99	95	1191	1302	1400	1492	1544	1600
145	Community Water Co.-Rolling Hills (P-Rains)	765	712	765	765	765	765	765	115	111	107	103	99	95	92	95	92	88	85	81
146	Tri County Water Corp.-Country Wood Estates	117	109	117	117	117	117	117	115	111	107	103	99	95	14	15	14	13	13	12
147	Texas A&M University-Commerce	773	719	773	773	773	773	773	115	111	107	103	99	95	93	96	93	89	86	82
148	Combined Consumers WSC (FLH)	47	44	47	47	47	47	47	115	111	107	103	99	95	6	6	6	5	5	5
149	Hasco Water Systems Co. Inc.-Coastal Acres	29	27	29	29	29	29	29	115	111	107	103	99	95	3	4	3	3	3	3
150	Hasco Water Systems Co. Inc.-Oakridge Estates	50	47	50	50	50	50	50	115	111	107	103	99	95	6	6	6	6	6	5
151	Hasco Water Systems Co. Inc.-Rockwall E-Mini Rai	73	68	73	73	73	73	73	115	111	107	103	99	95	9	9	9	8	8	8
152	Hickory Creek Special Utility District (P-Collin, Fan	2006	1867	2208	2594	2952	3140	3376	115	111	107	103	99	95	241	275	311	341	348	359
153	Caddo Basin Special Utility District (P-Collin)	4032	5334	6230	6674	7192	8046	8811	115	111	107	103	99	95	687	775	800	830	892	938
154	Jacobia WSC	825	768	778	788	798	808	818	115	111	107	103	99	95	99	97	94	92	90	87
155	Little Creek Acres	204	190	204	204	204	204	204	115	111	107	103	99	95	24	25	24	24	23	22
156	Maloy WSC	368	370	395	490	560	650	740	115	111	107	103	99	95	48	49	59	65	72	79
157	Hasco Water Systems Co. Inc.-M.G.M. Estates	89	83	89	89	89	89	89	115	111	107	103	99	95	11	11	11	10	10	9
158	Combined Consumers WSC (N.H.)	68	63	68	68	68	68	68	115	111	107	103	99	95	8	8	8	8	8	7
159	North Hunt WSC (P-Delta, Fannin)	2268	2111	2352	2594	2835	3370	3816	115	111	107	103	99	95	272	292	311	327	374	406
160	Combined Consumers WSC (Tawakoni) (P-Van Zan	5968	5555	6317	7095	7905	8255	9174	115	111	107	103	99	95	716	785	850	912	915	976
161	Tri County Water Corp.-Barrow Subdivision	235	219	235	235	235	235	235	115	111	107	103	99	95	28	29	28	27	26	25
162	Tri County Water Corp.-Quinlan North Subdivision	131	122	131	131	131	131	131	115	111	107	103	99	95	16	16	16	15	15	14
163	Tri County Water Corp.-Quinlan South Subdivision	97	90	97	97	97	97	97	115	111	107	103	99	95	12	12	12	11	11	10
164	Tri County Water Corp.-Crazy Horse Rancheros	264	246	264	264	264	264	264	115	111	107	103	99	95	32	33	32	30	29	28
165	Tri County Water Corp.-Whiskers Retreat Subdivisio	731	680	731	731	731	731	731	115	111	107	103	99	95	88	91	88	84	81	78
166	West Oaks Phoenix Corporation Water System	91	85	91	91	91	91	91	115	111	107	103	99	95	11	11	11	10	10	10
167	Whispering Oaks Water Co-Op 1 & 2	94	87	94	94	94	94	94	115	111	107	103	99	95	11	12	11	11	10	10
168	Lone Star WSC (P-Delta)	22	20	23	25	28	33	37	115	111	107	103	99	95	3	3	3	3	4	4
169	Macbee WSC (P-Van Zandt, Kaufman)	349	325	362	399	436	520	588	115	111	107	103	99	95	42	45	48	50	58	63
170	Miller Grove WSC (P-Rains, Hopkins)	13	12	13	15	16	20	22	115	111	107	103	99	95	2	2	2	2	2	2
171	Lone Oak, City of (P-Rains)	117	109	121	134	146	174	197	115	111	107	103	99	95	14	15	16	17	19	21
172	Self Supplied	2265	500	0	0	0	0	0	115	111	107	103	99	95	64	0	0	0	0	0
173	**TOTAL COUNTY OTHER**	**33792**	**31451**	**35049**	**38647**	**42243**	**45840**	**49440**							**4051**	**4358**	**4632**	**4874**	**5083**	**5261**
174																				
175	**LAMAR**																			
176	Lamar County Water Supply District (P-Red River)	15004	12559	13764	15124	16085	17052	18021	137.7	129.2	120.8	117.5	114.2	113.1	1937	1992	2045	2116	2182	2283
177	M-J-C WSC	614	514	514	514	514	514	514	137.7	129.2	120.8	117.5	114.2	113.1	79	74	70	68	66	65
178	Pattonville WSC	371	311	316	321	326	331	336	137.7	129.2	120.8	117.5	114.2	113.1	48	46	43	43	42	43
179	Petty WSC	136	114	122	130	137	137	137	137.7	129.2	120.8	117.5	114.2	113.1	18	18	18	18	18	17
180	410 WSC (P-Red River)	38	32	34	36	38	41	43	137.7	129.2	120.8	117.5	114.2	113.1	5	5	5	5	5	5
181	Self Supplied	768	643	400	0	0	0	0	137.7	129.2	120.8	117.5	114.2	113.1	99	58	0	0	0	0
182	**TOTAL COUNTY OTHER**	**16931**	**14173**	**15150**	**16125**	**17100**	**18075**	**19051**							**2186**	**2193**	**2181**	**2250**	**2313**	**2413**
183																				
184	**MARION**																			
185	Ore City (P-Upshur)	34	25	35	45	55	65	75	115	111	107	103	99	95	3	4	5	6	7	8
186	C & C Waterworks	135	101	101	101	101	101	101	115	111	107	103	99	95	13	13	12	12	11	11
187	East Marion WSC (P-Cass)	1325	992	1102	1212	1342	1452	1562	115	111	107	103	99	95	128	137	145	155	161	166

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
188	Mims WSC (P-Cass, Morris)	811	607	877	1147	1417	1687	1957	115	111	107	103	99	95	78	109	137	163	187	208
189	Holiday Harbor WSC	176	132	132	132	132	132	132	115	111	107	103	99	95	17	16	16	15	15	14
190	Indian Hills Subdivision	238	178	178	178	178	178	178	115	111	107	103	99	95	23	22	21	21	20	19
191	Kellyville Berea WSC	777	581	831	1081	1331	1581	1831	115	111	107	103	99	95	75	103	130	154	175	195
192	Pine Harbor	924	692	922	1152	1382	1612	1842	115	111	107	103	99	95	89	115	138	159	179	196
193	Shady Shores	412	308	378	448	518	588	658	115	111	107	103	99	95	40	47	54	60	65	70
194	Tejas Village	54	40	40	40	40	40	40	115	111	107	103	99	95	5	5	5	5	4	4
195	Crestwood	519	388	398	408	418	428	438	115	111	107	103	99	95	50	49	49	48	47	47
196	Harleton WSC (P-Harrison)	279	209	279	349	419	489	559	115	111	107	103	99	95	27	35	42	48	54	59
197	Diana WSC (P-Upshur,Harrison)	203	152	232	312	392	472	552	115	111	107	103	99	95	20	29	37	45	52	59
198	Self Supplied (1990)	5233	3917	3353	2790	2206	1643	1080	115	111	107	103	99	95	504	417	335	255	184	115
199	**TOTAL COUNTY OTHER**	**11120**	**8322**	**8858**	**9395**	**9931**	**10468**	**11005**							**1072**	**1101**	**1126**	**1146**	**1161**	**1171**
200																				
201	**MORRIS**																			
202	Tri WSC (P-Titus, Franklin)	1069	944	994	1044	1094	1144	1194	115	111	107	103	99	95	122	124	125	126	127	127
203	Bi-County WSC (P-Titus, Upshur, Camp)	1004	887	937	987	1037	1087	1137	115	111	107	103	99	95	114	117	118	120	121	121
204	Mims WSC (P-Marion, Cass)	13	11	11	11	11	11	11	115	111	107	103	99	95	1	1	1	1	1	1
205	Holly Springs WSC (P-Cass)	341	301	451	601	751	901	1051	115	111	107	103	99	95	39	56	72	87	100	112
206	Hughes Springs, City of	426	376	416	456	496	536	576	115	111	107	103	99	95	48	52	55	57	59	61
207	Daingerfield, City of	65	57	77	97	117	137	157	115	111	107	103	99	95	7	10	12	13	15	17
208	Self Supplied	4625	4085	3775	3465	3155	2845	2535	115	111	107	103	99	95	527	468	415	365	316	270
209	**TOTAL COUNTY OTHER**	**7543**	**6661**	**6661**	**6661**	**6661**	**6661**	**6661**							**858**	**828**	**798**	**769**	**739**	**709**
210																				
211	**RAINS**																			
212	Cedar Cove Landing	73	57	62	67	72	77	82	164.9	155.8	147.9	143.6	141	139.7	11	11	11	12	12	13
213	South Rains WSC	2171	1708	2054	2398	2742	3079	3401	164.9	155.8	147.9	143.6	141	139.7	316	359	399	441	488	531
214	Bright Star-Salem WSC (P-Wood)	2166	1705	2049	2392	2737	3072	3391	164.9	155.8	147.9	143.6	141	139.7	315	358	396	440	485	531
215	Golden WSC (P-Wood, Van Zandt)	27	21	25	30	34	38	43	164.9	155.8	147.9	143.6	141	139.7	4	4	5	5	6	7
216	Community Water Company (P-Hunt)	131	103	124	145	165	185	204	164.9	155.8	147.9	143.6	141	139.7	19	22	24	27	29	32
217	Cash WSC (P-Hopkins, Hunt, Rockwall)	537	423	507	592	676	759	837	164.9	155.8	147.9	143.6	141	139.7	78	88	98	109	120	131
218	Shirley WSC (P-Hopkins)	462	364	436	509	582	653	720	164.9	155.8	147.9	143.6	141	139.7	67	76	84	94	103	113
219	Miller Grove WSC (P-Hopkins, Hunt)	298	235	281	328	375	421	465	164.9	155.8	147.9	143.6	141	139.7	43	49	54	60	66	73
220	Lone Oak, City of (P-Hunt)	12	9	11	13	16	17	18	164.9	155.8	147.9	143.6	141	139.7	2	2	2	3	3	3
221	Self Supplied	643	506	420	332	244	180	156	164.9	155.8	147.9	143.6	141	139.7	93	73	55	39	28	24
222	**TOTAL COUNTY OTHER**	**6520**	**5131**	**5969**	**6806**	**7643**	**8481**	**9317**							**948**	**1042**	**1128**	**1230**	**1340**	**1458**
223																				
224	**RED RIVER**																			
225	Annona, City of	347	352	352	352	352	352	352	115	111	107	103	99	95	45	44	42	41	39	37
226	Avery, City of	640	650	650	650	650	650	650	115	111	107	103	99	95	84	81	78	75	72	69
227	English, Town of	160	163	161	155	150	145	130	115	111	107	103	99	95	21	20	19	17	16	14
228	Red River WSC	4401	4471	4477	4487	4494	4501	4518	115	111	107	103	99	95	575	557	539	519	500	481
229	410 WSC (P-Lamar)	1803	1931	2131	2331	2331	2331	2331	115	111	107	103	99	95	249	265	279	269	258	248
230	Lamar County WSC (P-Lamar)	52	53	53	53	53	53	53	115	111	107	103	99	95	7	7	6	6	6	6
231	Oak Grove WSC (P-Bowie)	60	61	59	57	55	53	51	115	111	107	103	99	95	8	7	7	6	6	5
232	Deport WSC (P-Lamar)	19	19	19	19	19	19	19	115	111	107	103	99	95	2	2	2	2	2	2
233	Talco, City of (P-Titus)	14	14	12	10	10	10	10	115	111	107	103	99	95	2	1	1	1	1	1
234	Self Supplied (1990)	492	400	200	0	0	0	0	115	111	107	103	99	95	52	25	0	0	0	0

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	2000	2010	2020	2030	2040	2050	2000	2010	2020	2030	2040	2050	2000	2010	2020	2030	2040	2050
235	**TOTAL COUNTY OTHER**	**7988**	**8114**	**8114**	**8114**	**8114**	**8114**	**8114**							**1045**	**1009**	**973**	**936**	**900**	**863**
236																				
237	**SMITH**																			
238	Crystal Systems Texas, Inc.	0	0	0	0	0	0	0	135.8	127.7	120.6	116.6	113.7	112.8	0	0	0	0	0	0
239	Duck Creek WSC (P-Wood)	974	1007	1393	1780	2167	2553	2940	135.8	127.7	120.6	116.6	113.7	112.8	153	199	240	283	325	371
240	Enchanted Lakes Water Co.	420	434	600	768	868	868	868	135.8	127.7	120.6	116.6	113.7	112.8	66	86	104	113	111	110
241	Garden Valley Golf Resort	34	35	40	44	49	53	58	135.8	127.7	120.6	116.6	113.7	112.8	5	6	6	6	7	7
242	Silver Leaf Vacation Club, Inc.	1026	1060	1198	1336	1473	1611	1748	135.8	127.7	120.6	116.6	113.7	112.8	161	171	180	192	205	221
243	Lindale Rural WSC	4996	5164	7147	9130	11114	13098	15079	135.8	127.7	120.6	116.6	113.7	112.8	786	1022	1233	1452	1668	1905
244	Pine Ridge WSC (P-Van Zandt)	1167	1206	1670	2132	2596	3059	3523	135.8	127.7	120.6	116.6	113.7	112.8	183	239	288	339	390	445
245	Smith County WCID 1	974	1007	1393	1780	2167	2553	2940	135.8	127.7	120.6	116.6	113.7	112.8	153	199	240	283	325	371
246	Star Mountain WSC	1180	1220	1688	2156	2624	3094	3562	135.8	127.7	120.6	116.6	113.7	112.8	186	241	291	343	394	450
247	Starrville-Friendship WSC (P-Gregg)	678	701	970	1240	1509	1777	2046	135.8	127.7	120.6	116.6	113.7	112.8	107	139	168	197	226	259
248	Tyler State Park	5	5	6	7	7	8	9	135.8	127.7	120.6	116.6	113.7	112.8	1	1	1	1	1	1
249	Twin Oaks Ranch Water Supply	120	124	172	219	266	314	361	135.8	127.7	120.6	116.6	113.7	112.8	19	25	30	35	40	46
250	Winona, City of	707	731	826	920	1015	1110	1205	135.8	127.7	120.6	116.6	113.7	112.8	111	118	124	133	141	152
251	Ben Wheeler WSC (P-Van Zandt)	16	17	19	21	23	25	27	135.8	127.7	120.6	116.6	113.7	112.8	3	3	3	3	3	3
252	Van, City of (P-Van Zandt)	58	60	68	76	83	91	99	135.8	127.7	120.6	116.6	113.7	112.8	9	10	10	11	12	13
253	R-P-M WSC (P-Upshur, Henderson)	163	168	190	212	234	256	278	135.8	127.7	120.6	116.6	113.7	112.8	26	27	29	31	33	35
254	Liberty City WSC (P-Gregg)	37	38	53	67	82	97	112	135.8	127.7	120.6	116.6	113.7	112.8	6	8	9	11	12	14
255	West Gregg WSC (P-Gregg, Rusk)	742	767	1061	1357	1652	1946	2240	135.8	127.7	120.6	116.6	113.7	112.8	117	152	183	216	248	283
256	Self Supplied	8853	9150	7370	5590	3876	2262	650	135.8	127.7	120.6	116.6	113.7	112.8	1387	1047	751	498	279	74
257	**TOTAL COUNTY OTHER**	**22150**	**22894**	**25864**	**28835**	**31805**	**34775**	**37745**							**3479**	**3693**	**3890**	**4147**	**4420**	**4760**
258																				
259	**TITUS**																			
260	Northeast Texas Community College	0	178	178	178	178	178	178	120	116	112	108	104	100	24	23	22	22	21	20
261	Lake Bob Sandlin State Park	6	5	5	6	6	7	7	120	116	112	108	104	100	1	1	1	1	1	1
262	Tri WSC (P-Franklin, Morris)	9949	7839	10040	11519	12764	14155	15453	120	116	112	108	104	100	1053	1304	1445	1543	1648	1732
263	Winfield, City of (P-Franklin)	567	447	691	825	959	1093	1200	120	116	112	108	104	100	60	90	104	116	127	134
264	Bi-County WSC (P-Camp, Morris, Upshur)	355	280	507	624	881	1005	1022	120	116	112	108	104	100	38	66	78	107	117	114
265	Cypress Springs WSC (P-Franklin, Hopkins, Wood)	98	77	85	93	195	243	280	120	116	112	108	104	100	10	11	12	24	28	31
266	Talco, City of	110	87	96	105	113	160	269	120	116	112	108	104	100	12	12	13	14	19	30
267	Self Supplied	4370	3265	1822	1322	822	322	0	120	116	112	108	104	100	439	237	166	99	38	0
268	**TOTAL COUNTY OTHER**	**15455**	**12178**	**13424**	**14672**	**15918**	**17163**	**18409**							**1637**	**1744**	**1841**	**1926**	**1999**	**2062**
269																				
270	**UPSHUR**																			
271	Ambassador College	65	54	54	54	54	54	54	115	111	107	103	99	95	7	7	6	6	6	6
272	Brookshire's Camp Joy	221	183	183	183	183	183	183	115	111	107	103	99	95	24	23	22	21	20	19
273	Texas Water Systems, Inc.-Country Club Estates	83	69	69	69	69	69	69	115	111	107	103	99	95	9	9	8	8	8	7
274	Diana WSC (P-Marion, Harrison)	3265	2703	3433	4163	4893	5623	6353	115	111	107	103	99	95	348	427	499	565	624	676
275	Texas Water Systems, Inc.-Friendship System-Sys 1	126	104	104	104	104	104	104	115	111	107	103	99	95	13	13	12	12	12	11
276	Texas Water Systems, Inc.-Rosewood System-Sys 2	196	162	162	162	162	162	162	115	111	107	103	99	95	21	20	19	19	18	17
277	Glenwood WSC (P-Gregg)	1993	1650	1970	2290	2610	2930	3250	115	111	107	103	99	95	213	245	274	301	325	346
278	Harmony ISD	242	200	330	460	590	720	850	115	111	107	103	99	95	26	41	55	68	80	90
279	Pritchett WSC (P-Wood)	5598	4635	5645	6655	7665	8675	9685	115	111	107	103	99	95	597	702	798	884	962	1031
280	Union Grove WSC	1977	1637	1977	2317	2657	2997	3337	115	111	107	103	99	95	211	246	278	307	332	355
281	Sharon WSC (P-Wood, Camp)	1696	1404	1534	1664	1794	1924	2054	115	111	107	103	99	95	181	191	199	207	213	219

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
282	Fouke WSC (P-Wood)	46	38	48	58	68	78	88	115	111	107	103	99	95	5	6	7	8	9	9
283	Bi-County WSC (P-Camp, Titus, Morris)	2728	2259	2429	2599	2769	2939	3109	115	111	107	103	99	95	291	302	312	319	326	331
284	White Oak, City of (P-Gregg)	99	82	82	82	82	82	82	115	111	107	103	99	95	11	10	10	9	9	9
285	Warren City, City of (P-Gregg)	35	29	29	29	29	29	29	115	111	107	103	99	95	4	4	3	3	3	3
286	Gladewater, City of (P-Gregg)	135	112	112	112	112	112	112	115	111	107	103	99	95	14	14	13	13	12	12
287	Self Supplied (1990)	7236	5992	5411	3536	2534	1797	473	115	111	107	103	99	95	770	671	426	293	199	51
288	**TOTAL COUNTY OTHER**	**25741**	**21313**	**23572**	**24537**	**26375**	**28478**	**29994**							**2745**	**2931**	**2941**	**3043**	**3158**	**3192**
289																				
290	**VAN ZANDT**																			
291	Texas Water Services, Inc.-Callender Lake Subdivisi	1664	1497	2113	2729	3346	3963	4580	115	111	107	103	99	95	193	263	327	386	439	487
292	Ben Wheeler WSC (P-Smith)	1557	1400	1611	1821	2031	2242	2452	115	111	107	103	99	95	180	200	218	234	249	261
293	Canton North Estates	88	79	91	103	115	127	139	115	111	107	103	99	95	10	11	12	13	14	15
294	Corinth WSC	754	678	958	1237	1517	1796	2074	115	111	107	103	99	95	87	119	148	175	199	221
295	Crooked Creek WSC	601	541	764	986	1208	1431	1653	115	111	107	103	99	95	70	95	118	139	159	176
296	Edom WSC (P-Henderson)	884	795	1122	1450	1777	2105	2433	115	111	107	103	99	95	102	140	174	205	233	259
297	Fruitvale WSC	2584	2324	3282	4239	5196	6153	7111	115	111	107	103	99	95	299	408	508	599	682	757
298	Little Hope-Moore WSC	1425	1282	1810	2338	2865	3394	3922	115	111	107	103	99	95	165	225	280	331	376	417
299	Martins Mill WSC	125	112	158	205	251	298	344	115	111	107	103	99	95	14	20	25	29	33	37
300	Mac Bee WSC (P-Hunt, Kaufman)	6543	5885	6769	7653	8537	9421	10304	115	111	107	103	99	95	758	842	917	985	1045	1096
301	Myrtle Springs WSC	463	416	588	760	931	1103	1274	115	111	107	103	99	95	54	73	91	107	122	136
302	Pruitt-Sandflat WSC	1040	935	1321	1706	2092	2476	2863	115	111	107	103	99	95	120	164	204	241	275	305
303	R-P-M WSC (P-Smith, Henderson)	1302	1171	1347	1523	1699	1875	2050	115	111	107	103	99	95	151	167	183	196	208	218
304	South Tawakoni WSC	3172	2853	4028	5204	6378	7553	8729	115	111	107	103	99	95	368	501	624	736	838	929
305	Tall Oaks Estates Water Supply	62	56	77	102	126	147	171	115	111	107	103	99	95	7	10	12	15	16	18
306	Golden WSC (P-Wood, Rains)	385	346	398	450	502	554	606	115	111	107	103	99	95	45	49	54	58	61	64
307	Combined Consumers WSC (Tawakoni) (P-Hunt)	1486	1336	1537	1738	1939	2140	2340	115	111	107	103	99	95	172	191	208	224	237	249
308	Self Supplied	9706	8730	7034	5338	3642	1946	250	115	111	107	103	99	95	1126	875	641	421	217	26
309	**TOTAL COUNTY OTHER**	**33841**	**30436**	**35008**	**39582**	**44152**	**48724**	**53295**							**3921**	**4353**	**4744**	**5094**	**5403**	**5671**
310																				
311	**WOOD**																			
312	Alba, City of	687	458	458	458	458	458	458	126.6	118.2	110.9	108	103.3	104.9	65	61	57	55	53	54
313	Big Woods Springs Water System	239	159	159	159	159	159	159	126.6	118.2	110.9	108	103.3	104.9	23	21	20	19	18	19
314	Bright Star-Salem WSC (P-Rains)	1481	987	1247	1507	1767	2027	2287	126.6	118.2	110.9	108	103.3	104.9	140	165	187	214	235	269
315	Clear Lakes Village Subdivision	772	514	514	514	514	514	514	126.6	118.2	110.9	108	103.3	104.9	73	68	64	62	59	60
316	Fouke WSC (P-Upshur)	4201	2799	3319	3839	4359	4879	5399	126.6	118.2	110.9	108	103.3	104.9	397	439	477	527	565	634
317	Golden WSC (P-Rains, Van Zandt)	2247	1497	1757	2017	2277	2537	2797	126.6	118.2	110.9	108	103.3	104.9	212	233	251	275	294	329
318	Holly Ranch Water Co., Inc.	3476	2316	2316	2316	2316	2316	2316	126.6	118.2	110.9	108	103.3	104.9	328	307	288	280	268	272
319	Lake Fork WSC (P-Hopkins)	2095	1396	2116	2836	3556	4276	4996	126.6	118.2	110.9	108	103.3	104.9	198	280	352	430	495	587
320	Jarvis Christian College	750	500	500	500	500	500	500	126.6	118.2	110.9	108	103.3	104.9	71	66	62	60	58	59
321	Jones WSC (P-Hopkins)	3654	2434	2834	3234	3634	4034	4434	126.6	118.2	110.9	108	103.3	104.9	345	375	402	440	467	521
322	New Hope WSC	1738	1158	1378	1598	1818	2038	2258	126.6	118.2	110.9	108	103.3	104.9	164	182	199	220	236	265
323	Ramey WSC	2642	1760	2140	2520	2900	3280	3660	126.6	118.2	110.9	108	103.3	104.9	250	283	313	351	380	430
324	Sharon WSC (P-Upshur, Camp)	3444	2294	2534	2774	3014	3254	3494	126.6	118.2	110.9	108	103.3	104.9	325	336	345	365	377	411
325	Yantis, City of	585	390	390	489	539	589	639	126.6	118.2	110.9	108	103.3	104.9	55	52	61	65	68	75
326	Cypress Springs WSC (P-Franklin, Titus, Hopkins)	178	119	119	119	119	119	119	126.6	118.2	110.9	108	103.3	104.9	17	16	15	14	14	14
327	Pritchett WSC (P-Upshur)	25	17	17	17	17	17	17	126.6	118.2	110.9	108	103.3	104.9	2	2	2	2	2	2
328	Duck Creek WSC (P-Smith)	620	413	413	413	413	413	413	126.6	118.2	110.9	108	103.3	104.9	59	55	51	50	48	49

		POPULATION							PROJECTED PER CAPITA USE						MUNICIPAL WATER DEMAND (ac-ft/yr)					
		1998	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
329	Hawkins, City of	100	67	67	67	67	67	67	126.6	118.2	110.9	108	103.3	104.9	10	9	8	8	8	8
330	Mineola, City of	436	290	290	290	290	290	290	126.6	118.2	110.9	108	103.3	104.9	41	38	36	35	34	34
331	Self Supplied	4425	2945	2825	2606	2436	2265	2097	126.6	118.2	110.9	108	103.3	104.9	417	373	323	296	257	246
332	**TOTAL COUNTY OTHER**	**33795**	**22513**	**25393**	**28273**	**31153**	**34032**	**36914**							**3192**	**3361**	**3513**	**3768**	**3936**	**4338**

WOOD COUNTY POPULATION AND WATER USE PROJECTIONS

	Persons per Household	# of Residential Connections	Additional Multi-Family Units	Total Number of Households	1998 Population Estimate	1998 Water Use (1000 gal/yr)	Per Capita Use Per Day
CITIES							
Hawkins	2.56	570	7	577	1477	44852	83
Mineola	2.47	1934	59	1993	4923	295163	164
Quitman	2.26	920	79	999	2258	140820	171
Winnsboro (P-Franklin)	2.23	1272	0	1272	2837	219292	212
COUNTY-OTHER							
Alba, City of	2.49	259	17	276	687	21100	84
Big Woods Springs Water System	2.49	96	0	96	239	5789	66
Bright Star-Salem WSC (P-Rains)	2.49	595	0	595	1481	50095	93
Clear Lakes Village Subdivision	2.49	310	0	310	772	18250	65
Fouke WSC (P-Upshur)	2.49	1687	0	1687	4201	168819	110
Golden WSC (P-Rains, Van Zandt)	2.49	899	3	902	2247	78706	96
Holly Ranch Water Co., Inc.	2.49	1396	0	1396	3476	111325	88
Lake Fork WSC (P-Hopkins)	2.49	829	12	841	2095	53447	70
Jarvis Christian College	2.49	301	0	301	750	31025	113
Jones WSC (P-Hopkins)	2.49	1429	39	1468	3654	114264	86
New Hope WSC	2.49	695	3	698	1738	85485	135
Ramey WSC	2.49	1016	45	1061	2642	111662	116
Sharon WSC (P-Upshur, Camp)	2.49	1383	0	1383	3444	97472	78
Yantis, City of	2.49	235	0	235	585	11206	52
Cypress Springs WSC (P-Franklin, Titus, Hopkins)	2.49	71	0	71	178	6896	106
Pritchett WSC (P-Upshur)	2.49	10	0	10	25	767	84
Duck Creek WSC (P-Smith)	2.49	249	0	249	620	23866	106
Hawkins, City of	2.49	40	0	40	100	3148	87
Mineola, City of	2.49	175	0	175	436	33894	213
Self Supplied	2.49			1777	4425		
TOTAL COUNTY OTHER				13572	33793	1027216	96
TOTAL				18413	45288	1727343	

TABLE 1: POPULATION BY CITY AND RURAL COUNTY

WUG NAME	COUNTY NAME	BASIN NAME	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNT Y NUM	BASIN NUM	pop1996	pop2000	pop2010	pop2020	pop2030	pop2040	pop2050
DE KALB	BOWIE	RED	040232019	D	0232	155	019	2	973	930	1,011	1,093	1,174	1,256	1,338
DE KALB	BOWIE	SULPHUR	040232019	D	0232	155	019	3	976	933	1,015	1,097	1,179	1,260	1,342
HOOKS	BOWIE	RED	040416019	D	0416	284	019	2	2,791	2,822	3,070	3,318	3,565	3,813	4,061
MAUD	BOWIE	SULPHUR	040572019	D	0572	393	019	3	1,030	1,023	1,112	1,202	1,292	1,382	1,471
NASH	BOWIE	SULPHUR	040622019	D	0622	423	019	3	2,377	2,313	2,516	2,719	2,922	3,125	3,328
NEW BOSTON	BOWIE	RED	040628019	D	0628	429	019	2	1,022	1,009	1,097	1,185	1,274	1,363	1,451
NEW BOSTON	BOWIE	SULPHUR	040628019	D	0628	429	019	3	4,092	4,034	4,388	4,743	5,096	5,450	5,804
REDWATER	BOWIE	SULPHUR	040740019	D	0740	945	019	3	865	843	917	991	1,065	1,139	1,213
TEXARKANA	BOWIE	RED	040889019	D	0889	601	019	2	316	400	435	472	505	540	575
TEXARKANA	BOWIE	SULPHUR	040889019	D	0889	601	019	3	32,873	41,793	45,461	49,127	52,796	56,464	60,132
WAKE VILLAGE	BOWIE	SULPHUR	040937019	D	0937	628	019	3	5,240	5,098	5,546	5,993	6,441	6,888	7,336
COUNTY-OTHER	BOWIE	RED	040996019	D	0996	757	019	2	7,707	7,272	7,896	8,522	9,150	9,792	10,433
COUNTY-OTHER	BOWIE	SULPHUR	040996019	D	0996	757	019	3	24,711	23,279	25,337	27,391	29,446	31,485	33,525
PITTSBURG	CAMP	CYPRESS	040701032	D	0701	469	032	4	4,421	4,454	4,790	5,126	5,463	5,799	6,135
COUNTY-OTHER	CAMP	CYPRESS	040996032	D	0996	757	032	4	6,271	6,395	8,878	9,362	9,844	10,328	10,811
ATLANTA	CASS	SULPHUR	040042034	D	0042	29	034	3	187	193	202	208	214	217	220
ATLANTA	CASS	CYPRESS	040042034	D	0042	29	034	4	5,980	6,149	6,435	6,649	6,824	6,917	7,009
HUGHES SPRINGS	CASS	CYPRESS	040423034	D	0423	288	034	4	2,067	2,148	2,281	2,308	2,354	2,354	2,354
LINDEN	CASS	CYPRESS	040524034	D	0524	358	034	4	2,357	2,465	2,635	2,806	2,976	3,146	3,317
QUEEN CITY	CASS	SULPHUR	040728034	D	0728	489	034	3	577	614	657	700	741	784	826
QUEEN CITY	CASS	CYPRESS	040728034	D	0728	489	034	4	1,354	1,444	1,544	1,643	1,744	1,843	1,944
COUNTY-OTHER	CASS	SULPHUR	040996034	D	0996	757	034	3	3,211	3,382	3,644	3,937	4,234	4,555	4,876
COUNTY-OTHER	CASS	CYPRESS	040996034	D	0996	757	034	4	14,992	15,790	17,011	18,383	19,771	21,267	22,761
COOPER	DELTA	SULPHUR	040200060	D	0200	132	060	3	2,210	2,346	2,382	2,403	2,403	2,403	2,403
COUNTY-OTHER	DELTA	SULPHUR	040996060	D	0996	757	060	3	2,804	3,745	3,745	3,745	3,745	3,745	3,745
MOUNT VERNON	FRANKLIN	SULPHUR	040614080	D	0614	417	080	3	2,468	2,631	3,031	3,428	3,874	4,120	4,382
WINNSBORO	FRANKLIN	CYPRESS	040981080	D	0981	661	080	4	598	682	794	905	1,029	1,099	1,173
WINNSBORO	FRANKLIN	SABINE	040981080	D	0981	661	080	5	82	94	109	125	142	151	161
COUNTY-OTHER	FRANKLIN	SULPHUR	040996080	D	0996	757	080	3	2,919	3,054	3,573	4,085	4,661	4,981	5,322
COUNTY-OTHER	FRANKLIN	CYPRESS	040996080	D	0996	757	080	4	2,657	2,781	3,253	3,720	4,244	4,535	4,847
COUNTY-OTHER	FRANKLIN	SABINE	040996080	D	0996	757	080	5	0	0	0	0	0	0	0
CLARKSVILLE CITY	GREGG	SABINE	040172092	D	0172	844	092	5	872	964	1,057	1,151	1,244	1,337	1,431
GLADEWATER	GREGG	SABINE	040342092	D	0342	237	092	5	3,822	4,126	4,525	4,925	5,325	5,724	6,124
KILGORE	GREGG	SABINE	040469092	D	0469	321	092	5	9,017	9,276	10,174	11,073	11,971	12,870	13,769
LIBERTY CITY	GREGG	SABINE	040522092	D	0522	715	092	5	1,715	1,834	2,012	2,190	2,367	2,545	2,723
LAKEPORT	GREGG	SABINE	040502092	D	0502	893	092	5	857	945	1,036	1,128	1,219	1,311	1,402

TABLE 1: POPULATION BY CITY AND RURAL COUNTY

WUG NAME	COUNTY NAME	BASIN NAME	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	pop1996	pop2000	pop2010	pop2020	pop2030	pop2040	pop2050
LONGVIEW	GREGG	SABINE	040539092	D	0539	367	092	5	72,613	76,438	82,596	89,188	95,336	101,080	107,170
WHITE OAK	GREGG	SABINE	040963092	D	0963	649	092	5	5,620	6,056	6,643	7,230	7,817	8,403	8,990
COUNTY-OTHER	GREGG	CYPRESS	040996092	D	0996	757	092	4	1,711	1,485	1,782	2,036	2,359	2,763	3,188
COUNTY-OTHER	GREGG	SABINE	040996092	D	0996	757	092	5	15,282	12,865	15,207	17,154	19,481	22,129	24,408
HALLSVILLE	HARRISON	SABINE	040374102	D	0374	260	102	5	2,752	2,849	3,133	3,335	3,565	3,808	4,042
LONGVIEW	HARRISON	SABINE	040539102	D	0539	367	102	5	1,756	1,807	1,987	2,115	2,261	2,415	2,564
MARSHALL	HARRISON	CYPRESS	040566102	D	0566	388	102	4	5,444	5,410	5,949	6,332	6,769	7,230	7,675
MARSHALL	HARRISON	SABINE	040566102	D	0566	388	102	5	20,029	19,906	21,886	23,299	24,905	26,602	28,243
WASKOM	HARRISON	CYPRESS	040941102	D	0941	631	102	4	1,890	1,890	2,078	2,212	2,364	2,525	2,681
COUNTY-OTHER	HARRISON	CYPRESS	040996102	D	0996	757	102	4	13,743	14,115	15,520	16,521	17,660	18,864	20,027
COUNTY-OTHER	HARRISON	SABINE	040996102	D	0996	757	102	5	14,835	15,237	16,752	17,832	19,063	20,360	21,618
COMO	HOPKINS	SULPHUR	040196112	D	0196	847	112	3	618	643	713	783	853	923	992
CUMBY	HOPKINS	SABINE	040221112	D	0221	852	112	5	670	701	777	853	929	1,005	1,081
SULPHUR SPRINGS	HOPKINS	SULPHUR	040869112	D	0869	586	112	3	14,970	15,367	17,034	18,701	20,369	22,036	23,703
COUNTY-OTHER	HOPKINS	SULPHUR	040996112	D	0996	757	112	3	8,312	8,641	9,588	10,526	11,460	12,406	13,351
COUNTY-OTHER	HOPKINS	CYPRESS	040996112	D	0996	757	112	4	299	315	347	382	417	455	491
COUNTY-OTHER	HOPKINS	SABINE	040996112	D	0996	757	112	5	6,144	6,328	7,008	7,693	8,382	9,056	9,735
CADDO MILLS	HUNT	SABINE	040135116	D	0135	685	116	5	1,142	1,180	1,315	1,450	1,585	1,720	1,855
CAMPBELL	HUNT	SABINE	040141116	D	0141	837	116	5	790	836	932	1,027	1,123	1,219	1,314
CELESTE	HUNT	SABINE	040153116	D	0153	839	116	5	863	915	1,019	1,124	1,229	1,333	1,438
COMMERCE	HUNT	SULPHUR	040195116	D	0195	129	116	3	7,130	7,271	8,103	8,935	9,767	10,599	11,430
GREENVILLE	HUNT	SABINE	040361116	D	0361	250	116	5	24,217	25,764	28,711	31,658	34,605	37,553	40,500
LONE OAK	HUNT	SABINE	040537116	D	0537	901	116	5	595	627	698	770	842	914	985
QUINLAN	HUNT	SABINE	040729116	D	0729	736	116	5	1,577	1,650	1,838	2,027	2,216	2,405	2,593
WEST TAWAKONI	HUNT	SABINE	040956116	D	0956	989	116	5	1,119	1,192	1,329	1,465	1,602	1,738	1,874
WOLFE CITY	HUNT	SULPHUR	040983116	D	0983	663	116	3	1,571	1,633	1,820	2,007	2,194	2,381	2,568
COUNTY-OTHER	HUNT	SULPHUR	040996116	D	0996	757	116	3	4,310	4,505	4,984	5,469	5,971	6,489	6,990
COUNTY-OTHER	HUNT	SABINE	040996116	D	0996	757	116	5	25,480	26,545	29,622	32,692	35,741	38,775	41,829
COUNTY-OTHER	HUNT	TRINITY	040996116	D	0996	757	116	8	382	401	443	486	531	576	621
BLOSSOM	LAMAR	RED	040092139	D	0092	680	139	2	1,645	1,734	1,853	1,972	2,092	2,211	2,330
DEPORT	LAMAR	SULPHUR	040242139	D	0242	857	139	3	838	876	936	996	1,056	1,117	1,177
PARIS	LAMAR	RED	040678139	D	0678	455	139	2	12,607	13,486	14,414	15,342	16,269	17,197	18,126
PARIS	LAMAR	SULPHUR	040678139	D	0678	455	139	3	12,608	13,484	14,412	15,340	16,269	17,197	18,124
RENO	LAMAR	RED	040743139	D	0743	738	139	2	2,371	3,059	4,327	4,869	5,424	5,852	6,314
ROXTON	LAMAR	SULPHUR	040778139	D	0778	951	139	3	696	724	773	823	873	923	973
COUNTY-OTHER	LAMAR	RED	040996139	D	0996	757	139	2	5,967	5,656	6,000	6,333	6,664	7,003	7,346

TABLE 1: POPULATION BY CITY AND RURAL COUNTY

WUG NAME	COUNTY NAME	BASIN NAME	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNT Y NUM	BASIN NUM	pop1996	pop2000	pop2010	pop2020	pop2030	pop2040	pop2050
COUNTY-OTHER	LAMAR	SULPHUR	040996139	D	0996	757	139	3	8,924	8,517	9,150	9,792	10,436	11,072	11,705
JEFFERSON	MARION	CYPRESS	040446158	D	0446	306	158	4	2,432	2,642	2,813	2,983	3,154	3,324	3,494
COUNTY-OTHER	MARION	CYPRESS	040996158	D	0996	757	158	4	7,973	8,322	8,858	9,395	9,931	10,468	11,005
DAINGERFIELD	MORRIS	CYPRESS	040224172	D	0224	148	172	4	2,728	2,881	2,892	2,892	2,892	2,892	2,892
HUGHES SPRINGS	MORRIS	CYPRESS	040423172	D	0423	288	172	4	11	12	12	12	11	11	10
LONE STAR	MORRIS	CYPRESS	040538172	D	0538	366	172	4	1,653	2,069	2,077	2,077	2,077	2,077	2,077
NAPLES	MORRIS	SULPHUR	040621172	D	0621	422	172	3	448	498	537	556	565	565	565
NAPLES	MORRIS	CYPRESS	040621172	D	0621	422	172	4	1,046	1,162	1,253	1,296	1,318	1,318	1,318
OMAHA	MORRIS	CYPRESS	040657172	D	0657	932	172	4	964	1,163	1,227	1,269	1,289	1,289	1,289
COUNTY-OTHER	MORRIS	SULPHUR	040996172	D	0996	757	172	3	805	836	844	856	866	873	878
COUNTY-OTHER	MORRIS	CYPRESS	040996172	D	0996	757	172	4	5,830	5,825	5,817	5,805	5,795	5,788	5,783
EAST TAWAKONI	RAINS	SABINE	040263190	D	0263	861	190	5	730	762	886	1,011	1,135	1,259	1,384
EMORY	RAINS	SABINE	040282190	D	0282	191	190	5	1,029	1,056	1,228	1,401	1,573	1,745	1,918
POINT	RAINS	SABINE	040706190	D	0706	939	190	5	772	816	949	1,082	1,216	1,349	1,482
COUNTY-OTHER	RAINS	SABINE	040996190	D	0996	757	190	5	4,926	5,131	5,970	6,806	7,643	8,481	9,317
BOGATA	RED RIVER	SULPHUR	040096194	D	0096	64	194	3	1,398	1,495	1,495	1,495	1,495	1,495	1,495
CLARKSVILLE	RED RIVER	SULPHUR	040171194	D	0171	113	194	3	4,381	4,330	4,330	4,330	4,330	4,330	4,330
DETROIT	RED RIVER	SULPHUR	040243194	D	0243	858	194	3	787	822	853	868	901	950	998
COUNTY-OTHER	RED RIVER	RED	040996194	D	0996	757	194	2	2,888	2,947	2,970	2,989	3,033	3,093	3,172
COUNTY-OTHER	RED RIVER	SULPHUR	040996194	D	0996	757	194	3	5,208	5,167	5,144	5,125	5,081	5,021	4,942
LINDALE	SMITH	SABINE	040523212	D	0523	357	212	5	1,318	1,377	1,556	1,735	1,913	2,092	2,271
OVERTON	SMITH	SABINE	040662212	D	0662	445	212	5	82	78	88	98	109	119	129
TYLER	SMITH	SABINE	040918212	D	0918	613	212	5	9	8	9	10	11	13	14
COUNTY-OTHER	SMITH	SABINE	040996212	D	0996	757	212	5	21,968	22,894	25,864	28,835	31,805	34,775	37,745
MOUNT PLEASANT	TITUS	CYPRESS	040613225	D	0613	416	225	4	13,677	13,790	15,201	16,611	18,022	19,433	20,844
TALCO	TITUS	SULPHUR	040880225	D	0880	968	225	3	607	606	668	729	791	853	915
COUNTY-OTHER	TITUS	SULPHUR	040996225	D	0996	757	225	3	4,668	4,837	5,364	5,906	6,425	6,954	7,472
COUNTY-OTHER	TITUS	CYPRESS	040996225	D	0996	757	225	4	7,312	7,341	8,060	8,766	9,493	10,209	10,937
BIG SANDY	UPSHUR	SABINE	040084230	D	0084	57	230	5	1,291	1,400	1,548	1,611	1,732	1,870	1,970
EAST MOUNTAIN	UPSHUR	SABINE	040262230	D	0262	860	230	5	908	1,003	1,109	1,154	1,241	1,340	1,411
GILMER	UPSHUR	CYPRESS	040341230	D	0341	236	230	4	5,355	5,815	6,430	6,693	7,195	7,769	8,183
GLADEWATER	UPSHUR	SABINE	040342230	D	0342	237	230	5	2,456	2,560	2,831	2,947	3,168	3,421	3,603
ORE CITY	UPSHUR	CYPRESS	040661230	D	0661	728	230	4	1,034	1,124	1,243	1,294	1,391	1,501	1,581
COUNTY-OTHER	UPSHUR	CYPRESS	040996230	D	0996	757	230	4	15,902	14,488	16,010	16,647	17,872	19,275	20,270
COUNTY-OTHER	UPSHUR	SABINE	040996230	D	0996	757	230	5	7,574	6,825	7,562	7,890	8,503	9,203	9,724
CANTON	VAN ZANDT	SABINE	040143234	D	0143	94	234	5	3,422	3,559	4,094	4,628	5,163	5,698	6,232

TABLE 1: POPULATION BY CITY AND RURAL COUNTY

WUG NAME	COUNTY NAME	BASIN NAME	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	pop1996	pop2000	pop2010	pop2020	pop2030	pop2040	pop2050
EDGEWOOD	VAN ZANDT	SABINE	040268234	D	0268	181	234	5	1,494	1,588	1,826	2,064	2,303	2,541	2,780
GRAND SALINE	VAN ZANDT	SABINE	040354234	D	0354	246	234	5	2,871	3,010	3,462	3,914	4,366	4,818	5,270
VAN	VAN ZANDT	SABINE	040924234	D	0924	618	234	5	106	112	127	145	161	179	195
VAN	VAN ZANDT	NECHES	040924234	D	0924	618	234	6	2,062	2,143	2,467	2,787	3,110	3,431	3,754
WILLS POINT	VAN ZANDT	SABINE	040974234	D	0974	656	234	5	1,661	1,750	2,012	2,275	2,538	2,801	3,064
WILLS POINT	VAN ZANDT	TRINITY	040974234	D	0974	656	234	8	1,665	1,754	2,018	2,281	2,545	2,808	3,071
COUNTY-OTHER	VAN ZANDT	SABINE	040996234	D	0996	757	234	5	13,536	14,310	16,461	18,611	20,761	22,910	25,058
COUNTY-OTHER	VAN ZANDT	NECHES	040996234	D	0996	757	234	6	8,759	9,263	10,653	12,046	13,435	14,826	16,219
COUNTY-OTHER	VAN ZANDT	TRINITY	040996234	D	0996	757	234	8	6,491	6,863	7,894	8,925	9,956	10,988	12,018
HAWKINS	WOOD	SABINE	040385250	D	0385	701	250	5	1,427	1,447	1,632	1,817	2,002	2,187	2,372
MINEOLA	WOOD	SABINE	040599250	D	0599	406	250	5	4,744	4,838	5,457	6,076	6,695	7,314	7,933
QUITMAN	WOOD	SABINE	040731250	D	0731	490	250	5	1,879	1,881	2,122	2,362	2,603	2,844	3,084
WINNSBORO	WOOD	CYPRESS	040981250	D	0981	661	250	4	128	131	148	165	182	199	216
WINNSBORO	WOOD	SABINE	040981250	D	0981	661	250	5	2,419	2,492	2,810	3,129	3,447	3,766	4,084
COUNTY-OTHER	WOOD	CYPRESS	040996250	D	0996	757	250	4	1,792	1,777	2,004	2,231	2,458	2,685	2,911
COUNTY-OTHER	WOOD	SABINE	040996250	D	0996	757	250	5	20,923	20,736	23,389	26,042	28,695	31,347	34,003

TABLE 2: WATER DEMAND BY CITY AND CATEGORY																
WUG NAME	**COUNTY NAME**	**BASIN NAME**	**DATA CATEGORY**	**WUG NUM**	**RWPG**	**SEQ NUM**	**CITY NUM**	**COUNTY NUM**	**BASIN NUM**	**D1996**	**D2000**	**D2010**	**D2020**	**D2030**	**D2040**	**D2050**
DE KALB	BOWIE	RED	MUN	040232019	D	0232	155	019	2	144	123	126	127	132	137	144
DE KALB	BOWIE	SULPHUR	MUN	040232019	D	0232	155	019	3	145	123	126	128	131	137	144
HOOKS	BOWIE	RED	MUN	040416019	D	0416	284	019	2	282	440	454	465	484	495	528
MAUD	BOWIE	SULPHUR	MUN	040572019	D	0572	393	019	3	135	132	138	144	149	153	157
NASH	BOWIE	SULPHUR	MUN	040622019	D	0622	423	019	3	197	298	313	326	337	347	354
NEW BOSTON	BOWIE	RED	MUN	040628019	D	0628	429	019	2	126	221	232	243	256	269	285
NEW BOSTON	BOWIE	SULPHUR	MUN	040628019	D	0628	429	019	3	504	888	932	974	1,024	1,077	1,140
REDWATER	BOWIE	SULPHUR	MUN	040740019	D	0740	945	019	3	83	109	114	119	123	126	129
TEXARKANA	BOWIE	RED	MUN	040889019	D	0889	601	019	2	45	71	73	75	78	81	86
TEXARKANA	BOWIE	SULPHUR	MUN	040889019	D	0889	601	019	3	4,653	7,350	7,587	7,814	8,162	8,476	8,890
WAKE VILLAGE	BOWIE	SULPHUR	MUN	040937019	D	0937	628	019	3	548	657	690	718	743	764	781
COUNTY-OTHER	BOWIE	SULPHUR	MUN	040996019	D	0996	757	019	3	3,868	4,056	4,131	4,231	4,403	4,594	4,844
COUNTY-OTHER	BOWIE	RED	MUN	040996019	D	0996	757	019	2	1,207	1,189	1,212	1,242	1,291	1,349	1,425
IRRIGATION	BOWIE	RED	IRR	041004019	D	1004	1004	019	2	5,025	4,400	4,620	4,620	4,620	4,500	4,200
IRRIGATION	BOWIE	SULPHUR	IRR	041004019	D	1004	1004	019	3	0	0	0	0	0	0	0
LIVESTOCK	BOWIE	SULPHUR	STK	041005019	D	1005	1005	019	3	1,233	2,331	2,445	2,445	2,445	2,223	1,905
LIVESTOCK	BOWIE	RED	STK	041005019	D	1005	1005	019	2	708	1,340	1,405	1,405	1,405	1,277	1,095
MANUFACTURING	BOWIE	SULPHUR	MFG	041001019	D	1001	1001	019	3	1,880	1,937	2,143	2,355	2,576	2,809	3,051
MANUFACTURING	BOWIE	RED	MFG	041001019	D	1001	1001	019	2	5	7	9	11	14	17	20
MINING	BOWIE	SULPHUR	MIN	041003019	D	1003	1003	019	3	16	29	29	30	32	36	41
MINING	BOWIE	RED	MIN	041003019	D	1003	1003	019	2	25	24	23	23	24	25	25
STEAM ELECTRIC POWER	BOWIE	SULPHUR	PWR	041002019	D	1002	1002	019	3	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	BOWIE	RED	PWR	041002019	D	1002	1002	019	2	0	0	0	0	0	0	0
PITTSBURG	CAMP	CYPRESS	MUN	040701032	D	0701	469	032	4	895	923	944	964	1,003	1,046	1,100
COUNTY-OTHER	CAMP	CYPRESS	MUN	040996032	D	0996	757	032	4	707	824	1,104	1,122	1,136	1,145	1,150
IRRIGATION	CAMP	CYPRESS	IRR	041004032	D	1004	1004	032	4	32	87	87	87	87	87	87
LIVESTOCK	CAMP	CYPRESS	STK	041005032	D	1005	1005	032	4	982	800	800	800	800	800	800
MANUFACTURING	CAMP	CYPRESS	MFG	041001032	D	1001	1001	032	4	33	10	2,242	2,242	2,242	2,242	2,242
MINING	CAMP	CYPRESS	MIN	041003032	D	1003	1003	032	4	24	132	131	131	131	131	131
STEAM ELECTRIC POWER	CAMP	CYPRESS	PWR	041002032	D	1002	1002	032	4	0	0	0	0	0	0	0
ATLANTA	CASS	SULPHUR	MUN	040042034	D	0042	29	034	3	34	44	43	43	43	43	43
ATLANTA	CASS	CYPRESS	MUN	040042034	D	0042	29	034	4	1,077	1,377	1,377	1,363	1,368	1,363	1,374
HUGHES SPRINGS	CASS	CYPRESS	MUN	040423034	D	0423	288	034	4	359	488	496	478	480	469	467
LINDEN	CASS	CYPRESS	MUN	040524034	D	0524	358	034	4	303	326	325	327	337	342	357

TABLE 2: WATER DEMAND BY CITY AND CATEGORY

WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNT Y NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
QUEEN CITY	CASS	CYPRESS	MUN	040728034	D	0728	489	034	4	154	217	218	221	227	233	244
QUEEN CITY	CASS	SULPHUR	MUN	040728034	D	0728	489	034	3	65	92	93	94	96	99	104
COUNTY-OTHER	CASS	CYPRESS	MUN	040996034	D	0996	757	034	4	1,858	2,035	2,116	2,196	2,281	2,360	2,423
COUNTY-OTHER	CASS	SULPHUR	MUN	040996034	D	0996	757	034	3	398	435	452	479	489	504	518
IRRIGATION	CASS	CYPRESS	IRR	041004034	D	1004	1004	034	4	13	0	0	0	0	0	0
IRRIGATION	CASS	SULPHUR	IRR	041004034	D	1004	1004	034	3	0	0	0	0	0	0	0
LIVESTOCK	CASS	CYPRESS	STK	041005034	D	1005	1005	034	4	574	596	596	596	596	596	596
LIVESTOCK	CASS	SULPHUR	STK	041005034	D	1005	1005	034	3	246	255	255	255	255	255	255
MANUFACTURING	CASS	CYPRESS	MFG	041001034	D	1001	1001	034	4	57	27	33	37	41	48	55
MANUFACTURING	CASS	SULPHUR	MFG	041001034	D	1001	1001	034	3	79,066	80,102	76,834	76,834	74,528	77,507	80,609
MINING	CASS	SULPHUR	MIN	041003034	D	1003	1003	034	3	626	709	535	523	509	494	483
MINING	CASS	CYPRESS	MIN	041003034	D	1003	1003	034	4	419	545	455	419	393	378	13
STEAM ELECTRIC POWER	CASS	CYPRESS	PWR	041002034	D	1002	1002	034	4	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	CASS	SULPHUR	PWR	041002034	D	1002	1002	034	3	0	0	0	0	0	0	0
COOPER	DELTA	SULPHUR	MUN	040200060	D	0200	132	060	3	336	423	411	396	385	374	371
COUNTY-OTHER	DELTA	SULPHUR	MUN	040996060	D	0996	757	060	3	303	503	487	470	453	436	419
IRRIGATION	DELTA	SULPHUR	IRR	041004060	D	1004	1004	060	3	4	1,978	1,956	1,934	1,913	1,891	1,870
LIVESTOCK	DELTA	SULPHUR	STK	041005060	D	1005	1005	060	3	344	770	770	770	770	770	770
MANUFACTURING	DELTA	SULPHUR	MFG	041001060	D	1001	1001	060	3	0	8	8	8	8	8	8
MINING	DELTA	SULPHUR	MIN	041003060	D	1003	1003	060	3	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	DELTA	SULPHUR	PWR	041002060	D	1002	1002	060	3	0	0	0	0	0	0	0
MOUNT VERNON	FRANKLIN	SULPHUR	MUN	040614080	D	0614	417	080	3	341	545	594	637	707	738	780
WINNSBORO	FRANKLIN	SABINE	MUN	040981080	D	0981	661	080	5	14	18	20	21	24	25	26
WINNSBORO	FRANKLIN	CYPRESS	MUN	040981080	D	0981	661	080	4	104	128	142	155	172	180	191
COUNTY-OTHER	FRANKLIN	SABINE	MUN	040996080	D	0996	757	080	5	0	0	0	0	0	0	0
COUNTY-OTHER	FRANKLIN	CYPRESS	MUN	040996080	D	0996	757	080	4	508	626	696	763	851	899	956
COUNTY-OTHER	FRANKLIN	SULPHUR	MUN	040996080	D	0996	757	080	3	557	688	764	837	935	988	1,049
IRRIGATION	FRANKLIN	SABINE	IRR	041004080	D	1004	1004	080	5	0	0	0	0	0	0	0
IRRIGATION	FRANKLIN	CYPRESS	IRR	041004080	D	1004	1004	080	4	44	12	12	12	12	12	12
IRRIGATION	FRANKLIN	SULPHUR	IRR	041004080	D	1004	1004	080	3	0	21	21	21	21	21	21
LIVESTOCK	FRANKLIN	SULPHUR	STK	041005080	D	1005	1005	080	3	880	990	990	990	990	990	990
LIVESTOCK	FRANKLIN	CYPRESS	STK	041005080	D	1005	1005	080	4	536	603	603	603	603	603	603
LIVESTOCK	FRANKLIN	SABINE	STK	041005080	D	1005	1005	080	5	2	2	2	2	2	2	2
MANUFACTURING	FRANKLIN	SABINE	MFG	041001080	D	1001	1001	080	5	0	0	0	0	0	0	0

TABLE 2: WATER DEMAND BY CITY AND CATEGORY

WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNT Y NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
MANUFACTURING	FRANKLIN	SULPHUR	MFG	041001080	D	1001	1001	080	3	0	3	3	3	3	3	3
MANUFACTURING	FRANKLIN	CYPRESS	MFG	041001080	D	1001	1001	080	4	0	3	3	3	3	3	3
MINING	FRANKLIN	SABINE	MIN	041003080	D	1003	1003	080	5	0	0	0	0	0	0	0
MINING	FRANKLIN	CYPRESS	MIN	041003080	D	1003	1003	080	4	853	883	813	785	743	759	809
MINING	FRANKLIN	SULPHUR	MIN	041003080	D	1003	1003	080	3	501	596	571	553	535	538	550
STEAM ELECTRIC POWER	FRANKLIN	SABINE	PWR	041002080	D	1002	1002	080	5	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	FRANKLIN	SULPHUR	PWR	041002080	D	1002	1002	080	3	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	FRANKLIN	CYPRESS	PWR	041002080	D	1002	1002	080	4	0	0	0	0	0	0	0
CLARKSVILLE CITY	GREGG	SABINE	MUN	040172092	D	0172	844	092	5	98	124	131	138	144	148	152
GLADEWATER	GREGG	SABINE	MUN	040342092	D	0342	237	092	5	559	721	745	767	811	853	906
KILGORE	GREGG	SABINE	MUN	040469092	D	0469	321	092	5	1,814	1,984	2,074	2,158	2,280	2,407	2,560
LAKEPORT	GREGG	SABINE	MUN	040502092	D	0502	893	092	5	129	122	129	135	141	145	149
LIBERTY CITY	GREGG	SABINE	MUN	040522092	D	0522	715	092	5	274	345	356	368	390	414	439
LONGVIEW	GREGG	SABINE	MUN	040539092	D	0539	367	092	5	10,019	15,498	15,913	16,484	17,193	17,889	18,847
WHITE OAK	GREGG	SABINE	MUN	040963092	D	0963	649	092	5	887	848	870	890	928	969	1,027
COUNTY-OTHER	GREGG	CYPRESS	MUN	040996092	D	0996	757	092	4	274	201	225	236	275	310	355
COUNTY-OTHER	GREGG	SABINE	MUN	040996092	D	0996	757	092	5	2,442	1,839	2,044	2,139	2,466	2,739	3,058
IRRIGATION	GREGG	CYPRESS	IRR	041004092	D	1004	1004	092	4	0	0	0	0	0	0	0
IRRIGATION	GREGG	SABINE	IRR	041004092	D	1004	1004	092	5	25	0	0	0	0	0	0
LIVESTOCK	GREGG	SABINE	STK	041005092	D	1005	1005	092	5	187	230	230	230	230	230	230
LIVESTOCK	GREGG	CYPRESS	STK	041005092	D	1005	1005	092	4	28	35	35	35	35	35	35
MANUFACTURING	GREGG	SABINE	MFG	041001092	D	1001	1001	092	5	3,826	16,538	18,576	20,934	23,507	26,515	29,716
MANUFACTURING	GREGG	CYPRESS	MFG	041001092	D	1001	1001	092	4	0	0	0	0	0	0	0
MINING	GREGG	CYPRESS	MIN	041003092	D	1003	1003	092	4	0	0	0	0	0	0	0
MINING	GREGG	SABINE	MIN	041003092	D	1003	1003	092	5	129	96	67	46	37	29	27
STEAM ELECTRIC POWER	GREGG	CYPRESS	PWR	041002092	D	1002	1002	092	4	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	GREGG	SABINE	PWR	041002092	D	1002	1002	092	5	1,723	1,251	1,251	1,251	1,251	1,251	1,251
HALLSVILLE	HARRISON	SABINE	MUN	040374102	D	0374	260	102	5	307	383	407	418	431	444	453
LONGVIEW	HARRISON	SABINE	MUN	040539102	D	0539	367	102	5	296	366	382	391	408	427	451
MARSHALL	HARRISON	SABINE	MUN	040566102	D	0566	388	102	5	3,567	3,858	4,020	4,071	4,241	4,410	4,682
MARSHALL	HARRISON	CYPRESS	MUN	040566102	D	0566	388	102	4	969	1,048	1,093	1,106	1,152	1,199	1,273
WASKOM	HARRISON	CYPRESS	MUN	040941102	D	0941	631	102	4	226	277	289	292	301	312	331
COUNTY-OTHER	HARRISON	SABINE	MUN	040996102	D	0996	757	102	5	1,602	2,046	2,174	2,236	2,304	2,370	2,419
COUNTY-OTHER	HARRISON	CYPRESS	MUN	040996102	D	0996	757	102	4	1,485	1,899	2,019	2,074	2,139	2,199	2,246

TABLE 2: WATER DEMAND BY CITY AND CATEGORY

WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
IRRIGATION	HARRISON	SABINE	IRR	041004102	D	1004	1004	102	5	0	50	50	50	50	50	50
IRRIGATION	HARRISON	CYPRESS	IRR	041004102	D	1004	1004	102	4	106	50	50	50	50	50	50
LIVESTOCK	HARRISON	SABINE	STK	041005102	D	1005	1005	102	5	302	421	441	464	487	511	537
LIVESTOCK	HARRISON	CYPRESS	STK	041005102	D	1005	1005	102	4	410	570	599	628	660	694	727
MANUFACTURING	HARRISON	SABINE	MFG	041001102	D	1001	1001	102	5	49,260	109,321	133,587	140,270	146,243	159,506	174,422
MANUFACTURING	HARRISON	CYPRESS	MFG	041001102	D	1001	1001	102	4	432	1,267	1,579	1,643	1,706	1,864	2,049
MINING	HARRISON	SABINE	MIN	041003102	D	1003	1003	102	5	283	190	178	173	159	166	169
MINING	HARRISON	CYPRESS	MIN	041003102	D	1003	1003	102	4	209	180	192	197	211	204	201
STEAM ELECTRIC POWER	HARRISON	CYPRESS	PWR	041002102	D	1002	1002	102	4	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	HARRISON	SABINE	PWR	041002102	D	1002	1002	102	5	8,972	5,760	5,760	5,760	5,760	5,760	5,760
COMO	HOPKINS	SULPHUR	MUN	040196112	D	0196	847	112	3	80	100	105	109	115	121	129
CUMBY	HOPKINS	SABINE	MUN	040221112	D	0221	852	112	5	102	105	110	113	120	125	133
SULPHUR SPRINGS	HOPKINS	SULPHUR	MUN	040869112	D	0869	586	112	3	2,802	2,771	2,920	3,037	3,240	3,407	3,637
COUNTY-OTHER	HOPKINS	SABINE	MUN	040996112	D	0996	757	112	5	1,273	1,064	1,122	1,171	1,239	1,300	1,389
COUNTY-OTHER	HOPKINS	CYPRESS	MUN	040996112	D	0996	757	112	4	62	51	55	57	61	65	68
COUNTY-OTHER	HOPKINS	SULPHUR	MUN	040996112	D	0996	757	112	3	1,722	1,440	1,523	1,591	1,680	1,764	1,882
IRRIGATION	HOPKINS	SULPHUR	IRR	041004112	D	1004	1004	112	3	25	0	0	0	0	0	0
IRRIGATION	HOPKINS	CYPRESS	IRR	041004112	D	1004	1004	112	4	0	0	0	0	0	0	0
IRRIGATION	HOPKINS	SABINE	IRR	041004112	D	1004	1004	112	5	0	0	0	0	0	0	0
LIVESTOCK	HOPKINS	CYPRESS	STK	041005112	D	1005	1005	112	4	189	199	199	199	199	199	199
LIVESTOCK	HOPKINS	SABINE	STK	041005112	D	1005	1005	112	5	2,023	2,130	2,130	2,130	2,130	2,130	2,130
LIVESTOCK	HOPKINS	SULPHUR	STK	041005112	D	1005	1005	112	3	4,532	4,771	4,771	4,771	4,771	4,771	4,771
MANUFACTURING	HOPKINS	SULPHUR	MFG	041001112	D	1001	1001	112	3	627	2,646	2,841	3,004	3,131	3,389	3,648
MANUFACTURING	HOPKINS	CYPRESS	MFG	041001112	D	1001	1001	112	4	0	0	0	0	0	0	0
MANUFACTURING	HOPKINS	SABINE	MFG	041001112	D	1001	1001	112	5	0	8	12	12	17	21	21
MINING	HOPKINS	SULPHUR	MIN	041003112	D	1003	1003	112	3	148	125	122	120	117	116	116
MINING	HOPKINS	CYPRESS	MIN	041003112	D	1003	1003	112	4	0	0	0	0	0	0	0
MINING	HOPKINS	SABINE	MIN	041003112	D	1003	1003	112	5	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	HOPKINS	SABINE	PWR	041002112	D	1002	1002	112	5	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	HOPKINS	SULPHUR	PWR	041002112	D	1002	1002	112	3	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	HOPKINS	CYPRESS	PWR	041002112	D	1002	1002	112	4	0	0	0	0	0	0	0
CADDO MILLS	HUNT	SABINE	MUN	040135116	D	0135	685	116	5	153	152	164	174	183	191	197
CAMPBELL	HUNT	SABINE	MUN	040141116	D	0141	837	116	5	69	112	121	129	136	142	147
CELESTE	HUNT	SABINE	MUN	040153116	D	0153	839	116	5	70	118	127	135	142	148	153

TABLE 2: WATER DEMAND BY CITY AND CATEGORY																
WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNT Y NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
COMMERCE	HUNT	SULPHUR	MUN	040195116	D	0195	129	116	3	1,363	2,036	2,178	2,302	2,483	2,647	2,855
GREENVILLE	HUNT	SABINE	MUN	040361116	D	0361	250	116	5	4,261	6,291	6,689	7,021	7,520	8,034	8,620
LONE OAK	HUNT	SABINE	MUN	040537116	D	0537	901	116	5	58	81	87	92	97	101	105
QUINLAN	HUNT	SABINE	MUN	040729116	D	0729	736	116	5	341	213	229	243	256	267	276
WEST TAWAKONI	HUNT	SABINE	MUN	040956116	D	0956	989	116	5	217	207	219	228	244	258	275
WOLFE CITY	HUNT	SULPHUR	MUN	040983116	D	0983	663	116	3	231	214	222	229	243	256	274
COUNTY-OTHER	HUNT	TRINITY	MUN	040996116	D	0996	757	116	8	44	56	59	165	65	70	71
COUNTY-OTHER	HUNT	SABINE	MUN	040996116	D	0996	757	116	5	2,937	3,410	3,673	3,804	4,112	4,287	4,439
COUNTY-OTHER	HUNT	SULPHUR	MUN	040996116	D	0996	757	116	3	497	585	626	663	697	726	751
IRRIGATION	HUNT	SABINE	IRR	041004116	D	1004	1004	116	5	476	271	271	271	271	271	271
IRRIGATION	HUNT	TRINITY	IRR	041004116	D	1004	1004	116	8	0	0	0	0	0	0	0
IRRIGATION	HUNT	SULPHUR	IRR	041004116	D	1004	1004	116	3	142	0	0	0	0	0	0
LIVESTOCK	HUNT	SULPHUR	STK	041005116	D	1005	1005	116	3	477	331	331	331	331	331	331
LIVESTOCK	HUNT	SABINE	STK	041005116	D	1005	1005	116	5	1,288	896	896	896	896	896	896
LIVESTOCK	HUNT	TRINITY	STK	041005116	D	1005	1005	116	8	14	10	10	10	10	10	10
MANUFACTURING	HUNT	SULPHUR	MFG	041001116	D	1001	1001	116	3	78	190	246	314	396	499	620
MANUFACTURING	HUNT	SABINE	MFG	041001116	D	1001	1001	116	5	725	550	572	589	602	630	656
MANUFACTURING	HUNT	TRINITY	MFG	041001116	D	1001	1001	116	8	0	0	0	0	0	0	0
MINING	HUNT	SABINE	MIN	041003116	D	1003	1003	116	5	67	70	71	73	75	77	79
MINING	HUNT	SULPHUR	MIN	041003116	D	1003	1003	116	3	0	0	0	0	0	0	0
MINING	HUNT	TRINITY	MIN	041003116	D	1003	1003	116	8	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	HUNT	SULPHUR	PWR	041002116	D	1002	1002	116	3	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	HUNT	SABINE	PWR	041002116	D	1002	1002	116	5	405	516	516	516	516	516	516
STEAM ELECTRIC POWER	HUNT	TRINITY	PWR	041002116	D	1002	1002	116	8	0	0	0	0	0	0	0
BLOSSOM	LAMAR	RED	MUN	040092139	D	0092	680	139	2	117	223	230	236	241	245	248
DEPORT	LAMAR	SULPHUR	MUN	040242139	D	0242	857	139	3	71	113	116	119	122	124	125
PARIS	LAMAR	SULPHUR	MUN	040678139	D	0678	455	139	3	2,265	3,791	3,875	3,952	4,118	4,276	4,486
PARIS	LAMAR	RED	MUN	040678139	D	0678	455	139	2	2,265	3,792	3,875	3,952	4,119	4,276	4,487
RENO	LAMAR	RED	MUN	040743139	D	0743	738	139	2	216	411	562	611	656	682	707
ROXTON	LAMAR	SULPHUR	MUN	040778139	D	0778	951	139	3	78	93	96	99	101	102	103
COUNTY-OTHER	LAMAR	SULPHUR	MUN	040996139	D	0996	757	139	3	1,314	1,337	1,346	1,309	1,392	1,434	1,500
COUNTY-OTHER	LAMAR	RED	MUN	040996139	D	0996	757	139	2	879	849	847	872	858	879	913
IRRIGATION	LAMAR	RED	IRR	041004139	D	1004	1004	139	2	4,700	4,368	4,319	4,271	4,223	4,176	4,129
IRRIGATION	LAMAR	SULPHUR	IRR	041004139	D	1004	1004	139	3	0	0	0	0	0	0	0

TABLE 2: WATER DEMAND BY CITY AND CATEGORY

WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
LIVESTOCK	LAMAR	SULPHUR	STK	041005139	D	1005	1005	139	3	737	570	570	570	570	570	570
LIVESTOCK	LAMAR	RED	STK	041005139	D	1005	1005	139	2	1,233	953	953	953	953	953	953
MANUFACTURING	LAMAR	SULPHUR	MFG	041001139	D	1001	1001	139	3	4,557	4,867	5,648	6,357	6,993	7,969	8,938
MANUFACTURING	LAMAR	RED	MFG	041001139	D	1001	1001	139	2	622	555	565	575	582	621	670
MINING	LAMAR	SULPHUR	MIN	041003139	D	1003	1003	139	3	11	12	11	11	12	12	12
MINING	LAMAR	RED	MIN	041003139	D	1003	1003	139	2	11	13	13	13	13	13	13
STEAM ELECTRIC POWER	LAMAR	SULPHUR	PWR	041002139	D	1002	1002	139	3	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	LAMAR	RED	PWR	041002139	D	1002	1002	139	2	0	12,209	12,209	12,209	12,209	12,209	12,209
JEFFERSON	MARION	CYPRESS	MUN	040446158	D	0446	306	158	4	559	624	636	648	667	693	725
COUNTY-OTHER	MARION	CYPRESS	MUN	040996158	D	0996	757	158	4	826	1,072	1,101	1,126	1,146	1,161	1,171
IRRIGATION	MARION	CYPRESS	IRR	041004158	D	1004	1004	158	4	98	0	0	0	0	0	0
LIVESTOCK	MARION	CYPRESS	STK	041005158	D	1005	1005	158	4	165	182	182	182	182	182	182
MANUFACTURING	MARION	CYPRESS	MFG	041001158	D	1001	1001	158	4	35	20	20	20	20	20	20
MINING	MARION	CYPRESS	MIN	041003158	D	1003	1003	158	4	99	71	43	30	24	20	34
STEAM ELECTRIC POWER	MARION	CYPRESS	PWR	041002158	D	1002	1002	158	4	3,321	2,868	2,868	2,868	2,868	2,868	2,868
DAINGERFIELD	MORRIS	CYPRESS	MUN	040224172	D	0224	148	172	4	448	400	379	357	340	327	327
HUGHES SPRINGS	MORRIS	CYPRESS	MUN	040423172	D	0423	288	172	4	2	3	3	2	2	2	2
LONE STAR	MORRIS	CYPRESS	MUN	040538172	D	0538	366	172	4	159	267	258	249	240	230	221
NAPLES	MORRIS	CYPRESS	MUN	040621172	D	0621	422	172	4	134	171	174	171	167	163	161
NAPLES	MORRIS	SULPHUR	MUN	040621172	D	0621	422	172	3	58	75	75	72	72	69	69
OMAHA	MORRIS	CYPRESS	MUN	040657172	D	0657	932	172	4	140	163	163	158	156	151	149
COUNTY-OTHER	MORRIS	SULPHUR	MUN	040996172	D	0996	757	172	3	77	110	109	104	104	100	96
COUNTY-OTHER	MORRIS	CYPRESS	MUN	040996172	D	0996	757	172	4	560	748	719	694	665	639	613
IRRIGATION	MORRIS	CYPRESS	IRR	041004172	D	1004	1004	172	4	121	190	188	186	184	182	180
IRRIGATION	MORRIS	SULPHUR	IRR	041004172	D	1004	1004	172	3	0	0	0	0	0	0	0
LIVESTOCK	MORRIS	CYPRESS	STK	041005172	D	1005	1005	172	4	333	424	424	424	424	424	424
LIVESTOCK	MORRIS	SULPHUR	STK	041005172	D	1005	1005	172	3	157	200	200	200	200	200	200
MANUFACTURING	MORRIS	SULPHUR	MFG	041001172	D	1001	1001	172	3	4	0	0	0	0	0	0
MANUFACTURING	MORRIS	CYPRESS	MFG	041001172	D	1001	1001	172	4	96,267	132,451	135,264	129,869	124,443	119,127	113,929
MINING	MORRIS	CYPRESS	MIN	041003172	D	1003	1003	172	4	39	31	16	12	10	10	11
MINING	MORRIS	SULPHUR	MIN	041003172	D	1003	1003	172	3	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	MORRIS	CYPRESS	PWR	041002172	D	1002	1002	172	4	16	48	48	48	48	48	48
STEAM ELECTRIC POWER	MORRIS	SULPHUR	PWR	041002172	D	1002	1002	172	3	0	0	0	0	0	0	0
EAST TAWAKONI	RAINS	SABINE	MUN	040263190	D	0263	861	190	5	104	107	117	126	138	147	160

TABLE 2: WATER DEMAND BY CITY AND CATEGORY

WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
EMORY	RAINS	SABINE	MUN	040282190	D	0282	191	190	5	233	209	232	252	278	302	329
POINT	RAINS	SABINE	MUN	040706190	D	0706	939	190	5	67	110	122	131	141	151	164
COUNTY-OTHER	RAINS	SABINE	MUN	040996190	D	0996	757	190	5	815	948	1,042	1,128	1,230	1,340	1,458
IRRIGATION	RAINS	SABINE	IRR	041004190	D	1004	1004	190	5	27	20	20	20	20	20	20
LIVESTOCK	RAINS	SABINE	STK	041005190	D	1005	1005	190	5	721	700	700	700	700	700	700
MANUFACTURING	RAINS	SABINE	MFG	041001190	D	1001	1001	190	5	1	2	2	2	2	2	2
MINING	RAINS	SABINE	MIN	041003190	D	1003	1003	190	5	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	RAINS	SABINE	PWR	041002190	D	1002	1002	190	5	0	0	0	0	0	0	0
BOGATA	RED RIVER	SULPHUR	MUN	040096194	D	0096	64	194	3	131	193	186	179	172	166	159
CLARKSVILLE	RED RIVER	SULPHUR	MUN	040171194	D	0171	113	194	3	727	674	640	607	583	573	563
DETROIT	RED RIVER	SULPHUR	MUN	040243194	D	0243	858	194	3	73	106	106	104	104	105	106
COUNTY-OTHER	RED RIVER	SULPHUR	MUN	040996194	D	0996	757	194	3	658	674	650	625	599	572	542
COUNTY-OTHER	RED RIVER	RED	MUN	040996194	D	0996	757	194	2	365	371	359	348	337	328	321
IRRIGATION	RED RIVER	SULPHUR	IRR	041004194	D	1004	1004	194	3	2,680	45	44	44	43	43	42
IRRIGATION	RED RIVER	RED	IRR	041004194	D	1004	1004	194	2	800	54	54	53	53	52	52
LIVESTOCK	RED RIVER	SULPHUR	STK	041005194	D	1005	1005	194	3	1,142	698	698	698	698	698	698
LIVESTOCK	RED RIVER	RED	STK	041005194	D	1005	1005	194	2	787	482	482	482	482	482	482
MANUFACTURING	RED RIVER	RED	MFG	041001194	D	1001	1001	194	2	0	0	0	0	0	0	0
MANUFACTURING	RED RIVER	SULPHUR	MFG	041001194	D	1001	1001	194	3	9	11	15	17	19	21	25
MINING	RED RIVER	SULPHUR	MIN	041003194	D	1003	1003	194	3	0	0	0	0	0	0	0
MINING	RED RIVER	RED	MIN	041003194	D	1003	1003	194	2	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	RED RIVER	SULPHUR	PWR	041002194	D	1002	1002	194	3	227	1,500	5,000	7,000	10,000	10,000	10,000
STEAM ELECTRIC POWER	RED RIVER	RED	PWR	041002194	D	1002	1002	194	2	0	0	0	0	0	0	0
LINDALE	SMITH	SABINE	MUN	040523212	D	0523	357	212	5	179	262	279	295	319	342	369
OVERTON	SMITH	SABINE	MUN	040662212	D	0662	445	212	5	27	16	18	19	20	21	22
TYLER	SMITH	SABINE	MUN	040918212	D	0918	613	212	5	2	2	2	2	2	3	3
COUNTY-OTHER	SMITH	SABINE	MUN	040996212	D	0996	757	212	5	4,070	3,479	3,693	3,890	4,148	4,420	4,760
IRRIGATION	SMITH	SABINE	IRR	041004212	D	1004	1004	212	5	86	446	468	491	516	542	569
LIVESTOCK	SMITH	SABINE	STK	041005212	D	1005	1005	212	5	383	453	453	453	453	453	453
MANUFACTURING	SMITH	SABINE	MFG	041001212	D	1001	1001	212	5	181	262	298	325	346	377	403
MINING	SMITH	SABINE	MIN	041003212	D	1003	1003	212	5	203	425	178	91	32	18	6
STEAM ELECTRIC POWER	SMITH	SABINE	PWR	041002212	D	1002	1002	212	5	0	0	0	0	0	0	0
MOUNT PLEASANT	TITUS	CYPRESS	MUN	040613225	D	0613	416	225	4	3,693	3,012	3,167	3,312	3,512	3,722	3,970
TALCO	TITUS	SULPHUR	MUN	040880225	D	0880	968	225	3	59	78	83	87	91	95	97

TABLE 2: WATER DEMAND BY CITY AND CATEGORY

WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
COUNTY-OTHER	TITUS	SULPHUR	MUN	040996225	D	0996	757	225	3	731	655	702	746	782	814	841
COUNTY-OTHER	TITUS	CYPRESS	MUN	040996225	D	0996	757	225	4	1,146	982	1,042	1,095	1,144	1,185	1,221
IRRIGATION	TITUS	CYPRESS	IRR	041004225	D	1004	1004	225	4	0	0	0	0	0	0	0
IRRIGATION	TITUS	SULPHUR	IRR	041004225	D	1004	1004	225	3	0	0	0	0	0	0	0
LIVESTOCK	TITUS	CYPRESS	STK	041005225	D	1005	1005	225	4	479	370	370	370	370	370	370
LIVESTOCK	TITUS	SULPHUR	STK	041005225	D	1005	1005	225	3	632	488	488	488	488	488	488
MANUFACTURING	TITUS	SULPHUR	MFG	041001225	D	1001	1001	225	3	0	0	0	0	0	0	0
MANUFACTURING	TITUS	CYPRESS	MFG	041001225	D	1001	1001	225	4	2,832	3,734	3,997	4,199	4,357	4,722	5,079
MINING	TITUS	SULPHUR	MIN	041003225	D	1003	1003	225	3	304	254	121	61	30	10	0
MINING	TITUS	CYPRESS	MIN	041003225	D	1003	1003	225	4	3,045	2,518	1,870	1,735	1,692	1,695	1,744
STEAM ELECTRIC POWER	TITUS	CYPRESS	PWR	041002225	D	1002	1002	225	4	31,388	28,280	31,280	31,280	36,280	36,280	36,280
STEAM ELECTRIC POWER	TITUS	SULPHUR	PWR	041002225	D	1002	1002	225	3	0	0	0	0	0	0	0
BIG SANDY	UPSHUR	SABINE	MUN	040084230	D	0084	57	230	5	193	231	239	237	247	260	272
EAST MOUNTAIN	UPSHUR	SABINE	MUN	040262230	D	0262	860	230	5	80	135	144	145	150	156	158
GILMER	UPSHUR	CYPRESS	MUN	040341230	D	0341	236	230	4	868	1,354	1,426	1,417	1,499	1,593	1,669
GLADEWATER	UPSHUR	SABINE	MUN	040342230	D	0342	237	230	5	359	448	466	459	482	509	533
ORE CITY	UPSHUR	CYPRESS	MUN	040661230	D	0661	728	230	4	131	154	159	155	162	170	177
COUNTY-OTHER	UPSHUR	CYPRESS	MUN	040996230	D	0996	757	230	4	1,964	1,725	1,844	1,849	1,912	1,982	2,003
COUNTY-OTHER	UPSHUR	SABINE	MUN	040996230	D	0996	757	230	5	935	1,020	1,087	1,092	1,131	1,176	1,189
IRRIGATION	UPSHUR	SABINE	IRR	041004230	D	1004	1004	230	5	0	0	0	0	0	0	0
IRRIGATION	UPSHUR	CYPRESS	IRR	041004230	D	1004	1004	230	4	20	0	0	0	0	0	0
LIVESTOCK	UPSHUR	CYPRESS	STK	041005230	D	1005	1005	230	4	1,885	1,510	1,510	1,510	1,510	1,510	1,510
LIVESTOCK	UPSHUR	SABINE	STK	041005230	D	1005	1005	230	5	522	418	418	418	418	418	418
MANUFACTURING	UPSHUR	CYPRESS	MFG	041001230	D	1001	1001	230	4	161	215	232	241	243	277	314
MANUFACTURING	UPSHUR	SABINE	MFG	041001230	D	1001	1001	230	5	0	0	0	0	0	0	0
MINING	UPSHUR	SABINE	MIN	041003230	D	1003	1003	230	5	0	0	0	0	0	0	0
MINING	UPSHUR	CYPRESS	MIN	041003230	D	1003	1003	230	4	1	1	1	1	1	1	0
STEAM ELECTRIC POWER	UPSHUR	CYPRESS	PWR	041002230	D	1002	1002	230	4	0	0	5,601	5,601	5,601	5,601	5,601
STEAM ELECTRIC POWER	UPSHUR	SABINE	PWR	041002230	D	1002	1002	230	5	0	0	0	0	0	0	0
CANTON	VAN ZANDT	SABINE	MUN	040143234	D	0143	94	234	5	649	694	757	814	891	951	1,039
EDGEWOOD	VAN ZANDT	SABINE	MUN	040268234	D	0268	181	234	5	172	215	231	248	266	281	309
GRAND SALINE	VAN ZANDT	SABINE	MUN	040354234	D	0354	246	234	5	453	583	636	684	749	804	880
VAN	VAN ZANDT	NECHES	MUN	040924234	D	0924	618	234	6	496	486	533	575	630	680	744
VAN	VAN ZANDT	SABINE	MUN	040924234	D	0924	618	234	5	26	25	27	30	33	35	38

TABLE 2: WATER DEMAND BY CITY AND CATEGORY

WUG NAME	COUNTY NAME	BASIN NAME	DATA CATEGORY	WUG NUM	RWPG	SEQ NUM	CITY NUM	COUNT Y NUM	BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
WILLS POINT	VAN ZANDT	SABINE	MUN	040974234	D	0974	656	234	5	204	294	320	341	369	395	433
WILLS POINT	VAN ZANDT	TRINITY	MUN	040974234	D	0974	656	234	8	205	295	322	343	371	397	434
COUNTY-OTHER	VAN ZANDT	SABINE	MUN	040996234	D	0996	757	234	5	1,610	1,885	2,092	2,281	2,453	2,608	2,740
COUNTY-OTHER	VAN ZANDT	NECHES	MUN	040996234	D	0996	757	234	6	1,042	1,169	1,299	1,414	1,518	1,606	1,684
COUNTY-OTHER	VAN ZANDT	TRINITY	MUN	040996234	D	0996	757	234	8	772	867	962	1,049	1,123	1,189	1,247
IRRIGATION	VAN ZANDT	SABINE	IRR	041004234	D	1004	1004	234	5	0	0	0	0	0	0	0
IRRIGATION	VAN ZANDT	NECHES	IRR	041004234	D	1004	1004	234	6	1,015	0	0	0	0	0	0
IRRIGATION	VAN ZANDT	TRINITY	IRR	041004234	D	1004	1004	234	8	0	220	220	220	220	220	220
LIVESTOCK	VAN ZANDT	TRINITY	STK	041005234	D	1005	1005	234	8	605	624	624	624	624	624	624
LIVESTOCK	VAN ZANDT	SABINE	STK	041005234	D	1005	1005	234	5	1,068	1,100	1,100	1,100	1,100	1,100	1,100
LIVESTOCK	VAN ZANDT	NECHES	STK	041005234	D	1005	1005	234	6	638	657	657	657	657	657	657
MANUFACTURING	VAN ZANDT	TRINITY	MFG	041001234	D	1001	1001	234	8	0	0	0	0	0	0	0
MANUFACTURING	VAN ZANDT	SABINE	MFG	041001234	D	1001	1001	234	5	607	280	344	396	451	508	566
MANUFACTURING	VAN ZANDT	NECHES	MFG	041001234	D	1001	1001	234	6	0	0	0	0	0	0	0
MINING	VAN ZANDT	SABINE	MIN	041003234	D	1003	1003	234	5	1,328	1,233	1,073	1,026	1,014	1,025	1,055
MINING	VAN ZANDT	NECHES	MIN	041003234	D	1003	1003	234	6	48	80	48	28	19	14	14
MINING	VAN ZANDT	TRINITY	MIN	041003234	D	1003	1003	234	8	45	46	46	45	44	45	46
STEAM ELECTRIC POWER	VAN ZANDT	NECHES	PWR	041002234	D	1002	1002	234	6	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	VAN ZANDT	TRINITY	PWR	041002234	D	1002	1002	234	8	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	VAN ZANDT	SABINE	PWR	041002234	D	1002	1002	234	5	0	0	0	0	0	0	0
HAWKINS	WOOD	SABINE	MUN	040385250	D	0385	701	250	5	162	244	260	273	294	309	337
MINEOLA	WOOD	SABINE	MUN	040599250	D	0599	406	250	5	933	867	929	980	1,057	1,114	1,209
QUITMAN	WOOD	SABINE	MUN	040731250	D	0731	490	250	5	350	392	423	450	484	517	560
WINNSBORO	WOOD	SABINE	MUN	040981250	D	0981	661	250	5	421	469	503	536	576	616	664
WINNSBORO	WOOD	CYPRESS	MUN	040981250	D	0981	661	250	4	22	24	27	28	30	32	35
COUNTY-OTHER	WOOD	SABINE	MUN	040996250	D	0996	757	250	5	3,009	2,951	3,107	3,248	3,485	3,641	4,015
COUNTY-OTHER	WOOD	CYPRESS	MUN	040996250	D	0996	757	250	4	258	241	254	265	283	295	323
IRRIGATION	WOOD	SABINE	IRR	041004250	D	1004	1004	250	5	179	235	235	235	235	235	235
IRRIGATION	WOOD	CYPRESS	IRR	041004250	D	1004	1004	250	4	40	119	119	119	119	119	119
LIVESTOCK	WOOD	CYPRESS	STK	041005250	D	1005	1005	250	4	215	202	202	202	202	202	202
LIVESTOCK	WOOD	SABINE	STK	041005250	D	1005	1005	250	5	2,513	2,360	2,360	2,360	2,360	2,360	2,360
MANUFACTURING	WOOD	SABINE	MFG	041001250	D	1001	1001	250	5	149	244	290	341	391	468	544
MANUFACTURING	WOOD	CYPRESS	MFG	041001250	D	1001	1001	250	4	0	0	0	0	0	0	0
MINING	WOOD	SABINE	MIN	041003250	D	1003	1003	250	5	562	2,102	17,584	17,344	17,107	16,107	4,641

TABLE 2: WATER DEMAND BY CITY AND CATEGORY																
WUG NAME	**COUNTY NAME**	**BASIN NAME**	**DATA CATEGORY**	**WUG NUM**	**RWPG**	**SEQ NUM**	**CITY NUM**	**COUNTY NUM**	**BASIN NUM**	**D1996**	**D2000**	**D2010**	**D2020**	**D2030**	**D2040**	**D2050**
MINING	WOOD	CYPRESS	MIN	041003250	D	1003	1003	250	4	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	WOOD	CYPRESS	PWR	041002250	D	1002	1002	250	4	0	0	0	0	0	0	0
STEAM ELECTRIC POWER	WOOD	SABINE	PWR	041002250	D	1002	1002	250	5	0	0	7,500	7,500	7,500	7,500	15,000

TABLE 3: WATER DEMAND BY MAJOR WATER PROVIDER OF MUNICIPAL AND OTHER CATEGORIES

MAJOR WATER PROVIDER NAME	SYSTEM NAME	NAME OF RECIPIENT OF WATER	RECIPENT'S CITY NAME	RECIPIENT'S COUNTY NAME	RECIPIENT'S BASIN NAME	RECIPIENT'S DATA CATEGORY	MWP NUM	WATER RECIPIENT FROM MWP NUM	RECIPIENT'S WUG ID	RECIPIENT'S RWPG	RECIPIENT'S SEQ NUM	RECIPIENT'S CITY NUM	RECIPIENT'S COUNTY NUM	RECIPIENT'S BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
CHEROKEE WATER COMPANY	CITY OF LONGVIEW	LONGVIEW	LONGVIEW	GREGG	SABINE	MUN	110	512010	040539000	D	0539	367	092	5	15360	15360	15360	15360	15360	15360	15360
CHEROKEE WATER COMPANY	CITY OF LONGVIEW	LONGVIEW	LONGVIEW	HARRISON	SABINE	MUN	110	512010	040539000	D	0539	367	102	5	640	640	640	640	640	640	640
CHEROKEE WATER COMPANY	SOUTHWESTERN ELECTRIC POWER CO.	KNOX LEE POWER PLANT	STEAM ELECTRIC	GREGG	SABINE	PWR	110	811400	040539092	D	0539	367	092	5	2000	2000	2000	2000	2000	2000	2000
																18000	**18000**	**18000**	**18000**	**18000**	**18000**
FRANKLIN COUNTY WATER DISTRICT	CITY OF MOUNT VERNON	MOUNT VERNON	MOUNT VERNON	FRANKLIN	CYPRESS	MUN	50	582250	040614000	D	0614	417	080	4	3000	3000	3000	3000	3000	3000	3000
FRANKLIN COUNTY WATER DISTRICT	CITY OF WINNSBORO	WINNSBORO	WINNSBORO	FRANKLIN	SABINE	MUN	50	952800	040981000	D	0981	661	080	5	450	450	450	450	450	450	450
FRANKLIN COUNTY WATER DISTRICT	CYPRESS SPRINGS WSC	COUNTY OTHER	COUNTY OTHER	FRANKLIN	SULPHUR	MUN	50	806825	040996080	D	0996	757	080	3	490	490	490	490	490	490	490
FRANKLIN COUNTY WATER DISTRICT	CYPRESS SPRINGS WSC	COUNTY OTHER	COUNTY OTHER	FRANKLIN	CYPRESS	MUN	50	806825	040996080	D	0996	757	080	4	2555	2555	2555	2555	2555	2555	2555
FRANKLIN COUNTY WATER DISTRICT	CYPRESS SPRINGS WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	CYPRESS	MUN	50	806825	040996112	D	0996	757	112	4	280	280	280	280	280	280	280
FRANKLIN COUNTY WATER DISTRICT	CYPRESS SPRINGS WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SULPHUR	MUN	50	806825	040996112	D	0996	757	112	3	70	70	70	70	70	70	70
FRANKLIN COUNTY WATER DISTRICT	CYPRESS SPRINGS WSC	COUNTY OTHER	COUNTY OTHER	TITUS	CYPRESS	MUN	50	806825	040996225	D	0996	757	225	4	35	35	35	35	35	35	35
FRANKLIN COUNTY WATER DISTRICT	CITY OF WINNSBORO	WINNSBORO	WINNSBORO	WOOD	SABINE	MUN	50	952800	040981000	D	0981	661	250	5	4550	4550	4550	4550	4550	4550	4550
FRANKLIN COUNTY WATER DISTRICT	CYPRESS SPRINGS WSC	COUNTY OTHER	COUNTY OTHER	WOOD	CYPRESS	MUN	50	806825	040996250	D	0996	757	250	4	70	70	70	70	70	70	70
																11500	**11500**	**11500**	**11500**	**11500**	**11500**
NETMWD	CITY OF PITTSBURG	PITTSBURG	PITTSBURG	CAMP	CYPRESS	MUN	60	683450	040701000	D	0701	469	032	4	1930	1930	1930	1930	1930	1930	1930
NETMWD	CITY OF PITTSBURG	PITTSBURG	PITTSBURG	CAMP	CYPRESS	MUN	60	683450	040701000	D	0701	469	032	4	11703	11703	11703	11703	11703	11703	11703
NETMWD	CITY OF HUGHES SPRINGS	HUGHES SPRINGS	HUGHES SPRINGS	CASS	CYPRESS	MUN	60	399600	040423000	D	0423	288	034	4	4650	4650	4650	4650	4650	4650	4650
NETMWD	CITY OF AVINGER	COUNTY OTHER	COUNTY OTHER	CASS	CYPRESS	MUN	60	43000	040996034	D	0996	757	034	4	1551	1551	1551	1551	1551	1551	1551
NETMWD	MIMS WSC	COUNTY OTHER	COUNTY OTHER	CASS	CYPRESS	MUN	60	370395	040996034	D	0996	757	034	4	168	168.2	168.2	168.2	168.2	168.2	168.2
NETMWD	CITY OF HUGHES SPRINGS	COUNTY OTHER	COUNTY OTHER	CASS	CYPRESS	MUN	60	399600	040996034	D	0996	757	034	4	98	98	98	98	98	98	98
NETMWD	CITY OF LONGVIEW	LONGVIEW	LONGVIEW	GREGG	SABINE	MUN	60	512010	040539000	D	0539	367	092	5	19200	19200	19200	19200	19200	19200	19200
NETMWD	CITY OF LONGVIEW	LONGVIEW	LONGVIEW	HARRISON	SABINE	MUN	60	512010	040539000	D	0539	367	102	5	800	800	800	800	800	800	800
NETMWD	STEAM ELECTRIC	STEAM ELECTRIC	STEAM ELECTRIC	HARRISON	SABINE	PWR	60		041002102	D	1002	1002	102	5	18000	18000	18000	18000	18000	18000	18000
NETMWD	CITY OF ORE CITY	COUNTY OTHER	COUNTY OTHER	MARION	CYPRESS	MUN	60	629000	040996158	D	0996	757	158	4	83	83.2	83.2	83.2	83.2	83.2	83.2
NETMWD	MIMS WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	MARION	CYPRESS	MUN	60	370395	040996158	D	0996	757	158	4	625	624.8	624.8	624.8	624.8	624.8	624.8
NETMWD	STEAM ELECTRIC	STEAM ELECTRIC	STEAM ELECTRIC	MARION	CYPRESS	PWR	60		041002158	D	1002	1002	158	4	6700	6700	6700	6700	6700	6700	6700
NETMWD	CITY OF JEFFERSON	JEFFERSON	JEFFERSON	MARION	CYPRESS	MUN	60	436800	040446000	D	0446	306	158	4	9776	9776	9776	9776	9776	9776	9776
NETMWD	CITY OF LONE STAR	LONESTAR	LONESTAR	MORRIS	CYPRESS	MUN	60	508750	040538000	D	0538	366	172	4	4841	4841	4841	4841	4841	4841	4841
NETMWD	CITY OF DAINGERFIELD	COUNTY OTHER	COUNTY OTHER	MORRIS	CYPRESS	MUN	60	205200	040996172	D	0996	757	172	4	243	243.2	243.2	243.2	243.2	243.2	243.2
NETMWD	CITY OF HUGHES SPRINGS	COUNTY OTHER	COUNTY OTHER	MORRIS	CYPRESS	MUN	60	399600	040996172	D	0996	757	172	4	1002	1002	1002	1002	1002	1002	1002
NETMWD	MIMS WSC	COUNTY OTHER	COUNTY OTHER	MORRIS	CYPRESS	MUN	60	370395	040996172	D	0996	757	172	4	8	8	8	8	8	8	8
NETMWD	MANUFACTURING	MANUFACTURING	MANUFACTURING	MORRIS	CYPRESS	MFG	60		041001172	D	1001	1001	172	4	32400	32400	32400	32400	32400	32400	32400
NETMWD	CITY OF DAINGERFIELD	DAINGERFIELD	DAINGERFIELD	MORRIS	CYPRESS	MUN	60	205200	040224000	D	0224	148	172	4	10329	10329	10329	10329	10329	10329	10329
NETMWD	CITY OF HUGHES SPRINGS	HUGHES SPRINGS	HUGHES SPRINGS	MORRIS	CYPRESS	MUN	60	399600	040423000	D	0423	288	172	4	31	31	31	31	31	31	31
NETMWD	STEAM ELECTRIC	STEAM ELECTRIC	STEAM ELECTRIC	MORRIS	CYPRESS	PWR	60		041002172	D	1002	1002	172	4	12000	12000	12000	12000	12000	12000	12000
NETMWD	STEAM ELECTRIC	STEAM ELECTRIC	STEAM ELECTRIC	TITUS	CYPRESS	PWR	60		041002225	D	1002	1002	225	4	10000	10000	10000	10000	10000	10000	10000
NETMWD	CITY OF ORE CITY	ORECITY	ORECITY	UPSHUR	CYPRESS	MUN	60	629000	040661000	D	0661	728	230	4	2690	2690	2690	2690	2690	2690	2690
																148828.4	**148828.4**	**148828.4**	**148828.4**	**148828.4**	**148828.4**
SABINE RIVER AUTHORITY	CITY OF LONGVIEW	LONGVIEW	LONGVIEW	GREGG	SABINE	MUN	95	512010	040539000	D	0539	367	092	5	19200	19200	19200	19200	19200	19200	19200
SABINE RIVER AUTHORITY	CITY OF KILGORE	KILGORE	KILGORE	GREGG	SABINE	MUN	95	465800	040469000	D	0469	321	092	5	6049	6049	6049	6049	6049	6049	6049
SABINE RIVER AUTHORITY	CITY OF KILGORE	COUNTY OTHER	COUNTY OTHER	GREGG	SABINE	MUN	95	465800	040996092	D	0996	757	092	5	672	672	672	672	672	672	672
SABINE RIVER AUTHORITY	CITY OF LONGVIEW	LONGVIEW	LONGVIEW	HARRISON	SABINE	MUN	95	512010	040539000	D	0539	367	102	5	800	800	800	800	800	800	800
SABINE RIVER AUTHORITY	MANUFACTURING	MANUFACTURING	MANUFACTURING	HARRISON	SABINE	MFG	100		041001102	D	1001	1001	102	5	3500	3500	3500	3500	3500	3500	3500
SABINE RIVER AUTHORITY	MINING	MINING	MINING	HARRISON	SABINE	MIN	100		041003102	D	1003	1003	102	5	7000	7000	7000	7000	7000	7000	7000
SABINE RIVER AUTHORITY	CASH WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SABINE	MUN	95	138350	040996112	D	0996	757	112	5	57	57	57	57	57	57	57
SABINE RIVER AUTHORITY	CASH WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SABINE	MUN	95	138350	040996112	D	0996	757	112	5	50	50	50	50	50	50	50
SABINE RIVER AUTHORITY	CITY OF COMMERCE	COMMERCE	COMMERCE	HUNT	SULPHUR	MUN	95	177000	040195000	D	0195	129	116	3	8396	8396	8396	8396	4481	4481	4481
SABINE RIVER AUTHORITY	CITY OF GREENVILLE	GREENVILLE	GREENVILLE	HUNT	SABINE	MUN	95	342340	040361000	D	0361	250	116	5	21283	21283	21283	21283	21283	21283	21283
SABINE RIVER AUTHORITY	CITY OF WEST TAWAKONI	WEST TAWAKONI	WEST TAWAKONI	HUNT	SABINE	MUN	95	934890	040956000	D	0956	989	116	5	1120	1120	1120	1120	1120	1120	1120
SABINE RIVER AUTHORITY	CASH WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HUNT	SABINE	MUN	95	138350	040996116	D	0996	757	116	5	1511	1511	1511	1511	1511	1511	1511
SABINE RIVER AUTHORITY	CASH WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HUNT	SABINE	MUN	95	138350	040996116	D	0996	757	116	5	1696	1696	1696	1696	1696	1696	1696
SABINE RIVER AUTHORITY	COMBINED CONSUMERS WSC	COUNTY OTHER	COUNTY OTHER	HUNT	SABINE	MUN	95	602690	040996116	D	0996	757	116	5	2240	2240	2240	2240	2240	2240	2240
SABINE RIVER AUTHORITY	MAC BEE WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HUNT	SABINE	MUN	95	546300	040996116	D	0996	757	116	5	1493	1493	1493	1493	1493	1493	1493
SABINE RIVER AUTHORITY	MAC BEE WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HUNT	SABINE	MUN	95	546300	040996116	D	0996	757	116	5	747	747	747	747	747	747	747
SABINE RIVER AUTHORITY	CITY OF EMORY	EMORY	EMORY	RAINS	SABINE	MUN	95	267000	040282000	D	0282	191	190	5	2016	2016	2016	2016	2016	2016	2016
SABINE RIVER AUTHORITY	CITY OF POINT	POINT	POINT	RAINS	SABINE	MUN	95	688857	040706000	D	0706	939	190	5	448	448	448	448	448	448	448
SABINE RIVER AUTHORITY	CITY OF WILLS POINT	WILLS POINT	WILLS POINT	VAN ZANDT	SABINE	MUN	90	949520	040974000	D	0974	656	234	5	2540	2540	2540	2540	2540	2540	2540
SABINE RIVER AUTHORITY	MAC BEE WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	VAN ZANDT	SABINE	MUN	90	546300	040996234	D	0996	757	234	5	2106	2106	2106	2106	2106	2106	2106
SABINE RIVER AUTHORITY	MAC BEE WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	VAN ZANDT	SABINE	MUN	90	546300	040996234	D	0996	757	234	5	1053	1053	1053	1053	1053	1053	1053
SABINE RIVER AUTHORITY	SOUTH TAWAKONI WATER SUPPLY CORP	COUNTY OTHER	COUNTY OTHER	VAN ZANDT	SABINE	MUN	90	809103	040996234	D	0996	757	234	5	560	560	560	560	560	560	560
SABINE RIVER AUTHORITY	CITY OF QUITMAN	QUITMAN	QUITMAN	WOOD	SABINE	MUN	90	712000	040731000	D	0731	490	250	5	1120	1120	1120	1120	1120	1120	1120
SABINE RIVER AUTHORITY	CITY OF EDGEWOOD	EDGEWOOD	EDGEWOOD	VAN ZANDT	SABINE	MUN	90	253920	040268000	D	0268	181	234	5	840	840	840	840	840	840	840
																86497	**86497**	**86497**	**82582**	**82582**	**82582**
TITUS COUNTY FRESH WATER DISTRICT	CITY OF MOUNT PLEASANT	MOUNT PLEASANT	MOUNT PLEASANT	TITUS	CYPRESS	MUN	70	582250	040613000	D	0613	416	225	4	10000	10000	10000	10000	10000	10000	10000
TITUS COUNTY FRESH WATER DISTRICT	TEXAS UTILITIES	MINING	MINING	TITUS	CYPRESS	MIN	70		041003225	D	1003	1003	225	4	38500	38500	38500	38500	38500	38500	38500
																48500	**48500**	**48500**	**48500**	**48500**	**48500**
CITY OF GREENVILLE	CITY OF CADDO MILLS	CADDOMILLS	CADDOMILLS	HUNT	SABINE	MUN	3E+05	127500	040135000	D	0135	685	116	5	166	166	166	174	183	191	197
CITY OF GREENVILLE	CITY OF GREENVILLE	GREENVILLE	GREENVILLE	HUNT	SABINE	MUN	3E+05	342340	040361000	D	0361	250	116	5	4261	6291	6689	7021	7520	8034	8620
CITY OF GREENVILLE	JACOBIA WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HUNT	SABINE	MUN	3E+05	432950	040996116	D	0996	757	116	5	336	336	336	336	336	336	336
CITY OF GREENVILLE	MANUFACTURING	MANUFACTURING	GREENVILLE	HUNT	SULPHUR	MFG	3E+05		041001116	D	1001	1001	116	3	51	190	246	314	396	499	620
CITY OF GREENVILLE	MANUFACTURING	MANUFACTURING	GREENVILLE	HUNT	SABINE	MFG	3E+05		041001116	D	1001	1001	116	5	725	550	572	589	602	630	656
CITY OF GREENVILLE	MINING	MINING	GREENVILLE	HUNT	SABINE	MIN	3E+05		041003116	D	1003	1003	116	5	0	24	25	27	33	35	45
CITY OF GREENVILLE	STEAM ELECTRIC	STEAM ELECTRIC	GREENVILLE	HUNT	SABINE	PWR	3E+05		041002116	D	1002	1002	116	5	405	800	800	800	800	800	800
																8357	**8834**	**9261**	**9870**	**10525**	**11274**
CITY OF LONGVIEW	CITY OF WHITE OAK	WHITE OAK	WHITE OAK	GREGG	SABINE	MUN	5E+05	941955	040963000	D	0963	649	092	5	1088	1087.5	1087.5	1087.5	1087.5	1087.5	1087.5

TABLE 3: WATER DEMAND BY MAJOR WATER PROVIDER OF MUNICIPAL AND OTHER CATEGORIES

MAJOR WATER PROVIDER NAME	SYSTEM NAME	NAME OF RECIPIENT OF WATER	RECIPIENT'S CITY NAME	RECIPIENT'S COUNTY NAME	RECIPIENT'S BASIN NAME	RECIPIENT'S DATA CATEGORY	MWP NUM	WATER RECIPIENT FROM MWP NUM	RECIPIENT'S WUG ID	RECIPIENT'S RWPG	RECIPIENT'S SEQ NUM	RECIPIENT'S CITY NUM	RECIPIENT'S COUNTY NUM	RECIPIENT'S BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
CITY OF LONGVIEW	C&C MOBILE HOME PARK	COUNTY OTHER	COUNTY OTHER	GREGG	SABINE	MUN	5E+05	116270	040996092	D	0996	757	092	5	18	17.9	17.9	17.9	17.9	17.9	17.9
CITY OF LONGVIEW	ELDERVILLE WSC.	COUNTY OTHER	COUNTY OTHER	GREGG	SABINE	MUN	5E+05	255400	040996092	D	0996	757	092	5	516	515.6	515.6	515.6	570.4	646.4	744.4
CITY OF LONGVIEW	TRYON ROAD WSC.	COUNTY OTHER	COUNTY OTHER	GREGG	SABINE	MUN	5E+05	876750	040996092	D	0996	757	092	5	412	412.1	412.1	412.1	412.1	412.1	412.1
CITY OF LONGVIEW	TRYON ROAD WSC.	COUNTY OTHER	COUNTY OTHER	GREGG	CYPRESS	MUN	5E+05	876750	040996092	D	0996	757	092	4	516	516	516	516	516	516	516
CITY OF LONGVIEW	CITY OF WHITE OAK	COUNTY OTHER	COUNTY OTHER	GREGG	SABINE	MUN	5E+05	941955	040996092	D	0996	757	092	5	12	12.3	12.3	12.3	12.3	12.3	12.3
CITY OF LONGVIEW	CITY OF HALLSVILLE	HALLSVILLE	HALLSVILLE	HARRISON	SABINE	MUN	5E+05	366000	040374000	D	0374	260	102	5	368	368.3	368.3	368.3	368.3	368.3	368.3
CITY OF LONGVIEW	GUM SPRINGS WSC.	COUNTY OTHER	COUNTY OTHER	HARRISON	SABINE	MUN	5E+05	358500	040996102	D	0996	757	102	5	366	366.3	406.3	422.3	444.3	461.3	474.3
CITY OF LONGVIEW	GUM SPRINGS WSC.	COUNTY OTHER	COUNTY OTHER	HARRISON	CYPRESS	MUN	5E+05	358500	040996102	D	0996	757	102	4	49	48.7	184.7	331.7	461.7	579.7	686.7
CITY OF LONGVIEW	TRYON ROAD WSC	COUNTY OTHER	COUNTY OTHER	HARRISON	CYPRESS	MUN	5E+05	876750	040996102	D	0996	757	102	4	103	103.1	103.1	103.1	103.1	103.1	103.1
CITY OF LONGVIEW	CITY OF WHITE OAK	COUNTY OTHER	COUNTY OTHER	UPSHUR	SABINE	MUN	5E+05	941955	040996230	D	0996	757	230	5	20	20.2	20.2	20.2	20.2	20.2	20.2
CITY OF LONGVIEW	CITY OF LONGVIEW	LONGVIEW-MUNICIPAL	LONGVIEW	GREGG	SABINE	MUN	5E+05	512010	040539000	D	0539	367	092	5	13740	15498	15913	16484	17193	17889	18847
CITY OF LONGVIEW	CITY OF LONGVIEW	LONGVIEW-MUNICIPAL	LONGVIEW	HARRISON	SABINE	MUN	5E+05	512010	040539000	D	0539	367	102	5	324	366	382	391	408	427	451
CITY OF LONGVIEW	CITY OF LONGVIEW	LONGVIEW-MANUFACTURING	LONGVIEW	GREGG	SABINE	MFG	5E+05	512010	041001092	D	1001	1001	092	5	3704	3021	3393	3824	4294	4843	5428
CITY OF LONGVIEW	CITY OF LONGVIEW	LONGVIEW-MANUFACTURING	LONGVIEW	HARRISON	SABINE	MFG	5E+05	512010	041001102	D	1001	1001	102	5	3721	6224	7608	7988	8328	9083	9933
																28577	**30940**	**32494**	**34236.8**	**36466.8**	**39101.8**
CITY OF MARSHALL	CYPRESS VALLEY WATER SUPPLY CORP	COUNTY OTHER	COUNTY OTHER	HARRISON	CYPRESS	MUN	5E+05	202000	040996102	D	0996	757	102	4	5	5	5	5	5	5	5
CITY OF MARSHALL	GILL WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HARRISON	SABINE	MUN	5E+05	325500	040996102	D	0996	757	102	5	125	125	125	125	125	125	125
CITY OF MARSHALL	LEIGH WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HARRISON	CYPRESS	MUN	5E+05	490500	040996102	D	0996	757	102	4	184	184.13	184.13	184.13	184.13	184.13	184.13
CITY OF MARSHALL	TALLEY WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HARRISON	CYPRESS	MUN	5E+05	842820	040996102	D	0996	757	102	4	6	6	16	28	38	45	54
CITY OF MARSHALL	TALLEY WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HARRISON	SABINE	MUN	5E+05	842820	040996102	D	0996	757	102	5	25	25	33	37	41	45	49
CITY OF MARSHALL	CITY OF MARSHALL	MARSHALL	MARSHALL	HARRISON	CYPRESS	MUN	5E+05	538090	040566000	D	0566	388	102	4	239	245	256	259	270	280	298
CITY OF MARSHALL	CITY OF MARSHALL	MARSHALL	MARSHALL	HARRISON	SABINE	MUN	5E+05	538090	040566000	D	0566	388	102	5	4550	4661	4857	4918	5123	5329	5657
																5251.13	**5476.13**	**5556.13**	**5786.13**	**6013.13**	**6372.13**
CITY OF MOUNT PLEASANT	TRI WATER SUPPLY CORPORATION	COUNTY OTHER	COUNTY OTHER	FRANKLIN	CYPRESS	MUN	6E+05	872795	040996080	D	0996	757	080	4		45	48	54	61	68	76
CITY OF MOUNT PLEASANT	TRI WATER SUPPLY CORPORATION	COUNTY OTHER	COUNTY OTHER	MORRIS	CYPRESS	MUN	6E+05	872795	040996172	D	0996	757	172	4		122	124	125	126	127	127
CITY OF MOUNT PLEASANT	CITY OF WINFIELD	COUNTY OTHER	COUNTY OTHER	TITUS	CYPRESS	MUN	6E+05	951800	040996225	D	0996	757	225	4	153	153	153	153	153	153	153
CITY OF MOUNT PLEASANT	TRI WATER SUPPLY CORPORATION	COUNTY OTHER	COUNTY OTHER	TITUS	CYPRESS	MUN	6E+05	872795	040996225	D	0996	757	225	4		753	782	867	926	989	1039
CITY OF MOUNT PLEASANT	TRI WATER SUPPLY CORPORATION	COUNTY OTHER	COUNTY OTHER	TITUS	SULPHUR	MUN	6E+05	872795	040996225	D	0996	757	225	3		515	522	578	617	659	693
CITY OF MOUNT PLEASANT	MANUFACTURING	MANUFACTURING	MANUFACTURING	TITUS	CYPRESS	MFG	6E+05		041001225	D	1001	1001	225	4	2537	3421	3421	3421	3421	3650	3882
CITY OF MOUNT PLEASANT	CITY OF MOUNT PLEASANT	MT. PLEASANT	MT. PLEASANT	TITUS	CYPRESS	MUN	6E+05	582250	040613000	D	0613	416	225	4	3693	3012	3167	3312	3512	3722	3970
CITY OF MOUNT PLEASANT	LAKE BOB SANDLIN STATE PARK	COUNTY OTHER	COUNTY OTHER	TITUS	CYPRESS	MUN	6E+05		040996225	D	0996	757	225	4	1	1	1	1	1	1	1
CITY OF MOUNT PLEASANT	MINING	MINING	MINING	TITUS	CYPRESS	MIN	6E+05		041003225	D	1003	1003	225	4	1620	1098	450	315	272	275	324
																9120	**8668**	**8826**	**9089**	**9644**	**10265**
CITY OF PARIS	CITY OF PARIS	PARIS	PARIS	LAMAR	RED	MUN	7E+05	651250	040678000	D	0678	455	139	2	2315	3792	3875	3952	4119	4276	4487
CITY OF PARIS	CITY OF PARIS	PARIS	PARIS	LAMAR	SULPHUR	MUN	7E+05	651250	040678000	D	0678	455	139	3	2215	3791	3875	3952	4118	4276	4486
CITY OF PARIS	CITY OF PARIS	PARIS	PARIS	LAMAR	RED	MUN	7E+05	651250	040678000	D	0678	455	139	2		500	500	500	500	500	500
CITY OF PARIS	CITY OF PARIS	PARIS	PARIS	LAMAR	SULPHUR	MUN	7E+05	651250	040678000	D	0678	455	139	3		500	500	500	500	500	500
CITY OF PARIS	LAMAR COUNTY WATER SUPPLY DIST.	COUNTY OTHER	COUNTY OTHER	LAMAR	SULPHUR	MUN	7E+05	482989	040996139	D	0996	757	139	3	2000	2000	2000	2000	2000	2000	2000
CITY OF PARIS	LAMAR COUNTY WATER SUPPLY DIST.	COUNTY OTHER	COUNTY OTHER	LAMAR	RED	MUN	7E+05	482989	040996139	D	0996	757	139	2	2000	2000	2000	2000	2000	2000	2000
CITY OF PARIS	M-J-C WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	LAMAR	SULPHUR	MUN	7E+05	573200	040996139	D	0996	757	139	3	92	92	92	92	92	92	92
CITY OF PARIS	MANUFACTURING	MANUFACTURING	MANUFACTURING	LAMAR	RED	MFG	7E+05		041001139	D	1001	1001	139	2	622	555	565	575	582	621	670
CITY OF PARIS	MANUFACTURING	MANUFACTURING	MANUFACTURING	LAMAR	SULPHUR	MFG	7E+05		041001139	D	1001	1001	139	3	4557	4867	5648	6357	6993	7969	8938
CITY OF PARIS	STEAM ELECTRIC	STEAM ELECTRIC	STEAM ELECTRIC	LAMAR	RED	PWR	7E+05		041002139	D	1002	1002	139	2	0	12209	12209	12209	12209	12209	12209
CITY OF PARIS	LAMAR COUNTY WSD	COUNTY OTHER	COUNTY OTHER	RED RIVER	RED	MUN	7E+05	482989	040996194	D	0996	757	194	2	801	801	801	801	801	801	801
CITY OF PARIS	LAMAR COUNTY WSD	COUNTY OTHER	COUNTY OTHER	RED RIVER	SULPHUR	MUN	7E+05	482989	040996194	D	0996	757	194	3	800	800	800	800	800	800	800
																31907	**32865**	**33738**	**34714**	**36044**	**37483**
CITY OF SULPHUR SPRINGS	MANUFACTURING	MANUFACTURING	MANUFACTURING	FRANKLIN	CYPRESS	MFG	8E+05		041001080	D	1001	1001	080	4	0	5640	5640	5640	5640	5640	5640
CITY OF SULPHUR SPRINGS	CITY OF SULPHUR SPRINGS	SULPHUR SPRINGS	SULPHUR SPRINGS	HOPKINS	SULPHUR	MUN	8E+05	828100	040869000	D	0869	586	112	3	2802	4836	5234	5167	5104	4975	4845
CITY OF SULPHUR SPRINGS	BRASHEAR WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HOPKINS	SABINE	MUN	8E+05	94920	040996112	D	0996	757	112	5		47	47	46	46	45	46
CITY OF SULPHUR SPRINGS	BRASHEAR WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	HOPKINS	SULPHUR	MUN	8E+05	94920	040996112	D	0996	757	112	3		126	76	74	74	74	75
CITY OF SULPHUR SPRINGS	BRINKER WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SULPHUR	MUN	8E+05	98150	040996112	D	0996	757	112	3		70	114	221	275	281	294
CITY OF SULPHUR SPRINGS	GAFFORD CHAPEL WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SULPHUR	MUN	8E+05	313520	040996112	D	0996	757	112	3		62	109	130	234	254	280
CITY OF SULPHUR SPRINGS	MARTIN SPRINGS WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SABINE	MUN	8E+05	539908	040996112	D	0996	757	112	5		223	376	402	452	463	481
CITY OF SULPHUR SPRINGS	NORTH HOPKINS WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SULPHUR	MUN	8E+05	607830	040996112	D	0996	757	112	3		713	778	831	893	954	1030
CITY OF SULPHUR SPRINGS	PLEASANT HILL WTR. SUP. CORP. #2	COUNTY OTHER	COUNTY OTHER	HOPKINS	SULPHUR	MUN	8E+05	686810	040996112	D	0996	757	112	3		28	30	31	33	35	37
CITY OF SULPHUR SPRINGS	SHADY GROVE # 2 WSC	COUNTY OTHER	COUNTY OTHER	HOPKINS	SULPHUR	MUN	8E+05	788548	040996112	D	0996	757	112	3		72	76	79	84	88	94
CITY OF SULPHUR SPRINGS	MANUFACTURING	MANUFACTURING	MANUFACTURING	HOPKINS	SULPHUR	MFG	8E+05		041001112	D	1001	1001	112	3	627	2666	2861	3024	3151	3409	3668
CITY OF SULPHUR SPRINGS	LIVESTOCK	LIVESTOCK	LIVESTOCK	HOPKINS	SULPHUR	STK	8E+05		041005112	D	1005	1005	112	3	4046	2221	2310	2431	2696	2711	3000
																16704	**17651**	**18076**	**18682**	**18929**	**19490**
CITY OF TEXARKANA	CITY OF DEKALB	DE KALB	DE KALB	BOWIE	RED	MUN	8E+05	218800	040232000	D	0232	155	019	2	235	235	235	235	235	235	235
CITY OF TEXARKANA	CITY OF DEKALB	DE KALB	DE KALB	BOWIE	SULPHUR	MUN	8E+05	218800	040232000	D	0232	155	019	3	204	204	204	204	204	204	204
CITY OF TEXARKANA	CITY OF HOOKS	HOOKS	HOOKS	BOWIE	SULPHUR	MUN	8E+05	395330	040416000	D	0416	284	019	3	0	0	0	0	0	0	0
CITY OF TEXARKANA	CITY OF HOOKS	HOOKS	HOOKS	BOWIE	RED	MUN	8E+05	395330	040416000	D	0416	284	019	2	500	500	500	500	500	500	528
CITY OF TEXARKANA	CITY OF MAUD	MAUD	MAUD	BOWIE	SULPHUR	MUN	8E+05	543800	040572000	D	0572	393	019	3	246	246	246	246	246	246	246
CITY OF TEXARKANA	CITY OF NASH	NASH	NASH	BOWIE	SULPHUR	MUN	8E+05	592900	040622000	D	0622	423	019	3	368	368	368	368	368	368	368
CITY OF TEXARKANA	CITY OF NEW BOSTON	NEW BOSTON	NEW BOSTON	BOWIE	RED	MUN	8E+05	601000	040628000	D	0628	429	019	2	157	157	233	243	256	269	285
CITY OF TEXARKANA	CITY OF NEW BOSTON	NEW BOSTON	NEW BOSTON	BOWIE	SULPHUR	MUN	8E+05	601000	040628000	D	0628	429	019	3	627	627	931	974	1024	1077	1140
CITY OF TEXARKANA	CITY OF REDWATER	REDWATER	REDWATER	BOWIE	SULPHUR	MUN	8E+05	721200	040740000	D	0740	945	019	3	147	64	147	152	223	258	296
CITY OF TEXARKANA	CITY OF TEXARKANA	TEXARKANA	TEXARKANA	BOWIE	SULPHUR	MUN	8E+05	848000	040889000	D	0889	601	019	3	4698	7350	7587	7814	8162	8476	8890
CITY OF TEXARKANA	CITY OF WAKE VILLAGE	WAKE VILLAGE	WAKE VILLAGE	BOWIE	SULPHUR	MUN	8E+05	914400	040937000	D	0937	628	019	3	358	358	690	718	743	764	781
CITY OF TEXARKANA	CENTRAL BOWIE WSC	COUNTY OTHER	COUNTY OTHER	BOWIE	SULPHUR	MUN	8E+05	143790	040996019	D	0996	757	019	3	376	206	206	879	897	1035	1412
CITY OF TEXARKANA	CENTRAL BOWIE WSC	COUNTY OTHER	COUNTY OTHER	BOWIE	RED	MUN	8E+05	143790	040996019	D	0996	757	019	2	94	52	52	220	224	259	353
CITY OF TEXARKANA	FEDERAL CORRECTION INST.	COUNTY OTHER	COUNTY OTHER	BOWIE	SULPHUR	MUN	8E+05	283685	040996019	D	0996	757	019	3		230	235	240	250	261	275
CITY OF TEXARKANA	MACEDONIA-EYLAU MUD #1	COUNTY OTHER	COUNTY OTHER	BOWIE	SULPHUR	MUN	8E+05	521680	040996019	D	0996	757	019	3	552	552	552	552	1151	1312	1412
CITY OF TEXARKANA	OAK GROVE WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	BOWIE	RED	MUN	8E+05	617440	040996019	D	0996	757	019	2	37	37	37	50	62	70	78
CITY OF TEXARKANA	OAK GROVE WATER SUPPLY CORP.	COUNTY OTHER	COUNTY OTHER	BOWIE	SULPHUR	MUN	8E+05	617440	040996019	D	0996	757	019	3	37	37	37	50	63	70	79
CITY OF TEXARKANA	MANUFACTURING	MANUFACTURING	MANUFACTURING	BOWIE	RED	MFG	8E+05		041001019	D	1001	1001	019	2	5	7	9	11	14	17	20
CITY OF TEXARKANA	MANUFACTURING	MANUFACTURING	MANUFACTURING	BOWIE	SULPHUR	MFG	8E+05		041001019	D	1001	1001	019	3	1864	1909	2115	2327	2548	2781	3023

TABLE 3: WATER DEMAND BY MAJOR WATER PROVIDER OF MUNICIPAL AND OTHER CATEGORIES

MAJOR WATER PROVIDER NAME	SYSTEM NAME	NAME OF RECIPIENT OF WATER	RECIPENT'S CITY NAME	RECIPIENT'S COUNTY NAME	RECIPIENT'S BASIN NAME	RECIPIENT'S DATA CATEGORY	MWP NUM	WATER RECIPIENT FROM MWP NUM	RECIPIENT'S WUG ID	RECIPIENT'S RWPG	RECIPIENT'S SEQ NUM	RECIPIENT'S CITY NUM	RECIPIENT'S COUNTY NUM	RECIPIENT'S BASIN NUM	D1996	D2000	D2010	D2020	D2030	D2040	D2050
CITY OF TEXARKANA	CITY OF DE KALB	COUNTY OTHER	COUNTY OTHER	BOWIE	SULPHUR	MUN	8E+05	218800	040996019	D	0996	757	019	3	31	31	31	31	31	31	31
CITY OF TEXARKANA	CITY OF REDWATER	COUNTY OTHER	COUNTY OTHER	BOWIE	SULPHUR	MUN	8E+05	721200	040996019	D	0996	757	019	3	83	83	188	193	283	329	377
CITY OF TEXARKANA	CITY OF ATLANTA	ATLANTA	ATLANTA	CASS	CYPRESS	MUN	8E+05	39000	040042000	D	0042	29	034	4	26	1878	1878	1878	1878	1878	1878
CITY OF TEXARKANA	CITY OF QUEEN CITY	QUEEN CITY	QUEEN CITY	CASS	SULPHUR	MUN	8E+05	709600	040728000	D	0728	489	034	3	193	193	193	193	193	193	203
CITY OF TEXARKANA	CITY OF QUEEN CITY	QUEEN CITY	QUEEN CITY	CASS	CYPRESS	MUN	8E+05	709600	040728000	D	0728	489	034	4	155	155	155	155	155	155	165
CITY OF TEXARKANA	CITY OF DOMINO	COUNTY OTHER	COUNTY OTHER	CASS	SULPHUR	MUN	8E+05	232810	040996034	D	0996	757	034	3	55	55.24	55.24	55.24	55.24	55.24	55.24
CITY OF TEXARKANA	MANUFACTURING	MANUFACTURING	MANUFACTURING	CASS	SULPHUR	MFG	8E+05		041001034	D	1001	1001	034	3	79066	80082	76814	76814	74508	77487	80589
CITY OF TEXARKANA	CITY OF ATLANTA	COUNTY OTHER	COUNTY OTHER	CASS	CYPRESS	MUN	8E+05	39000	040996034	D	0996	757	034	4	26	26	26	26	26	26	26
CITY OF TEXARKANA	CITY OF QUEEN CITY	COUNTY OTHER	COUNTY OTHER	CASS	CYPRESS	MUN	8E+05	709600	040996034	D	0996	757	034	4	17	17	17	17	17	17	17
CITY OF TEXARKANA	CITY OF ANNONA	COUNTY OTHER	COUNTY OTHER	RED RIVER	SULPHUR	MUN	8E+05	29650	040996194	D	0996	757	194	3	68	68	68	68	68	68	68
CITY OF TEXARKANA	CITY OF AVERY	COUNTY OTHER	COUNTY OTHER	RED RIVER	SULPHUR	MUN	8E+05	42295	040996194	D	0996	757	194	3	37	37	37	37	37	37	37
CITY OF TEXARKANA	CITY OF AVERY	COUNTY OTHER	COUNTY OTHER	RED RIVER	RED	MUN	8E+05	42295	040996194	D	0996	757	194	2	55	55	55	55	85	96	104
CITY OF TEXARKANA	OAK GROVE WSC	COUNTY OTHER	COUNTY OTHER	RED RIVER	SULPHUR	MUN	8E+05	617440	040996194	D	0996	757	194	3	8	8	8	12	14	16	18
CITY OF TEXARKANA	RED RIVER COUNTY WSC	COUNTY OTHER	COUNTY OTHER	RED RIVER	SULPHUR	MUN	8E+05	721179	040996194	D	0996	757	194	3	55	55	55	55	55	55	55
CITY OF TEXARKANA	RED RIVER COUNTY WSC	COUNTY OTHER	COUNTY OTHER	RED RIVER	RED	MUN	8E+05	721179	040996194	D	0996	757	194	2	55	55	55	55	55	55	55
																95937.24	**94019.24**	**95427.24**	**94630.24**	**98700.24**	**103303.24**

Table 4 - Northeast Texas Region Water Supply Sources

Name of Source (Reservoir/ Aquifer)	Type of Supply	Source Region	Source County	Source Basin	Source Identifier	Supply During Drought of Record Conditions (AF/yr) Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
LAKE TEXOMA	00	C		02	02230	932,950	932,950	932,950	932,950	932,950	932,950
PAT MAYSE LAKE	00	D		02	02290	59,900	59,570	59,200	58,900	58,600	58,300
CROOK LAKE	00	D		02	02300	1,100	1,100	1,100	1,100	1,100	1,100
BIG CREEK LAKE	00	D		03	03000	1,518	1,518	1,518	1,518	1,518	1,518
COOPER RESERVOIR	00	D		03	03010	137,344	136,335	135,326	134,317	133,308	132,298
LAKE SULPHUR SPRINGS	00	D		03	03040	11,100	11,100	11,100	11,100	11,100	11,100
WRIGHT PATMAN LAKE	00	D		03	03080	282,000	282,000	282,000	282,000	282,000	282,000
RIVER CREST LAKE*	00	D			03240	10,000	10,000	10,000	10,000	10,000	10,000
SULPHUR (ROR)	00	D		03	03500	10,000	10,000	10,000	10,000	10,000	10,000
LAKE CYPRESS SPRINGS*	00	D		04	04010	16,200	16,200	16,200	16,200	16,200	16,200
MONTICELLO LAKE*	00	D		04	04020	7,700	7,700	7,700	7,700	7,700	7,700
LAKE BOB SANDLIN*	00	D		04	04030	60,500	60,500	60,500	60,500	60,500	60,500
WELSH RESERVOIR*	00	D		04	04040	18,000	18,000	18,000	18,000	18,000	18,000
ELLISON CREEK LAKE*	00	D		04	04050	22,100	22,100	22,100	22,100	22,100	22,100
JOHNSON CREEK LAKE*	00	D		04	04060	6,700	6,700	6,700	6,700	6,700	6,700
LAKE O' THE PINES*	00	D		04	04070	130,600	130,600	130,600	130,600	130,600	130,600
CADDO LAKE*	00	D		04	04100	10,000	10,000	10,000	10,000	10,000	10,000
GILMER LAKE*	00	D		04	04170	7,470	7,470	7,470	7,470	7,470	7,470
CYPRESS ROR	00	D		04	04500	84,607	84,607	84,607	84,607	84,607	84,607
GREENVILLE CITY LAKE*	00	D		05	05000	1,205	1,205	1,205	1,205	1,205	1,205
LAKE TAWAKONI	00	D		05	05010	238,100	229,005	227,118	225,232	223,345	221,459
LAKE FORK	00	D		05	05040	188,600	187,776	187,590	187,403	187,217	187,031
LAKE GLADEWATER	00	D		05	05090	6,900	6,900	6,900	6,900	6,900	6,900

Name of Source (Reservoir/ Aquifer)	Type of Supply	Source Region	Source County	Source Basin	Source Identifier	Supply During Drought of Record Conditions (AF/yr) Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
LAKE CHEROKEE(3)	00	I		05	05110	39,400	39,400	39,400	39,400	39,400	39,400
TOLEDO BEND(4)	00	I		05	05170	1,043,300	1,043,300	1,043,300	1,043,300	1,043,300	1,043,300
SABINE ROR (u/s)	00	D		05	05500	166,156	166,156	166,156	166,156	166,156	166,156
LAKE QUITMAN(5)	00	D		05	05050	3,710	3,710	3,710	3,710	3,710	3,710
LAKE HOLBROOK(5)	00	D		05	05030	3,285	3,285	3,285	3,285	3,285	3,285
LAKE HAWKINS(5)	00	D		05	05060	8,035	8,035	8,035	8,035	8,035	8,035
LAKE WINNSBORO(5)	00	D		05	05070	5,760	5,760	5,760	5,760	5,760	5,760
LAKE TYLER(6)	00	I		06	06060	38,500	37,250	36,000	34,800	33,500	32,250
LAKE LAVON*	00	C		08	020C0	104,000	104,000	104,000	104,000	104,000	104,000
BIG SANDY CREEK (ROR)	00	D		05	05080	1,270	1,270	1,270	1,270	1,270	150
BLUNDELL CREEEK	00	D		04		16,300	16,300	16,300	16,300	16,300	16,300
BRANDY BRANCH	00	D		05		11,000	11,000	11,000	11,000	11,000	11,000
GARY'S CREEK	00	D		04		16,084	16,084	16,084	16,084	16,084	16,084
LAKE TANKERSLEY	00	D		04	04140	5,906	6,172	6,295	6,302	6,491	6,672
LAKE LANGFORD	00	D		03		420	420	420	420	420	420
LAKE LOMA	00	D		05		600	600	600	600	600	600
MILL CREEK LAKE	00	D		05	05270	706	706	706	706	706	706
EDGEWOOD CITY LAKE	00	D		05	05280	110	110	110	110	110	110
IRRIGATION LOCAL SUPPLY	00	D	019	02	019996	4,400	4,620	4,620	4,620	4,500	4,200
LIVESTOCK LOCAL SUPPLY	00	D	019	02	02997	289	289	289	289	289	289
LIVESTOCK LOCAL SUPPLY	00	D	019	03	03997	718	718	718	718	718	718
LIVESTOCK LOCAL SUPPLY	00	D	032	04	04997	395	395	395	395	395	395
LIVESTOCK LOCAL SUPPLY	00	D	034	04	04997	571	571	571	571	571	571
OTHER LOCAL SUPPLY	00	D	060	03	03999	23	24	25	26	26	26
IRRIGATION LOCAL SUPPLY	00	D	060	03	060996	1,420	1,420	1,420	1,420	1,420	1,420

Name of Source (Reservoir/ Aquifer)	Type of Supply	Source Region	Source County	Source Basin	Source Identifier	Supply During Drought of Record Conditions (AF/yr) Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
LIVESTOCK LOCAL SUPPLY	00	D	060	03	03997	451	451	451	451	451	451
IRRIGATION LOCAL SUPPLY	00	D	080	03	080996	21	21	21	21	21	21
LIVESTOCK LOCAL SUPPLY	00	D	080	04	04997	414	414	414	414	414	414
LIVESTOCK LOCAL SUPPLY	00	D	080	05	05997	2	2	2	2	2	2
LIVESTOCK LOCAL SUPPLY	00	D	080	03	03997	666	666	666	666	666	666
DIRECT REUSE	00	D	092	05	36083	727	4,065	4,562	4,622	4,688	4,765
OTHER LOCAL SUPPLY	00	D	092	05	05999	2,500	2,500	2,500	2,500	2,500	2,500
DIRECT REUSE	00	D	102	05	36084	0	2,769	3,045	2,935	2,725	2,633
IRRIGATION LOCAL SUPPLY	00	D	102	04	102996	28	28	28	28	28	28
IRRIGATION LOCAL SUPPLY	00	D	102	05	102996	39	39	39	39	39	39
LIVESTOCK LOCAL SUPPLY	00	D	102	04	04997	366	366	366	366	366	366
LIVESTOCK LOCAL SUPPLY	00	D	112	04	04997	147	147	147	147	147	147
LIVESTOCK LOCAL SUPPLY	00	D	112	05	05997	1,766	1,766	1,766	1,766	1,766	1,766
LIVESTOCK LOCAL SUPPLY	00	D	112	03	03997	2,550	2,461	2,340	2,075	2,060	1,771
OTHER LOCAL SUPPLY	00	D	116	03	03999	134	134	134	114	114	114
IRRIGATION LOCAL SUPPLY	00	D	116	05	116996	165	165	165	165	165	165
LIVESTOCK LOCAL SUPPLY	00	D	116	05	05997	896	896	896	896	896	896
LIVESTOCK LOCAL SUPPLY	00	D	116	03	03997	331	331	331	331	331	331
LIVESTOCK LOCAL SUPPLY	00	D	116	08	08997	6	6	6	6	6	7
IRRIGATION LOCAL SUPPLY	00	D	139	02	139996	2,310	2,310	2,310	2,310	2,310	2,310
LIVESTOCK LOCAL SUPPLY	00	D	139	02	02997	407	0	0	0	0	0
LIVESTOCK LOCAL SUPPLY	00	D	139	03	03997	480	480	480	489	489	504
IRRIGATION LOCAL SUPPLY	00	D	172	04	172996	190	188	186	184	182	180
LIVESTOCK LOCAL SUPPLY	00	D	172	04	04997	277	277	277	277	277	277
INDIRECT REUSE	00	D	172	04	35041	74,668	77,481	72,086	66,660	61,344	56,146

Name of Source (Reservoir/ Aquifer)	Type of Supply	Source Region	Source County	Source Basin	Source Identifier	Supply During Drought of Record Conditions (AF/yr) Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
IRRIGATION LOCAL SUPPLY	00	D	190	05	190996	20	20	20	20	20	20
LIVESTOCK LOCAL SUPPLY	00	D	190	05	05997	700	700	700	700	700	700
IRRIGATION LOCAL SUPPLY	00	D	194	02	194996	54	54	53	53	52	52
IRRIGATION LOCAL SUPPLY	00	D	194	03	194996	45	44	44	43	43	42
LIVESTOCK LOCAL SUPPLY	00	D	194	02	02997	289	289	289	289	289	289
LIVESTOCK LOCAL SUPPLY	00	D	194	03	03997	670	670	670	670	670	670
IRRIGATION LOCAL SUPPLY	00	D	212	05	212996	446	468	491	516	542	569
LIVESTOCK LOCAL SUPPLY	00	D	225	03	03997	133	133	133	133	133	133
LIVESTOCK LOCAL SUPPLY	00	D	230	04	04997	1,235	1,235	1,235	1,235	1,235	1,235
LIVESTOCK LOCAL SUPPLY	00	D	230	05	05997	363	363	363	363	363	363
OTHER LOCAL SUPPLY	00	D	234	05	05999	133	0	0	0	0	0
LIVESTOCK LOCAL SUPPLY	00	D	234	06	06997	599	599	599	599	599	599
LIVESTOCK LOCAL SUPPLY	00	D	234	05	05997	1,013	1,013	1,013	1,013	1,013	1,013
LIVESTOCK LOCAL SUPPLY	00	D	234	08	08997	599	587	516	440	333	276
OTHER LOCAL SUPPLY	00	D	250	05	05999	0	7,500	7,500	7,500	7,500	15,000
LIVESTOCK LOCAL SUPPLY	00	D	250	04	04997	202	202	202	202	202	202
LIVESTOCK LOCAL SUPPLY	00	D	250	05	05997	2,219	2,219	2,219	2,219	2,219	2,219
SURFACE WATER TOTAL						**3,815,213**	**3,818,990**	**3,809,618**	**3,799,238**	**3,789,066**	**3,785,176**
GROUNDWATER											
BLOSSOM	01	D	19	02	01907	73	73	73	73	73	73
NACATOCH	01	D	19	02	01920	1,050	1,050	1,050	1,050	1,050	1,050
CARRIZO-WILCOX	01	D	19	02	01910	111	111	111	111	111	111
CARRIZO-WILCOX	01	D	19	03	01910	13,889	13,889	13,889	13,889	13,889	13,889
NACATOCH	01	D	19	03	01920	584	584	584	584	584	584
OTHER AQUIFER	01	D	19	02	01922	124	124	124	124	124	124
CARRIZO-WILCOX	01	D	32	04	03210	2,500	2,500	2,500	2,500	2,500	2,500
QUEEN CITY	01	D	32	04	03224	11,725	11,725	11,725	11,725	11,725	11,725
CARRIZO-WILCOX	01	D	34	03	03410	15,733	15,733	15,733	15,733	15,733	15,733

Name of Source (Reservoir/ Aquifer)	Type of Supply	Source Region	Source County	Source Basin	Source Identifier	Supply During Drought of Record Conditions (AF/yr) Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
QUEEN CITY	01	D	34	03	03424	7,000	7,000	7,000	7,000	7,000	7,000
CARRIZO-WILCOX	01	D	34	04	03410	68,767	68,767	68,767	68,767	68,767	68,767
QUEEN CITY	01	D	34	04	03424	86,765	86,765	86,765	86,765	86,765	86,765
NACATOCH	01	D	60	03	06020	227	227	227	227	227	227
TRINITY	01	D	60	03	06028	1,117	1,117	1,117	1,117	1,117	1,117
WOODBINE	01	D	60	03	11629	10	10	10	10	10	10
CARRIZO-WILCOX	01	D	80	03	08010	950	545	545	545	545	545
NACATOCH	01	D	80	03	08020	10	10	10	10	10	10
CARRIZO-WILCOX	01	D	80	04	08010	1,750	2,155	2,155	2,155	2,155	2,155
CARRIZO-WILCOX	01	D	92	04	09210	1,333	1,333	1,333	1,333	1,333	1,333
QUEEN CITY	01	D	92	04	09224	4,690	4,690	4,690	4,690	4,690	4,690
CARRIZO-WILCOX	01	D	92	05	09210	20,267	20,267	20,267	20,267	20,267	20,267
QUEEN CITY	01	D	92	05	09224	9,646	9,646	9,646	9,646	9,646	9,646
CARRIZO-WILCOX	01	D	102	04	10210	71,429	71,429	71,429	71,429	71,429	71,429
QUEEN CITY	01	D	102	04	10224	23,450	23,450	23,450	23,450	23,450	23,450
CARRIZO-WILCOX	01	D	102	05	10210	112,071	112,071	112,071	112,071	112,071	112,071
OTHER AQUIFER	00	D	112	03	11222	245	242	240	237	236	236
QUEEN CITY	01	D	102	05	10224	2,756	2,756	2,756	2,756	2,756	2,756
CARRIZO-WILCOX	01	D	112	03	11210	1,100	1,100	1,100	1,100	1,100	1,100
NACATOCH	01	D	112	03	11220	32	32	32	32	32	32
CARRIZO-WILCOX	01	D	112	04	11210	68	68	68	68	68	68
CARRIZO-WILCOX	01	D	112	05	11210	4,033	4,033	4,033	4,033	4,033	4,033
NACATOCH	01	D	112	05	11220	319	319	319	319	319	319
CARRIZO-WILCOX	01	D	116	05	11610	5	5	5	5	5	5
NACATOCH	01	D	116	03	11620	400	400	400	400	400	400
TRINITY	01	D	116	03	11628	19	19	19	19	19	19
NACATOCH	01	D	116	05	11620	197	197	197	197	197	197
TRINITY	01	D	116	05	11628	433	433	433	433	433	433
NACATOCH	01	D	116	08	11620	2	2	2	2	2	2
TRINITY	01	D	116	08	11628	8	8	8	8	8	8
WOODBINE	01	D	116	03	11629	331	331	331	331	331	331
WOODBINE	01	D	116	05	11629	535	535	535	535	535	535
WOODBINE	01	D	116	08	11629	135	135	135	135	135	135
BLOSSOM	01	D	139	02	13907	10	10	10	10	10	10
NACATOCH	01	D	139	02	13920	3	3	3	3	3	3
TRINITY	01	D	139	02	13928	430	430	430	384	384	315
WOODBINE	01	D	139	02	13929	2,520	2,520	2,520	2,520	2,520	2,520
BLOSSOM	01	D	139	03	13907	68	68	68	68	68	68
NACATOCH	01	D	139	03	13920	45	45	45	45	45	45
TRINITY	01	D	139	02	13928	600	600	600	600	600	600

Name of Source (Reservoir/ Aquifer)	Type of Supply	Source Region	Source County	Source Basin	Source Identifier	Supply During Drought of Record Conditions (AF/yr) Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050
TRINITY	01	D	139	03	13928	477	477	477	426	426	349
CARRIZO-WILCOX	01	D	158	04	15810	1,300	1,300	1,300	1,300	1,300	1,300
QUEEN CITY	01	D	158	04	15824	30,485	30,485	30,485	30,485	30,485	30,485
CARRIZO-WILCOX	01	D	172	03	17210	27,596	27,596	27,596	27,596	27,596	27,596
CARRIZO-WILCOX	01	D	172	04	17210	109,004	109,004	109,004	109,004	109,004	109,004
QUEEN CITY	01	D	172	04	17224	16,415	16,415	16,415	16,415	16,415	16,415
CARRIZO-WILCOX	01	D	190	05	19010	1,400	1,400	1,400	1,400	1,400	1,400
NACATOCH	01	D	190	05	19020	2	2	2	2	2	2
BLOSSOM	01	D	194	02	19407	204	204	204	204	204	204
TRINITY	01	D	194	02	19428	383	383	383	328	328	268
WOODBINE	01	D	194	02	19429	700	700	700	700	700	700
BLOSSOM	01	D	194	03	19407	456	456	456	456	456	456
CARRIZO-WILCOX	01	D	194	03	19410	25	25	25	24	24	24
NACATOCH	01	D	194	02	19420	220	220	220	220	220	220
NACATOCH	01	D	194	03	19420	711	711	711	711	711	711
TRINITY	01	D	194	03	19428	219	219	219	187	187	154
CARRIZO-WILCOX	01	D	212	05	21210	7,894	7,894	7,894	7,894	7,894	7,894
CARRIZO-WILCOX	01	D	212	06	21210	300	300	300	300	300	300
QUEEN CITY	01	D	212	05	21224	46,852	46,852	46,852	46,852	46,852	46,852
CARRIZO-WILCOX	01	D	225	03	22510	700	700	700	700	700	700
CARRIZO-WILCOX	01	D	225	04	22510	6,400	6,400	6,400	6,400	6,400	6,400
NACATOCH	01	D	225	03	22520	550	550	550	550	550	550
CARRIZO-WILCOX	01	D	230	04	23010	4,027	4,027	4,027	4,027	4,027	4,027
QUEEN CITY	01	D	230	04	23024	53,935	53,935	53,935	53,935	53,935	53,935
CARRIZO-WILCOX	01	D	230	05	23010	1,473	1,473	1,473	1,473	1,473	1,473
QUEEN CITY	01	D	230	05	23024	22,048	22,048	22,048	22,048	22,048	22,048
CARRIZO-WILCOX	01	D	234	05	23410	3,567	3,567	3,567	3,567	3,567	3,567
CARRIZO-WILCOX	01	D	234	06	23410	1,843	1,843	1,843	1,843	1,843	1,843
QUEEN CITY	01	D	234	06	23424	7,839	7,839	7,839	7,839	7,839	7,839
CARRIZO-WILCOX	01	D	234	08	23410	390	390	390	390	390	390
CARRIZO-WILCOX	01	D	250	04	25010	164	164	164	164	164	164
QUEEN CITY	01	D	250	04	25024	7,035	7,035	7,035	7,035	7,035	7,035
CARRIZO-WILCOX	01	D	250	05	25010	9,000	9,000	9,000	9,000	9,000	9,000
QUEEN CITY	01	D	250	05	25024	53,742	53,742	53,742	53,742	53,742	53,742
GROUNDWATER TOTAL						**886,921**	**886,918**	**886,916**	**886,728**	**886,727**	**886,488**
TOTAL SUPPLY						**4,702,134**	**4,705,908**	**4,696,534**	**4,685,966**	**4,675,793**	**4,671,664**

Name of Source (Reservoir/ Aquifer)	Type of Supply	Source Region	Source County	Source Basin	Source Identifier	Supply During Drought of Record Conditions (AF/yr) Year 2000	Year 2010	Year 2020	Year 2030	Year 2040	Year 2050

* In the absence of information of sedimention effects on the projected firm yield, the firm yield for these reservoirs was held constant.

(1) Although Lake Texoma has a firm yield of 932,950 acre-feet per year, the planning group has elected to show no supply available due to a lack of current infrastructure to transport water to the North East Texas Region.

(2) Firm yield is estimated to be 282,000 AF/yr. However, the planning group has elected to show only the currently permitted amount (180,000 AF/yr) as available to the region.

(3) Lake Cherokee has a firm yield of 39,400 acre-feet/yr.

(4) Although Toledo Bend Reservoir has a firm yield of 1,043,300 acre-feet per year, the planning group has elected to show no supply available due to a lack of current infrastructure to transport water to the North East Texas Region.

(5) The Wood county lakes have the following firm yields: Lake Quitman - 3,710 acre-ft/yr, Lake Holbrook - 3,285 acre-ft/yr, Lake Hawkins 8,035 acre-ft/yr, and Lake Winnsboro - 5,760 acre-ft/yr.

(6) Although Lake Tyler has an estimated firm yield of 38,500 acre-feet per year, the planning group has elected to show no supply available due to a lack of current infrastructure to transport water to the North East Texas Region.

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
2	DE KALB	040232000	D	0232	155	019	02	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	235	0	0	0	0	0
3	DE KALB	040232000	D	0232	155	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	204	0	0	0	0	0
4	HOOKS	040416000	D	0416	284	019	02	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	371	0	0	0	0	0
5	HOOKS	040416000	D	0416	284	019	02	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	0	0	0	0	0	0
6	MAUD	040572000	D	0572	393	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	246	0	0	0	0	0
7	NASH	040622000	D	0622	423	019	03	01		D	019	3	01910	CARRIZO-WILCOX	13	13	13	13	13	13
8	NASH	040622000	D	0622	423	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	368	0	0	0	0	0
9	NEW BOSTON	040628000	D	0628	429	019	02	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	157	0	0	0	0	0
10	NEW BOSTON	040628000	D	0628	429	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	627	0	0	0	0	0
11	REDWATER	040740000	D	0740	945	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	64	0	0	0	0	0
12	REDWATER	040740000	D	0740	945	019	03	01		D	019	3	01910	CARRIZO-WILCOX	45	45	45	45	45	45
13	TEXARKANA	040889000	D	0889	601	019	02	03		D	019	3	03080	LAKE WRIGHT PATMAN	60	60	60	60	60	60
14	TEXARKANA	040889000	D	0889	601	019	03	03		D	019	3	03080	LAKE WRIGHT PATMAN	20263	28669	28787	31531	28316	24969
15	WAKE VILLAGE	040937000	D	0937	628	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	358	0	0	0	0	0
16	COUNTY OTHER	040996019	D	0996	757	019	02	03	395330	D	019	3	03080	LAKE WRIGHT PATMAN	129	0	0	0	0	0
17	COUNTY OTHER	040996019	D	0996	757	019	02	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	52	52	0	0	0	0
18	COUNTY OTHER	040996019	D	0996	757	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	206	206	0	0	0	0
19	COUNTY OTHER	040996019	D	0996	757	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	31	0	0	0	0	0
20	COUNTY OTHER	040996019	D	0996	757	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	83	0	0	0	0	0
21	COUNTY OTHER	040996019	D	0996	757	019	03	01		D	019	3	01910	CARRIZO-WILCOX	54	54	54	54	54	54
22	COUNTY OTHER	040996019	D	0996	757	019	02	01		D	019	2	01910	CARRIZO-WILCOX	64	64	64	64	64	64
23	COUNTY OTHER	040996019	D	0996	757	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	230	235	240	250	261	275
24	COUNTY OTHER	040996019	D	0996	757	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	552	552	552	0	0	0
25	COUNTY OTHER	040996019	D	0996	757	019	02	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	37	37	0	0	0	0
26	COUNTY OTHER	040996019	D	0996	757	019	03	03	848000	D	019	3	03080	LAKE WRIGHT PATMAN	37	37	0	0	0	0
27	COUNTY OTHER	040996019	D	0996	757	019	03	01		D	019	3	01910	CARRIZO-WILCOX	36	36	36	36	36	36
28	COUNTY OTHER	040996019	D	0996	757	019	02	01		D	019	2	01910	CARRIZO-WILCOX	47	47	47	47	47	47
29	COUNTY OTHER	040996019	D	0996	757	019	03	01		D	019	3	01910	CARRIZO-WILCOX	29	29	29	29	29	29
30	MANUFACTURING	041001019	D	1001	1001	019	02	03		D	019	2	03080	LAKE WRIGHT PATMAN	7	9	11	14	17	20
31	MANUFACTURING	041001019	D	1001	1001	019	03	03		D	019	3	03080	LAKE WRIGHT PATMAN	1909	2115	2327	2548	2781	3023
32	MANUFACTURING	041001019	D	1001	1001	019	03	01		D	019	3	01910	CARRIZO-WILCOX	28	28	28	28	28	28
33	MINING	041003019	D	1003	1003	019	02	01		D	019	2	01922	OTHER AQUIFER	24	23	23	24	25	25
34	MINING	041003019	D	1003	1003	019	03	01		D	019	3	01910	CARRIZO-WILCOX	29	29	30	32	36	41
35	IRRIGATION	041004019	D	1004	1004	019	02	00		D	019	2	019996	IRRIGATION LOCAL SUPPLY	4400	4620	4620	4620	4500	4200
36	LIVESTOCK	041005019	D	1005	1005	019	02	00		D	019	2	02997	LIVESTOCK LOCAL SUPPLY	289	289	289	289	289	289
37	LIVESTOCK	041005019	D	1005	1005	019	02	01		D	019	2	01920	NACATOCH	951	1016	1016	1016	888	706
38	LIVESTOCK	041005019	D	1005	1005	019	02	01		D	019	2	01922	OTHER AQUIFER	100	100	100	100	100	100
39	LIVESTOCK	041005019	D	1005	1005	019	03	00		D	019	3	03997	LIVESTOCK LOCAL SUPPLY	718	718	718	718	718	718
40	LIVESTOCK	041005019	D	1005	1005	019	03	01		D	019	3	01910	CARRIZO-WILCOX	1613	1727	1727	1727	1505	1187
42	PITTSBURG	040701000	D	0701	469	032	04	01		D	032	4	03210	CARRIZO-WILCOX	454	440	439	438	438	438
43	PITTSBURG	040701000	D	0701	469	032	04	03	60	D	225	4	04030	LAKE BOB SANDLIN	1930	1930	1930	1930	1930	1930
44	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	032	4	03210	CARRIZO-WILCOX	982	982	982	982	982	982
45	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	032	4	03210	CARRIZO-WILCOX	118	118	118	118	118	118
46	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	032	4	03210	CARRIZO-WILCOX	41	55	56	57	57	57
47	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	032	4	03210	CARRIZO-WILCOX	14	18	18	19	19	19
48	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	032	4	03210	CARRIZO-WILCOX	113	113	113	113	113	113
49	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	250	5	25010	CARRIZO-WILCOX	14	14	14	14	14	14
50	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	032	4	03210	CARRIZO-WILCOX	85	94	95	99	100	100
51	COUNTY OTHER	040996032	D	0996	757	032	04	01		D	032	4	03210	CARRIZO-WILCOX	16	16	16	16	16	16
52	MANUFACTURING	041001032	D	1001	1001	032	04	03		D	032	4	04030	LAKE BOB SANDLIN	10	10	10	10	10	10
53	MINING	041003032	D	1003	1003	032	04	01		D	032	4	03210	CARRIZO-WILCOX	132	131	131	131	131	131
54	IRRIGATION	041004032	D	1004	1004	032	04	01		D	032	4	03210	CARRIZO-WILCOX	87	87	87	87	87	87

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
55	LIVESTOCK	041005032	D	1005	1005	032	04	01		D	032	4	03210	CARRIZO-WILCOX	288	288	288	288	288	288
56	LIVESTOCK	041005032	D	1005	1005	032	04	01		D	032	4	03224	QUEEN CITY	117	117	117	117	117	117
57	LIVESTOCK	041005032	D	1005	1005	032	04	00		D	032	4	04997	LIVESTOCK LOCAL SUPPLY	395	395	395	395	395	395
58	ATLANTA	040042000	D	0042	29	034	04	03	3080	D	019	3	03080	LAKE WRIGHT PATMAN	1878	0	0	0	0	0
59	HUGHES SPRINGS	040423000	D	0423	288	034	04	03	60	D	158	4	04070	LAKE O' THE PINES	4528	4528	4528	4602	4602	4602
60	LINDEN	040524000	D	0524	358	034	04	01		D	034	4	03410	CARRIZO-WILCOX	231	231	231	231	231	231
61	QUEEN CITY	040728000	D	0728	489	034	04	01		D	034	4	03410	CARRIZO-WILCOX	124	124	124	124	124	124
62	QUEEN CITY	040728000	D	0728	489	034	04	03	3080	D	019	3	03080	WRIGHT PATMAN LAKE	155	0	0	0	0	0
63	QUEEN CITY	040728000	D	0728	489	034	03	01		D	034	3	03410	CARRIZO-WILCOX	155	155	155	155	155	155
64	QUEEN CITY	040728000	D	0728	489	034	03	03	3080	D	019	3	03080	WRIGHT PATMAN LAKE	193	0	0	0	0	0
65	COUNTY OTHER	040996034	D	0996	757	034	03	01		D	034	3	03410	CARRIZO-WILCOX	11	11	11	11	11	11
66	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	74	74	74	74	74	74
67	COUNTY OTHER	040996034	D	0996	757	034	03	01		D	034	3	03410	CARRIZO-WILCOX	49	49	49	49	49	49
68	COUNTY OTHER	040996034	D	0996	757	034	04	03	3080	D	019	3	03080	WRIGHT PATMAN LAKE	16.9	0	0	0	0	0
69	COUNTY OTHER	040996034	D	0996	757	034	04	03	60	D	158	4	04070	LAKE O' THE PINES	1551	1551	1551	1551	1551	1551
70	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	74.2	74.2	74.2	74.2	74.2	74.2
71	COUNTY OTHER	040996034	D	0996	757	034	03	03	3080	D	019	3	03080	WRIGHT PATMAN LAKE	55.24	0	0	0	0	0
72	COUNTY OTHER	040996034	D	0996	757	034	03	01		D	034	3	03410	CARRIZO-WILCOX	26	26	26	26	26	26
73	COUNTY OTHER	040996034	D	0996	757	034	04	03	60	D	158	4	04070	LAKE O' THE PINES	95.7	95.7	95.7	97.3	97.3	97.3
74	COUNTY OTHER	040996034	D	0996	757	034	04	03	3080	D	019	3	03080	WRIGHT PATMAN LAKE	17	0	0	0	0	0
75	COUNTY OTHER	040996034	D	0996	757	034	04	01	3410	D	034	4	03410	CARRIZO-WILCOX	12.9	12.9	12.9	12.9	12.9	12.9
76	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	46	46	46	46	46	46
77	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	22	22	22	22	22	22
78	COUNTY OTHER	040996034	D	0996	757	034	04	03	399600	D	034	4	04070	LAKE O' THE PINES	59.8	59.8	59.8	0	0	0
79	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	18.63	18.63	18.63	18.63	18.63	18.63
80	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	16	16	16	16	16	16
81	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	65	65	65	65	65	65
82	COUNTY OTHER	040996034	D	0996	757	034	03	01		D	034	3	03410	CARRIZO-WILCOX	9	9	9	9	9	9
83	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	45.16	45.16	45.16	45.16	45.16	45.16
84	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	58.55	58.55	58.55	58.55	58.55	58.55
85	COUNTY OTHER	040996034	D	0996	757	034	04	03	60	D	158	4	04070	LAKE O' THE PINES	168.2	168.2	168.2	168.2	168.2	168.2
86	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	16	16	16	16	16	16
87	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	16	16	16	16	16	16
88	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	0	0	0	0	0	0
89	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	16	16	16	16	16	16
90	COUNTY OTHER	040996034	D	0996	757	034	04	01		D	034	4	03410	CARRIZO-WILCOX	16	16	16	16	16	16
91	MANUFACTURING	041001034	D	1001	1001	034	04	00		D	034	4	04070	LAKE O' THE PINES	27	33	37	41	48	55
92	MANUFACTURING	041001034	D	1001	1001	034	03	00		D	034	3	03080	WRIGHT PATMAN LAKE	80082	76814	76814	74508	77487	80589
93	MANUFACTURING	041001034	D	1001	1001	034	03	01		D	034	3	03410	CARRIZO-WILCOX	20	20	20	20	20	20
94	MINING	041003034	D	1003	1003	034	04	01		D	034	4	03410	CARRIZO-WILCOX	25	25	25	25	25	13
95	MINING	041003034	D	1003	1003	034	04	01		D	034	4	03424	QUEEN CITY	520	430	394	368	353	0
96	MINING	041003034	D	1003	1003	034	03	01		D	034	3	03410	CARRIZO-WILCOX	20	20	20	20	20	20
97	MINING	041003034	D	1003	1003	034	03	01		D	034	3	03424	QUEEN CITY	689	515	503	489	474	463
98	LIVESTOCK	041005034	D	1005	1005	034	04	00		D	034	4	04997	LIVESTOCK LOCAL SUPPLY	571	571	571	571	571	571
99	LIVESTOCK	041005034	D	1005	1005	034	04	01		D	034	4	03410	CARRIZO-WILCOX	25	25	25	25	25	25
100	LIVESTOCK	041005034	D	1005	1005	034	03	01		D	034	3	03410	CARRIZO-WILCOX	20	20	20	20	20	20
101	LIVESTOCK	041005034	D	1005	1005	034	03	01		D	034	3	03424	QUEEN CITY	235	235	235	235	235	235
102	COOPER	040200000	D	0200	132	060	03	03	38	D	060	3	03010	COOPER RESERVOIR	0	0	0	0	0	0
103	COOPER	040200000	D	0200	132	060	03	00		D	060	3	03000	BIG CREEK	992	992	992	992	992	992
104	COUNTY OTHER	040996060	D	0996	757	060	03	01		D	060	3	06028	TRINITY	23	23	25	0	0	0
105	COUNTY OTHER	040996060	D	0996	757	060	03	03		D	060	3	03010	COOPER RESERVOIR	163	163	163	0	0	0
106	COUNTY OTHER	040996060	D	0996	757	060	03	00		D	060	3	03999	OTHER LOCAL SUPPLY	23	24	25	26	26	26

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
107	COUNTY OTHER	040996060	D	0996	757	060	03	03	183860	D	060	3	03010	COOPER RESERVOIR	0	0	0	0	0	0
108	COUNTY OTHER	040996060	D	0996	757	060	03	03	183860	D	060	3	03010	COOPER RESERVOIR	182	182	182	0	0	0
109	COUNTY OTHER	040996060	D	0996	757	060	03	03	69800	D	060	3	06028	TRINITY	62	62	60	0	0	0
110	COUNTY OTHER	040996060	D	0996	757	060	03	03	653865	D	060	3	03999	OTHER LOCAL SUPPLY	27	26	25	24	23	23
111	COUNTY OTHER	040996060	D	0996	757	060	03	01		D	116	3	11629	WOODBINE	7	7	7	7	7	7
112	COUNTY OTHER	040996060	D	0996	757	060	03	03	177000	D	116	3	03010	COOPER RESERVOIR	11	0	0	0	0	0
113	COUNTY OTHER	040996060	D	0996	757	060	03	01		D	060	3	06028	TRINITY	0	0	0	0	0	0
114	COUNTY OTHER	040996060	D	0996	757	060	03	03		D	060	3	03000	BIG CREEK	173	173	173	0	0	0
115	COUNTY OTHER	040996060	D	0996	757	060	03	03	177000	D	116	3	03010	COOPER RESERVOIR	74	74	0	0	0	0
116	MANUFACTURING	041001060	D	1001	1001	060	03	00		D	060	3	03010	COOPER RESERVOIR	9180	9180	9180	9180	9180	9180
117	MANUFACTURING	041001060	D	1001	1001	060	03	03		D	060	3	03010	COOPER RESERVOIR	8	8	8	8	8	8
118	IRRIGATION	041004060	D	1004	1004	060	03	01		D	060	3	06020	NACATOCH	22	133	175	211	227	227
119	IRRIGATION	041004060	D	1004	1004	060	03	01		D	060	3	06028	TRINITY	536	403	339	282	244	223
120	IRRIGATION	041004060	D	1004	1004	060	03	00		D	060	3	060996	IRRIGATION LOCAL SUPPLY	1420	1420	1420	1420	1420	1420
121	LIVESTOCK	041005060	D	1005	1005	060	03	01		D	060	3	06028	TRINITY	274	274	274	274	274	274
122	LIVESTOCK	041005060	D	1005	1005	060	03	00		D	060	3	03997	LIVESTOCK LOCAL SUPPLY	451	451	451	451	451	451
123	LIVESTOCK	041005060	D	1005	1005	060	03	01		D	060	3	06020	NACATOCH	45	45	45	45	45	45
124	MOUNT VERNON	040614000	D	0614	417	080	03	03		D	080	4	04010	LAKE CYPRESS SPRINGS	3000	3000	3000	0	0	0
125	WINNSBORO	040981000	D	0981	661	080	04	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	150	150	160	180	0	0
126	WINNSBORO	040981000	D	0981	661	080	05	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	300	300	290	270	0	0
127	COUNTY OTHER	040996080	D	0996	757	080	04	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	2482	2474	2477	2479	0	0
128	COUNTY OTHER	040996080	D	0996	757	080	04	01		D	080	4	08010	CARRIZO-WILCOX	55	55	55	55	55	55
129	COUNTY OTHER	040996080	D	0996	757	080	03	01		D	080	4	08010	CARRIZO-WILCOX	11	11	11	11	11	11
130	COUNTY OTHER	040996080	D	0996	757	080	03	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	490	490	490	490	0	0
131	COUNTY OTHER	040996080	D	0996	757	080	04	01		D	080	4	08010	CARRIZO-WILCOX	8	8	8	8	8	8
132	COUNTY OTHER	040996080	D	0996	757	080	04	03		D	080	4	04010	LAKE CYPRESS SPRINGS	73	81	78	76	0	0
133	COUNTY OTHER	040996080	D	0996	757	080	04	03	651250	D	225	4	04010	LAKE CYPRESS SPRINGS	45	0	0	0	0	0
134	MANUFACTURING	041001080	D	1001	1001	080	03	00		D	080	4	08010	CARRIZO-WILCOX	3	3	3	3	3	3
135	MANUFACTURING	041001080	D	1001	1001	080	04	00		D	080	4	08010	CARRIZO-WILCOX	4	4	4	4	4	4
136	MINING	041003080	D	1003	1003	080	04	01		D	080	4	08010	CARRIZO-WILCOX	883	813	785	743	759	809
137	MINING	041003080	D	1003	1003	080	03	01		D	080	3	08010	CARRIZO-WILCOX	596	571	553	535	538	550
138	IRRIGATION	041004080	D	1004	1004	080	04	01		D	080	4	08010	CARRIZO-WILCOX	12	12	12	12	12	12
139	IRRIGATION	041004080	D	1004	1004	080	03	00		D	080	3	080996	IRRIGATION LOCAL SUPPLY	21	21	21	21	21	21
140	LIVESTOCK	041005080	D	1005	1005	080	04	00		D	080	4	04997	LIVESTOCK LOCAL SUPPLY	414	414	414	414	414	414
141	LIVESTOCK	041005080	D	1005	1005	080	04	01		D	080	4	08010	CARRIZO-WILCOX	189	189	189	189	189	189
142	LIVESTOCK	041005080	D	1005	1005	080	05	00		D	080	5	05997	LIVESTOCK LOCAL SUPPLY	2	2	2	2	2	2
143	LIVESTOCK	041005080	D	1005	1005	080	03	00		D	080	3	03997	LIVESTOCK LOCAL SUPPLY	666	666	666	666	666	666
144	LIVESTOCK	041005080	D	1005	1005	080	03	01		D	080	3	08010	CARRIZO-WILCOX	324	324	324	324	324	324
145	CLARKSVILLE CITY	040172000	D	0172	844	092	05	03		D	230	5	05090	LAKE GLADEWATER	322.4	0	0	0	0	0
146	GLADEWATER	040342000	D	0342	237	092	05	00		D	230	5	05090	LAKE GLADEWATER	499	796	796	796	796	796
147	KILGORE	040469000	D	0469	321	092	05	00		D	250	5	05500	SABINE (ROR)	2240.7	2240.7	2240.7	2240.7	2240.7	2240.7
148	KILGORE	040469000	D	0469	321	092	05	01		D	092	5	09210	CARRIZO-WILCOX	490.2	490.2	490.2	490.2	490.2	490.2
149	LAKEPORT	040502000	D	0502	893	092	05	01		D	092	5	09210	CARRIZO-WILCOX	22.1	22.1	22.1	22.1	22.1	22.1
150	LAKEPORT	040502000	D	0502	893	092	05	03		D	092	5	05110	LAKE CHEROKEE	112.1	0	0	0	0	0
151	LIBERTY CITY	040522000	D	0522	715	092	05	01		D	092	5	09210	CARRIZO-WILCOX	356	356	356	356	356	356
152	LONGVIEW	040539000	D	0539	367	092	05	03	95	D	250	5	05040	LAKE FORK	15000	0	0	0	0	0
153	LONGVIEW	040539000	D	0539	367	092	05	03	60	D	158	4	04070	LAKE O' THE PINES	15000	15000	15000	15000	15000	0
154	LONGVIEW	040539000	D	0539	367	092	05	00		D	230	5	05080	BIG SANDY CREEK (ROR)	0	840	840	840	840	0
155	LONGVIEW	040539000	D	0539	367	092	05	03	110	D	092	5	05110	LAKE CHEROKEE	5600	5600	5600	5600	5600	5600
156	LONGVIEW	040539000	D	0539	367	092	05	00		D	092	5	05040	LAKE FORK	14502	14502	14502	14504	0	0
157	WHITE OAK	040963000	D	0963	649	092	05	03	512010	D	230	5	05080	BIG SANDY CREEK (ROR)	1035	0	0	0	0	0
158	COUNTY OTHER	040996092	D	0996	757	092	05	03	512010	D	092	5	05110	LAKE CHEROKEE	17.9	17.9	17.9	17.9	17.9	17.9

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
159	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	230	5	23010	CARRIZO-WILCOX	17.7	17.7	17.7	17.7	17.7	17.7
160	COUNTY OTHER	040996092	D	0996	757	092	05	00		D	092	5	05090	LAKE GLADEWATER	20.8	33.2	33.2	33.2	33.2	33.2
161	COUNTY OTHER	040996092	D	0996	757	092	05	00		D	250	5	05500	SABINE (ROR)	76.5	76.5	76.5	76.5	76.5	76.5
162	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	16.3	16.3	16.3	16.3	16.3	16.3
163	COUNTY OTHER	040996092	D	0996	757	092	05	03	327250	D	230	5	05090	LAKE GLADEWATER	214.8	0	0	0	0	0
164	COUNTY OTHER	040996092	D	0996	757	092	05	03	512010	D	230	5	05080	BIG SANDY CREEK (ROR)	11.7	0	0	0	0	0
165	COUNTY OTHER	040996092	D	0996	757	092	05	03	327250	D	230	5	05090	LAKE GLADEWATER	11.7	0	0	0	0	0
166	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	75.3	75.3	75.3	75.3	75.3	75.3
167	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	79.5	79.5	79.5	79.5	79.5	79.5
168	COUNTY OTHER	040996092	D	0996	757	092	05	03	512010	D	092	5	05110	LAKE CHEROKEE	403.5	0	0	0	0	0
169	COUNTY OTHER	040996092	D	0996	757	092	04	01		D	092	4	09210	CARRIZO-WILCOX	40.3	40.3	40.3	40.3	40.3	40.3
170	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	64.5	64.5	64.5	64.5	64.5	64.5
171	COUNTY OTHER	040996092	D	0996	757	092	04	01		D	230	4	23010	CARRIZO-WILCOX	18.8	18.8	18.8	18.8	18.8	18.8
172	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	106	106	106	106	106	106
173	COUNTY OTHER	040996092	D	0996	757	092	05	03	465800	D	092	5	05500	SABINE (ROR)	110	110	110	110	110	110
174	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	42.6	42.6	42.6	42.6	42.6	42.6
175	COUNTY OTHER	040996092	D	0996	757	092	05	03	327250	D	230	5	05090	LAKE GLADEWATER	18.4	18.4	18.4	18.4	18.4	18.4
176	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	76.4	76.4	76.4	76.4	76.4	76.4
177	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	16.1	16.1	16.1	16.1	16.1	16.1
178	COUNTY OTHER	040996092	D	0996	757	092	04	01		D	092	4	09210	CARRIZO-WILCOX	74	74	74	74	74	74
179	COUNTY OTHER	040996092	D	0996	757	092	04	03	512010	D	092	5	05110	LAKE CHEROKEE	516	0	0	0	0	0
180	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	59	59	59	59	59	59
181	COUNTY OTHER	040996092	D	0996	757	092	05	03	512010	D	092	5	05110	LAKE CHEROKEE	412.1	0	0	0	0	0
182	COUNTY OTHER	040996092	D	0996	757	092	05	01		D	092	5	09210	CARRIZO-WILCOX	244.3	244.3	244.3	244.3	244.3	244.3
183	MANUFACTURING	041001092	D	1001	1001	092	05	01		D	092	5	09210	CARRIZO-WILCOX	200	200	200	200	200	200
184	MANUFACTURING	041001092	D	1001	1001	092	05	00		D	092	5	36083	DIRECT REUSE	100	3395	3842	3842	3842	3842
185	MANUFACTURING	041001092	D	1001	1001	092	05	00		D	092	5	05999	LOCAL SUPPLY SOURCE	2500	2500	2500	2500	2500	2500
186	MANUFACTURING	041001092	D	1001	1001	092	05	00		D	092	5	05110	LAKE CHEROKEE	3021	3393	3824	4294	4843	5428
187	STEAM ELECTRIC	041002092	D	1002	1002	092	05	03	110	D	092	5	05110	LAKE CHEROKEE	2000	2000	2000	2000	2000	2000
188	STEAM ELECTRIC	041002092	D	1002	1002	092	05	01		D	092	5	09210	CARRIZO-WILCOX	185.5	185.5	185.5	185.5	185.5	185.5
189	STEAM ELECTRIC	041002092	D	1002	1002	092	05	00		D	092	5	36083	DIRECT REUSE	627	670	720	780	846	923
190	STEAM ELECTRIC	041002092	D	1002	1002	092	05	00		D	092	5	05110	LAKE CHEROKEE	1873	2330	2280	2220	2154	3077
191	MINING	041003092	D	1003	1003	092	05	01		D	092	5	09210	CARRIZO-WILCOX	96	67	46	37	29	27
192	LIVESTOCK	041005092	D	1005	1005	092	04	01		D	092	4	09210	CARRIZO-WILCOX	35	35	35	35	35	35
193	LIVESTOCK	041005092	D	1005	1005	092	05	01		D	092	5	09210	CARRIZO-WILCOX	230	230	230	230	230	230
194	HALLSVILLE	040374000	D	0374	260	102	05	03	512010	D	092	5	05110	LAKE CHEROKEE	368.3	0	0	0	0	0
195	HALLSVILLE	040374000	D	0374	260	102	05	01		D	102	5	10210	CARRIZO-WILCOX	143	143	143	143	143	143
196	LONGVIEW	040539000	D	0539	367	102	05	00		D	230	5	05080	BIG SANDY CREEK (ROR)	0	280	280	280	280	0
197	LONGVIEW	040539000	D	0539	367	102	05	03	60	D	158	4	04070	LAKE O' THE PINES	5000	5000	5000	5000	5000	0
198	LONGVIEW	040539000	D	0539	367	102	05	03	110	D	092	5	05110	LAKE CHEROKEE	10400	10400	10400	10400	10400	10400
199	LONGVIEW	040539000	D	0539	367	102	05	00		D	092	5	05500	SABINE (ROR)	4834.1	4834.1	4834.1	4834.1	4834.1	4834.1
200	LONGVIEW	040539000	D	0539	367	102	05	03	95	D	250	5	05040	LAKE FORK	5000	0	0	0	0	0
201	MARSHALL	040566000	D	0566	388	102	04	00		D	102	4	04500	CYPRESS (ROR)	691	691	691	691	691	691
202	MARSHALL	040566000	D	0566	388	102	05	00		D	102	4	04500	CYPRESS (ROR)	13124	13124	13124	13124	13124	13124
203	WASKOM	040941000	D	0941	631	102	04	01		D	102	4	10210	CARRIZO-WILCOX	291	291	291	291	291	291
204	COUNTY OTHER	040996102	D	0996	757	102	05	03	931834	D	102	5	10210	CARRIZO-WILCOX	28	28	28	28	28	28
205	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	16.7	16.7	16.7	16.7	16.7	16.7
206	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	128	128	128	128	128	128
207	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	21	21	21	21	21	21
208	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	143.4	143.4	143.4	143.4	143.4	143.4
209	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	129	129	129	129	129	129
210	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	61	61	61	61	61	61

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
211	COUNTY OTHER	040996102	D	0996	757	102	04	03		D	102	4	04500	CYPRESS (ROR)	5	5	5	5	5	5
212	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	155	155	155	155	155	155
213	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	230	4	23010	CARRIZO-WILCOX	29.8	29.8	29.8	29.8	29.8	29.8
214	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	89.4	89.4	89.4	89.4	89.4	89.4
215	COUNTY OTHER	040996102	D	0996	757	102	05	03	538090	D	102	4	04500	CYPRESS (ROR)	125	125	125	125	125	125
216	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	198	198	198	198	198	198
217	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	32.3	32.3	32.3	32.3	32.3	32.3
218	COUNTY OTHER	040996102	D	0996	757	102	04	03	512010	D	092	5	05110	LAKE CHEROKEE	44.3	0	0	0	0	0
219	COUNTY OTHER	040996102	D	0996	757	102	05	03	512010	D	092	5	05110	LAKE CHEROKEE	320	0	0	0	0	0
220	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	226	226	226	226	226	226
221	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	260.3	260.3	260.3	260.3	260.3	260.3
222	COUNTY OTHER	040996102	D	0996	757	102	05	03		D	102	5	10210	CARRIZO-WILCOX	13	13	13	13	13	13
223	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	122	122	122	122	122	122
224	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	150.4	150.4	150.4	150.4	150.4	150.4
225	COUNTY OTHER	040996102	D	0996	757	102	04	03	538090	D	102	4	04500	CYPRESS (ROR)	184.13	184.13	184.13	0	0	0
226	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	134.3	134.3	134.3	134.3	134.3	134.3
227	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	22.4	22.4	22.4	22.4	22.4	22.4
228	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	11.1	11.1	11.1	11.1	11.1	11.1
229	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	43	43	43	43	43	43
230	COUNTY OTHER	040996102	D	0996	757	102	04	03	538090	D	102	4	04500	CYPRESS (ROR)	0.8	0.8	0.8	0.8	0.8	0.8
231	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	21.4	21.4	21.4	21.4	21.4	21.4
232	COUNTY OTHER	040996102	D	0996	757	102	05	03	538090	D	102	4	04500	CYPRESS (ROR)	3.2	3.2	3.2	3.2	3.2	3.2
233	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	96.8	96.8	96.8	96.8	96.8	96.8
234	COUNTY OTHER	040996102	D	0996	757	102	04	03	512010	D	092	5	05110	LAKE CHEROKEE	103.1	0	0	0	0	0
235	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	092	4	09210	CARRIZO-WILCOX	14.8	14.8	14.8	14.8	14.8	14.8
236	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	117.1	117.1	117.1	117.1	117.1	117.1
237	COUNTY OTHER	040996102	D	0996	757	102	04	01		D	102	4	10210	CARRIZO-WILCOX	26	26	26	26	26	26
238	COUNTY OTHER	040996102	D	0996	757	102	05	01		D	102	5	10210	CARRIZO-WILCOX	135.5	135.5	135.5	135.5	135.5	135.5
239	MANUFACTURING	041001102	D	1001	1001	102	04	00		D	102	4	04100	CADDO LAKE	1217	1529	1593	1655	1814	1999
240	MANUFACTURING	041001102	D	1001	1001	102	04	00		D	102	4	1	GARY'S CREEK	16084	16084	16084	16084	16084	16084
241	MANUFACTURING	041001102	D	1001	1001	102	04	00		D	102	4	04500	CYPRESS (ROR)	37180	37180	37180	37180	37180	37180
242	MANUFACTURING	041001102	D	1001	1001	102	04	01		D	102	4	10210	CARRIZO-WILCOX	50	50	50	50	50	50
243	MANUFACTURING	041001102	D	1001	1001	102	05	00		D	102	5	05110	LAKE CHEROKEE	6224.4	7608	7988	8328	9083	9933
244	MANUFACTURING	041001102	D	1001	1001	102	05	00		D	102	5	05500	SABINE RIVER	134500	134500	134500	134500	134500	134500
245	MANUFACTURING	041001102	D	1001	1001	102	05	00		D	102	5	05040	LAKE FORK	0	0	0	0	0	0
246	MANUFACTURING	041001102	D	1001	1001	102	05	00		D	102	5	05500	SABINE RIVER	3500	3500	3500	3500	3500	3500
247	MANUFACTURING	041001102	D	1001	1001	102	05	00		D	102	5	36084	DIRECT REUSE	0	2769	3045	2935	2725	2633
248	STEAM ELECTRIC	041002102	D	1002	1002	102	05	00		D	102	5	0	BRANDY BRANCH	11000	11000	11000	11000	11000	11000
249	STEAM ELECTRIC	041002102	D	1002	1002	102	05	03	60	D	158	4	04070	LAKE O' THE PINES	18000	18000	18000	18000	18000	18000
250	MINING	041003102	D	1003	1003	102	04	01		D	102	4	10210	CARRIZO-WILCOX	54	146	190	211	204	201
251	MINING	041003102	D	1003	1003	102	04	01		D	102	4	10224	QUEEN CITY	126	46	7	0	0	0
252	MINING	041003102	D	1003	1003	102	05	00		D	102	5	05040	LAKE FORK	520	520	520	520	520	520
253	MINING	041003102	D	1003	1003	102	05	01		D	102	5	10210	CARRIZO-WILCOX	190	178	173	159	166	169
254	IRRIGATION	041004102	D	1004	1004	102	04	00		D	102	4	102996	IRRIGATION LOCAL SUPPLY	28	28	28	28	28	28
255	IRRIGATION	041004102	D	1004	1004	102	04	01		D	102	4	10210	CARRIZO-WILCOX	22	22	22	22	22	22
256	IRRIGATION	041004102	D	1004	1004	102	05	01		D	102	5	10210	CARRIZO-WILCOX	11	11	11	11	11	11
257	IRRIGATION	041004102	D	1004	1004	102	05	00		D	102	5	102996	IRRIGATION LOCAL SUPPLY	39	39	39	39	39	39
258	LIVESTOCK	041005102	D	1005	1005	102	04	01		D	102	4	10224	QUEEN CITY	26	26	26	26	26	26
259	LIVESTOCK	041005102	D	1005	1005	102	04	00		D	102	4	04997	LIVESTOCK LOCAL SUPPLY	366	366	366	366	366	366
260	LIVESTOCK	041005102	D	1005	1005	102	04	01		D	102	4	10210	CARRIZO-WILCOX	178	207	236	268	302	335
261	LIVESTOCK	041005102	D	1005	1005	102	05	01		D	102	5	10210	CARRIZO-WILCOX	421	441	464	487	511	537
262	COMO	040196000	D	0196	847	112	03	01		D	112	3	11210	CARRIZO-WILCOX	41	41	41	41	41	41

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
263	COMO	040196000	D	0196	847	112	03	01		D	112	3	11210	CARRIZO-WILCOX	62	62	62	62	62	62
264	CUMBY	040221000	D	0221	852	112	05	01		D	112	5	11220	NACATOCH	55	55	55	55	55	55
265	CUMBY	040221000	D	0221	852	112	05	01		D	112	5	11220	NACATOCH	82	82	82	82	82	82
266	SULPHUR SPRINGS	040869000	D	0869	586	112	03	03	38	D	060	3	03010	COOPER RESEERVOIR	13070	13389	13113	13041	12803	15902
267	SULPHUR SPRINGS	040869000	D	0869	586	112	03	00		D	112	3	03040	LAKE SULPHUR SPRINGS	1274	2116	2736	2408	2264	1845
268	COUNTY OTHER	040996112	D	0996	757	112	05	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	47	0	0	0	0	0
269	COUNTY OTHER	040996112	D	0996	757	112	03	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	126	0	0	0	0	0
270	COUNTY OTHER	040996112	D	0996	757	112	03	01		D	112	3	11210	CARRIZO-WILCOX	273	273	273	273	273	273
271	COUNTY OTHER	040996112	D	0996	757	112	03	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	70	0	0	0	0	0
272	COUNTY OTHER	040996112	D	0996	757	112	05	03	60	D	158	5	08160	LAKE LAVON	40	0	0	0	0	0
273	COUNTY OTHER	040996112	D	0996	757	112	05	03	95	D	250	5	05010	LAKE TAWAKONI	57	57	0	0	0	0
274	COUNTY OTHER	040996112	D	0996	757	112	05	03	95	D	190	5	05040	LAKE FORK	50	50	0	0	0	0
275	COUNTY OTHER	040996112	D	0996	757	112	04	01		D	112	5	11210	CARRIZO-WILCOX	128	128	128	128	128	128
276	COUNTY OTHER	040996112	D	0996	757	112	05	01		D	112	5	11210	CARRIZO-WILCOX	128	128	128	128	128	128
277	COUNTY OTHER	040996112	D	0996	757	112	04	03	50	D	080	3	04010	LAKE CYPRESS SPRINGS	280	280	280	280	0	0
278	COUNTY OTHER	040996112	D	0996	757	112	04	01		D	112	3	11210	CARRIZO-WILCOX	6	6	6	6	6	6
279	COUNTY OTHER	040996112	D	0996	757	112	03	03	50	D	080	3	04010	LAKE CYPRESS SPRINGS	70	70	70	70	0	0
280	COUNTY OTHER	040996112	D	0996	757	112	03	01		D	112	3	11210	CARRIZO-WILCOX	2	2	2	2	2	2
281	COUNTY OTHER	040996112	D	0996	757	112	03	01		D	112	3	11210	CARRIZO-WILCOX	84	84	84	84	84	84
282	COUNTY OTHER	040996112	D	0996	757	112	03	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	62	0	0	0	0	0
283	COUNTY OTHER	040996112	D	0996	757	112	05	01		D	112	5	11210	CARRIZO-WILCOX	7	7	7	7	7	7
284	COUNTY OTHER	040996112	D	0996	757	112	05	01		D	112	5	11210	CARRIZO-WILCOX	11	11	12	12	13	14
285	COUNTY OTHER	040996112	D	0996	757	112	05	01		D	112	3	11210	CARRIZO-WILCOX	403	403	403	403	403	403
286	COUNTY OTHER	040996112	D	0996	757	112	05	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	223	0	0	0	0	0
287	COUNTY OTHER	040996112	D	0996	757	112	05	03	138350	D	112	5	05010	LAKE TAWAKONI	3	0	0	0	0	0
288	COUNTY OTHER	040996112	D	0996	757	112	05	01		D	112	5	11210	CARRIZO-WILCOX	157	157	157	157	157	157
289	COUNTY OTHER	040996112	D	0996	757	112	03	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	713	778	0	0	0	0
290	COUNTY OTHER	040996112	D	0996	757	112	04	01		D	112	5	11210	CARRIZO-WILCOX	49	49	49	49	49	49
291	COUNTY OTHER	040996112	D	0996	757	112	05	01		D	112	5	11210	CARRIZO-WILCOX	49	49	49	49	49	49
292	COUNTY OTHER	040996112	D	0996	757	112	03	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	28	30	0	0	0	0
293	COUNTY OTHER	040996112	D	0996	757	112	03	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	72	0	0	0	0	0
294	COUNTY OTHER	040996112	D	0996	757	112	05	01		D	112	5	11210	CARRIZO-WILCOX	194	194	194	194	194	194
295	MANUFACTURING	041001112	D	1001	1001	112	05	01		D	112	5	11210	CARRIZO-WILCOX	2	3	3	4	5	5
296	MANUFACTURING	041001112	D	1001	1001	112	03	03		D	112	3	03040	LAKE SULPHUR SPRINGS	2666	2861	3024	3151	3409	3668
297	MINING	041003112	D	1003	1003	112	03	01		D	112	3	11222	OTHER AQUIFER	125	122	120	117	116	116
298	LIVESTOCK	041005112	D	1005	1005	112	04	00		D	112	4	04997	LIVESTOCK LOCAL SUPPLY	147	147	147	147	147	147
299	LIVESTOCK	041005112	D	1005	1005	112	04	01		D	112	4	11210	CARRIZO-WILCOX	52	52	52	52	52	52
300	LIVESTOCK	041005112	D	1005	1005	112	05	01		D	112	5	11210	CARRIZO-WILCOX	364	364	364	364	364	364
301	LIVESTOCK	041005112	D	1005	1005	112	05	00		D	112	5	05997	LIVESTOCK LOCAL SUPPLY	1766	1766	1766	1766	1766	1766
302	LIVESTOCK	041005112	D	1005	1005	112	03	01		D	112	3	11210	CARRIZO-WILCOX	208	208	208	208	208	208
303	LIVESTOCK	041005112	D	1005	1005	112	03	00		D	112	3	03997	LIVESTOCK LOCAL STOCK	2550	2461	2340	2075	2060	1771
304	LIVESTOCK	041005112	D	1005	1005	112	03	03	828100	D	112	3	03040	LAKE SULPHUR SPRINGS	2221	2310	2431	2696	2711	3000
305	LIVESTOCK	041005112	D	1005	1005	112	03	01		D	112	3	11222	OTHER AQUIFER	120	120	120	120	120	120
306	CADDOMILLS	040135000	D	0135	685	116	05	03	342340	D	116	5	05010	LAKE TAWAKONI	166	166	0	0	0	0
307	CADDOMILLS	040135000	D	0135	685	116	05	03	60	D	43	5	08160	LAKE LAVON	0	0	0	0	0	0
308	CAMPBELL	040141000	D	0141	837	116	05	01		D	116	5	11620	NACATOCH	147	147	147	147	147	147
309	CELESTE	040153000	D	0153	839	116	05	01		D	116	5	11629	WOODBINE	159	159	159	159	159	159
310	COMMERCE	040195000	D	0195	129	116	03	03	95	D	116	5	05010	LAKE TAWAKONI	4030	4155	4249	0	0	0
311	COMMERCE	040195000	D	0195	129	116	03	01		D	116	3	11620	NACATOCH	127	127	127	127	127	127
312	COMMERCE	040195000	D	0195	129	116	03	01		D	060	3	06020	NACATOCH	213	224	224	3	3	3
313	COMMERCE	040195000	D	0195	129	116	03	00		D	060	3	03010	COOPER RESERVOIR	0	0	0	0	0	0
314	COMMERCE	040195000	D	0195	129	116	03	03	38	D	060	3	03010	COOPER RESERVOIR	0	0	0	0	0	0

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
315	COMMERCE	040195000	D	0195	129	116	03	03	177000	D	116	5	03010	COOPER RESERVOIR	221	221	221	221	221	221
316	COMMERCE	040195000	D	0195	129	116	03	01		D	116	3	11620	NACATOCH	0	0	0	0	0	0
317	GREENVILLE	040361000	D	0361	250	116	05	00		D	116	5	05000	GREENVILLE CITY LAKES	1200	1200	1200	1200	1200	1200
318	GREENVILLE	040361000	D	0361	250	116	05	03	95	D	116	5	05010	LAKE TAWAKONI	21283	0	0	0	0	0
319	LONE OAK	040537000	D	0537	901	116	05	03	138350	D	116	5	05010	LAKE TAWAKONI	381	0	0	0	0	0
320	QUINLAN	040729000	D	0729	736	116	05	03	138350	D	116	5	05010	LAKE TAWAKONI	224	0	0	0	0	0
321	WEST TAWAKONI	040956000	D	0956	989	116	05	03	95	D	116	5	05010	LAKE TAWAKONI	1120	0	0	0	0	0
322	WOLFE CITY	040983000	D	0983	663	116	03	01		D	116	3	11629	WOODBINE	86	86	86	86	86	86
323	WOLFE CITY	040983000	D	0983	663	116	03	00		D	116	3	03999	OTHER LOCAL SUPPLY	134	134	134	114	114	114
324	COUNTY OTHER	040996116	D	0996	757	116	05	03	750700	C	199	5	08160	LAKE LAVON	182	0	0	0	0	0
325	COUNTY OTHER	040996116	D	0996	757	116	05	03	60	C	43	5	08160	LAKE LAVON	687	775	800	830	0	0
326	COUNTY OTHER	040996116	D	0996	757	116	05	03	95	D	116	5	05010	LAKE TAWAKONI	1696	1696	0	0	0	0
327	COUNTY OTHER	040996116	D	0996	757	116	05	03	60	C	43	5	08160	LAKE LAVON	1210	0	0	0	0	0
328	COUNTY OTHER	040996116	D	0996	757	116	05	03	95	D	116	5	05040	LAKE FORK	1511	1511	0	0	0	0
329	COUNTY OTHER	040996116	D	0996	757	116	05	03	138350	D	112	5	05010	LAKE TAWAKONI	14	0	0	0	0	0
330	COUNTY OTHER	040996116	D	0996	757	116	05	03	138350	D	116	5	05010	LAKE TAWAKONI	65	0	0	0	0	0
331	COUNTY OTHER	040996116	D	0996	757	116	05	03	95	D	116	5	05010	LAKE TAWAKONI	1344	1344	0	0	0	0
332	COUNTY OTHER	040996116	D	0996	757	116	05	03		D	190	5	05010	LAKE TAWAKONI	221	221	0	0	0	0
333	COUNTY OTHER	040996116	D	0996	757	116	05	01	11629	D	116	5	11629	WOODBINE	11	11	11	11	11	11
334	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	6	6	6	6	6	6
335	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	9	9	9	8	8	8
336	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	6	6	6	6	6	6
337	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	81	81	81	81	81	81
338	COUNTY OTHER	040996116	D	0996	757	116	03	01		D	116	3	11629	WOODBINE	189	189	189	189	189	189
339	COUNTY OTHER	040996116	D	0996	757	116	8	01		D	116	8	11629	WOODBINE	134	134	134	134	134	134
340	COUNTY OTHER	040996116	D	0996	757	116	05	03	342340	D	116	5	05010	LAKE TAWAKONI	336	336	336	0	0	0
341	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	112	112	112	112	112	112
342	COUNTY OTHER	040996116	D	0996	757	116	03	03		D	060	3	05000	GREENVILLE CITY LAKES	3	3	3	3	4	4
343	COUNTY OTHER	040996116	D	0996	757	116	05	03	95	D	116	5	05040	LAKE FORK	112	112	0	0	0	0
344	COUNTY OTHER	040996116	D	0996	757	116	05	03	95	D	116	5	05010	LAKE TAWAKONI	56	56	56	0	0	0
345	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11610	CARRIZO-WILCOX	5	5	5	5	5	5
346	COUNTY OTHER	040996116	D	0996	757	116	03	01		D	116	3	11620	NACATOCH	47	47	47	47	47	47
347	COUNTY OTHER	040996116	D	0996	757	116	03	03	177000	D	116	5	05010	LAKE TAWAKONI	67	0	0	0	0	0
348	COUNTY OTHER	040996116	D	0996	757	116	05	03		D	112	5	05010	LAKE TAWAKONI	2	2	2	2	2	2
349	COUNTY OTHER	040996116	D	0996	757	116	03	03	177000	D	116	5	05010	LAKE TAWAKONI	90	0	0	0	0	0
350	COUNTY OTHER	040996116	D	0996	757	116	03	01		D	116	3	11629	WOODBINE	56	56	56	56	56	56
351	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	10	10	10	10	10	10
352	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	12	12	12	12	12	12
353	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	30	30	30	30	30	30
354	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	8	8	8	8	8	8
355	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	22	22	22	22	22	22
356	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	53	53	53	53	53	53
357	COUNTY OTHER	040996116	D	0996	757	116	05	01		D	116	5	11629	WOODBINE	14	14	14	14	14	14
358	MANUFACTURING	041001116	D	1001	1001	116	05	03		D	116	5	05010	LAKE TAWAKONI	550	572	589	602	630	656
359	MANUFACTURING	041001116	D	1001	1001	116	05	01		D	116	5	11628	TRINITY	200	200	200	200	200	173
360	MANUFACTURING	041001116	D	1001	1001	116	03	03		D	116	5	05010	LAKE TAWAKONI	190	246	314	396	499	620
361	STEAM ELECTRIC	041002116	D	1002	1002	116	05	00		D	116	5	05010	LAKE TAWAKONI	800	0	0	0	0	0
362	MINING	041003116	D	1003	1003	116	05	00		D	116	5	05010	LAKE TAWAKONI	24	25	27	33	35	45
363	MINING	041003116	D	1003	1003	116	05	01		D	116	5	11628	TRINITY	46	46	46	42	42	34
364	IRRIGATION	041004116	D	1004	1004	116	05	00		D	116	5	116996	IRRIGATION LOCAL SUPPLY	165	165	165	165	165	165
365	IRRIGATION	041004116	D	1004	1004	116	05	01		D	116	5	11628	TRINITY	106	106	106	106	106	106
366	LIVESTOCK	041005116	D	1005	1005	116	05	00		D	116	5	05997	LIVESTOCK LOCAL SUPPLY	896	896	896	896	896	896

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
367	LIVESTOCK	041005116	D	1005	1005	116	03	00		D	116	3	03997	LIVESTOCK LOCAL SUPPLY	331	331	331	331	331	331
368	LIVESTOCK	041005116	D	1005	1005	116	8	00		D	116	8	08997	LIVESTOCK LOCAL SUPPLY	6	6	6	6	6	7
369	LIVESTOCK	041005116	D	1005	1005	116	8	01		D	116	8	11628	TRINITY	4	4	4	4	4	3
370	BLOSSOM	040092000	D	0092	680	139	02	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	111	115	0	0	0	0
371	BLOSSOM	040092000	D	0092	680	139	02	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	112	115	0	0	0	0
372	DEPORT	040242000	D	0242	857	139	03	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	113	0	0	0	0	0
373	PARIS	040678000	D	0678	455	139	02	03	2290	D	139	2	02290	PAT MAYSE RESERVOIR	9277	8848	8418	10673	10076	9364
374	PARIS	040678000	D	0678	455	139	02	00		D	139	2	02300	LAKE CROOK	500	500	500	500	500	500
375	PARIS	040678000	D	0678	455	139	03	03	2290	D	139	2	02290	PAT MAYSE RESERVOIR	21428	20991	20548	22794	22185	21458
376	PARIS	040678000	D	0678	455	139	03	00		D	139	2	02300	LAKE CROOK	500	500	500	500	500	500
377	RENO	040743000	D	0743	738	139	02	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	253	339	0	0	0	0
378	RENO	040743000	D	0743	738	139	02	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	158	223	0	0	0	0
379	ROXTON	040778000	D	0778	951	139	03	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	93	96	0	0	0	0
380	COUNTY OTHER	040996139	D	0996	757	139	02	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	5	5	0	0	0	0
381	COUNTY OTHER	040996139	D	0996	757	139	02	03	651250	D	139	2	02290	PAT MAYSE RESERVOIR	2325	2283	3055	0	0	0
382	COUNTY OTHER	040996139	D	0996	757	139	03	03	651250	D	139	2	02290	PAT MAYSE RESERVOIR	1684	1653	2212	0	0	0
383	COUNTY OTHER	040996139	D	0996	757	139	03	03	651250	D	139	2	02290	PAT MAYSE RESERVOIR	92	0	0	0	0	0
384	COUNTY OTHER	040996139	D	0996	757	139	03	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	54	65	76	0	0	0
385	COUNTY OTHER	040996139	D	0996	757	139	03	01		D	139	3	13928	TRINITY	18	18	0	0	0	0
386	MANUFACTURING	041001139	D	1001	1001	139	2	03		D	139	2	02290	PAT MAYSE RESERVOIR	555	565	575	582	621	670
387	MANUFACTURING	041001139	D	1001	1001	139	03	03		D	139	3	02290	PAT MAYSE RESERVOIR	4867	5648	6357	6993	7969	8938
388	STEAM ELECTRIC	041002139	D	1002	1002	139	02	03		D	139	2	02290	PAT MAYSE RESERVOIR	12209	12209	12209	12209	12209	12209
389	MINING	041003139	D	1003	1003	139	02	01		D	139	2	13928	TRINITY	13	13	13	13	13	13
390	MINING	041003139	D	1003	1003	139	03	01		D	139	3	13928	TRINITY	12	11	11	12	12	12
391	IRRIGATION	041004139	D	1004	1004	139	02	00		D	139	2	139996	IRRIGATION LOCAL SUPPLY	2310	2310	2310	2310	2310	2310
392	IRRIGATION	041004139	D	1004	1004	139	02	01		D	139	2	13928	TRINITY	0	408	408	364	364	316
393	IRRIGATION	041004139	D	1004	1004	139	02	01		D	139	2	13929	WOODBINE	2058	1601	1553	1549	1502	1503
394	LIVESTOCK	041005139	D	1005	1005	139	02	00		D	139	2	02997	LIVESTOCK LOCAL SUPPLY	407	0	0	0	0	0
395	LIVESTOCK	041005139	D	1005	1005	139	02	01		D	139	2	13928	TRINITY	154	154	154	137	137	112
396	LIVESTOCK	041005139	D	1005	1005	139	02	01		D	139	2	13929	WOODBINE	392	799	799	816	816	841
397	LIVESTOCK	041005139	D	1005	1005	139	03	00		D	139	3	03997	LIVESTOCK LOCAL SUPPLY	480	480	480	489	489	504
398	LIVESTOCK	041005139	D	1005	1005	139	03	01		D	139	3	13928	TRINITY	90	90	90	81	81	66
399	JEFFERSON	040446000	D	0446	306	158	04	00		D	158	4	04500	CYPRESS (ROR)	1287	1287	1287	1287	1287	1287
400	JEFFERSON	040446000	D	0446	306	158	04	03	60	D	158	4	04070	LAKE O' THE PINES	9760	9760	9760	9760	9760	9760
401	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	16	16	16	16	16	16
402	COUNTY OTHER	040996158	D	0996	757	158	04	03	60	D	158	4	04070	LAKE O' THE PINES	83.2	83.2	83.2	83.2	83.2	83.2
403	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	12	12	12	12	12	12
404	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	128	128	128	128	128	128
405	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	230	4	23010	CARRIZO-WILCOX	34.8	34.8	34.8	34.8	34.8	34.8
406	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	239	239	239	239	239	239
407	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	39	39	39	39	39	39
408	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	96.8	96.8	96.8	96.8	96.8	96.8
409	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	134.4	134.4	134.4	134.4	134.4	134.4
410	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	87	87	87	87	87	87
411	COUNTY OTHER	040996158	D	0996	757	158	04	03	60	D	158	4	04070	LAKE O' THE PINES	624.8	624.8	624.8	624.8	624.8	624.8
412	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	153.24	153.24	153.24	153.24	153.24	153.24
413	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	45.7	45.7	45.7	45.7	45.7	45.7
414	COUNTY OTHER	040996158	D	0996	757	158	04	01		D	158	4	15810	CARRIZO-WILCOX	8	8	8	8	8	8
415	MANUFACTURING	041001158	D	1001	1001	158	04	01		D	158	4	15810	CARRIZO-WILCOX	20	20	20	20	20	20
416	STEAM ELECTRIC	041002158	D	1002	1002	158	04	03	60	D	158	4	04070	LAKE O' THE PINES	6700	6700	6700	6700	6700	6700
417	STEAM ELECTRIC	041002158	D	1002	1002	158	04	00		D	158	4	04070	LAKE O' THE PINES	0	0	0	0	0	0
418	MINING	041003158	D	1003	1003	158	04	01		D	158	4	15810	CARRIZO-WILCOX	71	43	30	24	20	34

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
419	LIVESTOCK	041005158	D	1005	1005	158	04	01		D	158	4	15810	CARRIZO-WILCOX	26	26	26	26	26	26
420	LIVESTOCK	041005158	D	1005	1005	158	04	01		D	158	4	15824	QUEEN CITY	156	156	156	156	156	156
421	DAINGERFIELD	040224000	D	0224	148	172	04	03	60	D	158	4	04070	LAKE O' THE PINES	10329	10329	10329	10329	10329	10329
422	HUGHES SPRINGS	040423000	D	0423	288	172	04	03	60	D	158	4	04070	LAKE O' THE PINES	28.2	28.2	28.2	28.6	28.6	28.6
423	LONESTAR	040538000	D	0538	366	172	04	03	60	D	158	4	04070	LAKE O' THE PINES	4841	4841	4841	4841	4841	4841
424	NAPLES	040621000	D	0621	422	172	04	01		D	172	4	17210	CARRIZO-WILCOX	196.6	196.6	196.6	196.6	196.6	196.6
425	NAPLES	040621000	D	0621	422	172	03	01		D	172	3	17210	CARRIZO-WILCOX	52.3	52.3	52.3	52.3	52.3	52.3
426	OMAHA	040657000	D	0657	932	172	04	01		D	172	4	17210	CARRIZO-WILCOX	88.1	88.1	88.1	88.1	88.1	88.1
427	OMAHA	040657000	D	0657	932	172	04	01		D	172	3	17210	CARRIZO-WILCOX	103.2	103.2	103.2	103.2	103.2	103.2
428	COUNTY OTHER	040996172	D	0996	757	172	03	01		D	172	4	17210	CARRIZO-WILCOX	194	194	194	194	194	194
429	COUNTY OTHER	040996172	D	0996	757	172	04	03	60	D	158	4	04070	LAKE O' THE PINES	243.2	243.2	243.2	243.2	243.2	243.2
430	COUNTY OTHER	040996172	D	0996	757	172	04	03	60	D	158	4	04070	LAKE O' THE PINES	978	978	978	996	996	996
431	COUNTY OTHER	040996172	D	0996	757	172	04	03	399600	D	034	4	04070	LAKE O' THE PINES	32.4	32.4	32.4	0	0	0
432	COUNTY OTHER	040996172	D	0996	757	172	04	03	60	D	158	4	04070	LAKE O' THE PINES	8	8	8	8	8	8
433	COUNTY OTHER	040996172	D	0996	757	172	04	03	651250	D	225	4	04030	LAKE BOB SANDLIN	88	0	0	0	0	0
434	MANUFACTURING	041001172	D	1001	1001	172	04	03	60	D	158	4	04070	LAKE O' THE PINES	32400	32400	32400	32400	32400	32400
435	MANUFACTURING	041001172	D	1001	1001	172	04	00		D	172	4	35041	INDIRECT REUSE	74668	77481	72086	66660	61344	56146
436	MANUFACTURING	041001172	D	1001	1001	172	04	01		D	172	4	17224	QUEEN CITY	4383	4383	4383	4383	4383	4383
437	MANUFACTURING	041001172	D	1001	1001	172	04	00		D	172	4	04050	ELLISON CREEK	21000	21000	21000	21000	21000	21000
438	STEAM ELECTRIC	041002172	D	1002	1002	172	04	00	60	D	172	4	04070	LAKE O' THE PINES	12000	12000	12000	12000	12000	12000
439	MINING	041003172	D	1003	1003	172	04	01		D	172	4	17224	QUEEN CITY	31	16	12	10	10	11
440	IRRIGATION	041004172	D	1004	1004	172	04	00		D	172	4	172996	IRRIGATION LOCAL SUPPLY	190	188	186	184	182	180
441	LIVESTOCK	041005172	D	1005	1005	172	04	00		D	172	4	04997	LIVESTOCK LOCAL SUPPLY	277	277	277	277	277	277
442	LIVESTOCK	041005172	D	1005	1005	172	04	01		D	172	4	17224	QUEEN CITY	147	147	147	147	147	147
443	LIVESTOCK	041005172	D	1005	1005	172	03	01		D	172	3	17210	CARRIZO-WILCOX	200	200	200	200	200	200
444	EAST TAWAKONI	040263000	D	0263	861	190	05	03	267000	D	190	5	05010	LAKE TAWAKONI	552	552	0	0	0	0
445	EMORY	040282000	D	0282	191	190	05	03	95	D	116	5	05010	LAKE TAWAKONI	1105	1105	1105	0	0	0
446	POINT	040706000	D	0706	939	190	05	03	95	D	116	5	05010	LAKE TAWAKONI	224	224	0	0	0	0
447	COUNTY OTHER	040996190	D	0996	757	190	05	01		D	190	5	19010	CARRIZO-WILCOX	345.8	345.8	345.8	345.8	345.8	345.8
448	COUNTY OTHER	040996190	D	0996	757	190	05	00		D	190	5	05010	LAKE TAWAKONI	84	84	84	84	84	84
449	COUNTY OTHER	040996190	D	0996	757	190	05	00		D	190	5	05040	LAKE FORK	94.2	94.2	94.2	94.2	94.2	94.2
450	COUNTY OTHER	040996190	D	0996	757	190	05	00		I	116	5	08160	LAKE LAVON	67.2	67.2	67.2	67.2	67.2	67.2
451	COUNTY OTHER	040996190	D	0996	757	190	05	03	60	D	158	4	05010	LAKE TAWAKONI	0.15	0.15	0.15	0.15	0.15	0.15
452	COUNTY OTHER	040996190	D	0996	757	190	05	03	267000	D	190	5	05010	LAKE TAWAKONI	15	15	15	15	15	15
453	COUNTY OTHER	040996190	D	0996	757	190	05	03	138350	D	112	5	05010	LAKE TAWAKONI	15.22	15.22	15.22	15.22	15.22	15.22
454	COUNTY OTHER	040996190	D	0996	757	190	05	01		D	190	5	19010	CARRIZO-WILCOX	4.1	4.1	4.1	4.1	4.1	4.1
455	COUNTY OTHER	040996190	D	0996	757	190	05	01		D	190	5	19010	CARRIZO-WILCOX	38.45	38.45	38.45	38.45	38.45	38.45
456	COUNTY OTHER	040996190	D	0996	757	190	05	01		D	190	5	19010	CARRIZO-WILCOX	84.4	84.4	84.4	84.4	84.4	84.4
457	COUNTY OTHER	040996190	D	0996	757	190	05	03	267000	D	190	5	05010	LAKE TAWAKONI	264	264	0	0	0	0
458	MANUFACTURING	041001190	D	1001	1001	190	05	03		D	190	5	05010	LAKE TAWAKONI	2	2	2	2	2	2
459	IRRIGATION	041004190	D	1004	1004	190	05	00		D	190	5	190996	IRRIGATION LOCAL SUPPLY	20	20	20	20	20	20
460	LIVESTOCK	041005190	D	1005	1005	190	05	00		D	190	5	05997	LIVESTOCK LOCAL SUPPLY	686	686	686	686	686	686
461	LIVESTOCK	041005190	D	1005	1005	190	05	00		D	190	5	05997	LIVESTOCK LOCAL SUPPLY	14	14	14	14	14	14
462	BOGATA	040096000	D	0096	64	194	03	01		D	194	3	19420	NACATOCH	373	373	373	373	373	373
463	CLARKSVILLE	040171000	D	0171	113	194	03	00		D	194	2	0	LANGFORD LAKE	390	390	390	390	390	390
464	CLARKSVILLE	040171000	D	0171	113	194	03	01		D	194	3	19407	BLOSSOM	369	365	363	361	359	355
465	DETROIT	040243000	D	0243	858	194	03	01		D	194	3	19428	TRINITY	60	60	60	60	60	60
466	COUNTY OTHER	040996194	D	0996	757	194	02	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	23	47	0	0	0	0
467	COUNTY OTHER	040996194	D	0996	757	194	03	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	226	218	0	0	0	0
468	COUNTY OTHER	040996194	D	0996	757	194	03	03	848000	D	019	3	03080	WRIGHT PATMAN LAKE	68	0	0	0	0	0
469	COUNTY OTHER	040996194	D	0996	757	194	02	03	848000	D	019	3	03080	WRIGHT PATMAN LAKE	55	0	0	0	0	0
470	COUNTY OTHER	040996194	D	0996	757	194	03	03	848000	D	019	3	03080	WRIGHT PATMAN LAKE	37	0	0	0	0	0

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
471	COUNTY OTHER	040996194	D	0996	757	194	03	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	2	0	0	0	0	0
472	COUNTY OTHER	040996194	D	0996	757	194	03	01		D	194	3	19420	NACATOCH	11	11	11	11	11	11
473	COUNTY OTHER	040996194	D	0996	757	194	02	03	651250	D	139	2	02300	CROOK LAKE	74	74	74	0	0	0
474	COUNTY OTHER	040996194	D	0996	757	194	03	03	651250	D	139	2	02290	PAT MAYSE RESERVOIR	184	184	184	0	0	0
475	COUNTY OTHER	040996194	D	0996	757	194	03	03	848000	D	019	3	03080	WRIGHT PATMAN LAKE	8	8	0	0	0	0
476	COUNTY OTHER	040996194	D	0996	757	194	02	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	92	92	0	0	0	0
477	COUNTY OTHER	040996194	D	0996	757	194	02	03	848000	D	019	3	03080	WRIGHT PATMAN LAKE	55	55	55	0	0	0
478	COUNTY OTHER	040996194	D	0996	757	194	02	01		D	194	2	19420	NACATOCH	218	218	218	218	218	218
479	COUNTY OTHER	040996194	D	0996	757	194	03	01		D	194	3	19420	NACATOCH	218	218	218	218	218	218
480	COUNTY OTHER	040996194	D	0996	757	194	03	03	482989	D	139	2	02290	PAT MAYSE RESERVOIR	92	92	0	0	0	0
481	COUNTY OTHER	040996194	D	0996	757	194	03	03	848000	D	019	3	03080	WRIGHT PATMAN LAKE	55	55	55	0	0	0
482	COUNTY OTHER	040996194	D	0996	757	194	02	01		D	194	2	19428	TRINITY	14	14	14	14	14	14
483	MANUFACTURING	041001194	D	1001	1001	194	03	03		D	194	02		LANGFORD LAKE	11	15	17	19	21	25
484	STEAM ELECTRIC	041002194	D	1002	1002	194	03	00		D	194	3	03240	RIVER CREST LAKE	1500	1500	1500	1500	1500	1500
485	STEAM ELECTRIC	041002194	D	1002	1002	194	03	00		D	194	3	03500	SULPHUR RIVER	10000	10000	10000	10000	10000	10000
486	IRRIGATION	041004194	D	1004	1004	194	02	00		D	194	2	194996	IRRIGATION LOCAL SUPPLY	54	54	53	53	52	52
487	IRRIGATION	041004194	D	1004	1004	194	03	00		D	194	3	194996	IRRIGATION LOCAL SUPPLY	45	44	44	43	43	42
488	LIVESTOCK	041005194	D	1005	1005	194	02	01		D	194	2	19429	WOODBINE	124	124	124	124	124	124
489	LIVESTOCK	041005194	D	1005	1005	194	02	01		D	194	2	19407	BLOSSOM	69	69	69	69	69	69
490	LIVESTOCK	041005194	D	1005	1005	194	02	00		D	194	2	02997	LIVESTOCK LOCAL SUPPLY	289	289	289	289	289	289
491	LIVESTOCK	041005194	D	1005	1005	194	03	01		D	194	3	19420	NACATOCH	28	28	28	28	28	28
492	LIVESTOCK	041005194	D	1005	1005	194	03	00		D	194	3	03997	LIVESTOCK LOCAL SUPPLY	670	670	670	670	670	670
493	LINDALE	040523000	D	0523	357	212	05	01		D	212	5	21210	CARRIZO-WILCOX	1253	1207	1166	1123	1081	1035
494	OVERTON	040662000	D	0662	445	212	05	01		D	212	5	21210	CARRIZO-WILCOX	16	18	19	20	21	22
495	TYLER	040918000	D	0918	613	212	05	00		D	212	06	06060	LAKE TYLER	2	2	2	2	2	2
496	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	6	21210	CARRIZO-WILCOX	2.1	2.1	2.1	2.1	2.1	2.1
497	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	6	21210	CARRIZO-WILCOX	11.5	11.5	11.5	11.5	11.5	11.5
498	COUNTY OTHER	040996212	D	0996	757	212	05	03		D	212	5	06060	LAKE TYLER	21	28	34	43	51	62
499	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	90	90	90	90	90	90
500	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	195	195	195	195	195	195
501	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	118	118	118	118	118	118
502	COUNTY OTHER	040996212	D	0996	757	212	05	03		D	212	5	21210	CARRIZO-WILCOX	35	81	122	165	207	253
503	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	62	62	62	62	62	62
504	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	161	161	161	161	161	161
505	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	4.62	4.62	4.62	4.62	4.62	4.62
506	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	729	729	729	729	729	729
507	COUNTY OTHER	040996212	D	0996	757	212	05	03	497200	D	212	5	21210	CARRIZO-WILCOX	0	0	0	0	0	0
508	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	183	183	183	183	183	183
509	COUNTY OTHER	040996212	D	0996	757	212	05	03		D	212	5	21210	CARRIZO-WILCOX	0	56	105	156	207	262
510	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	6	21210	CARRIZO-WILCOX	258	258	258	258	258	258
511	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	575	575	575	575	575	575
512	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	887	887	887	887	887	887
513	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	108	108	108	108	108	108
514	COUNTY OTHER	040996212	D	0996	757	212	05	03	327250	D	230	5	05090	LAKE GLADEWATER	27.6	27.6	27.6	27.6	27.6	27.6
515	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	114.5	114.5	114.5	114.5	114.5	114.5
516	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	59	59	59	59	59	59
517	COUNTY OTHER	040996212	D	0996	757	212	05	01		D	212	5	21210	CARRIZO-WILCOX	89.5	89.5	89.5	89.5	89.5	89.5
518	MANUFACTURING	041001212	D	1001	1001	212	05	01		D	212	5	21210	CARRIZO-WILCOX	262	298	325	346	377	403
519	MINING	041003212	D	1003	1003	212	05	01		D	212	5	21210	CARRIZO-WILCOX	176	176	91	32	18	6
520	MINING	041003212	D	1003	1003	212	05	01		D	212	5	21224	QUEEN CITY	249	2	0	0	0	0
521	IRRIGATION	041004212	D	1004	1004	212	05	00		D	212	5	212996	IRRIGATION LOCAL SUPPLY	446	468	491	516	542	569
522	LIVESTOCK	041005212	D	1005	1005	212	05	01		D	212	5	21224	QUEEN CITY	242	242	242	242	242	242

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
523	LIVESTOCK	041005212	D	1005	1005	212	05	01		D	212	5	21210	CARRIZO-WILCOX	211	211	211	211	211	211
524	MOUNT PLEASANT	040613000	D	0613	416	225	04	00		D	080	4	04010	LAKE CYPRESS SPRINGS	2321	2641	2788	2797	2747	2686
525	MOUNT PLEASANT	040613000	D	0613	416	225	04	03		D	225	4	04030	LAKE BOB SANDLIN	6452	7341	7749	7774	7635	7465
526	MOUNT PLEASANT	040613000	D	0613	416	225	04	00		D	225	4	04140	LAKE TANKERSLEY	1936	2202	2325	2332	2291	2240
527	CITY OF TALCO	040880000	D	0880	968	225	03	01		D	225	3	22520	NACATOCH	338	545	545	545	545	545
528	COUNTY OTHER	040996225	D	0996	757	225	04	01		D	032	4	03210	CARRIZO-WILCOX	119	119	119	119	119	119
529	COUNTY OTHER	040996225	D	0996	757	225	03	01		D	225	3	22520	NACATOCH	436	436	436	436	436	436
530	COUNTY OTHER	040996225	D	0996	757	225	03	01		D	225	3	22520	NACATOCH	109	109	109	109	109	109
531	COUNTY OTHER	040996225	D	0996	757	225	04	03	582250	D	225	4	04030	LAKE BOB SANDLIN	153	153	153	0	0	0
532	COUNTY OTHER	040996225	D	0996	757	225	04	01		D	225	4	22510	CARRIZO-WILCOX	1	1	1	1	1	1
533	COUNTY OTHER	040996225	D	0996	757	225	04	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	35	35	35	35	0	0
534	COUNTY OTHER	040996225	D	0996	757	225	04	03	872795	D	225	4	04030	LAKE BOB SANDLIN	5	5	5	5	5	5
535	COUNTY OTHER	040996225	D	0996	757	225	04	01		D	225	4	22510	CARRIZO-WILCOX	1613	1613	1613	1613	1613	1613
536	COUNTY OTHER	040996225	D	0996	757	225	04	03	651250	D	225	4	04030	LAKE BOB SANDLIN	753	0	0	0	0	0
537	COUNTY OTHER	040996225	D	0996	757	225	03	03	651250	D	225	4	04030	LAKE BOB SANDLIN	515	0	0	0	0	0
538	MANUFACTURING	041001225	D	1001	1001	225	04	00		D	225	4	04030	LAKE BOB SANDLIN	38500	38500	38500	38500	38500	38500
539	MANUFACTURING	041001225	D	1001	1001	225	04	00		D	225	4	04140	LAKE TANKERSLEY	550	550	550	550	550	550
540	MANUFACTURING	041001225	D	1001	1001	225	04	03		D	225	4	04140	LAKE TANKERSLEY	3420	3420	3420	3420	3650	3882
541	MANUFACTURING	041001225	D	1001	1001	225	04	01		D	225	4	22510	CARRIZO-WILCOX	2427	2598	2729	2832	2840	2840
542	STEAM ELECTRIC	041002225	D	1002	1002	225	04	00		D	225	4		BLUNDELL CREEK	16300	16300	16300	16300	16300	16300
543	STEAM ELECTRIC	041002225	D	1002	1002	225	04	00		D	225	4	04020	MONTICELLO	7700	7700	7700	0	0	0
544	STEAM ELECTRIC	041002225	D	1002	1002	225	04	00		D	225	4	04040	WELSH CREEK	11000	11000	11000	11000	11000	11000
545	STEAM ELECTRIC	041002225	D	1002	1002	225	04	00	60	D	225	4	04030	LAKE BOB SANDLIN	10000	10000	10000	10000	10000	10000
546	MINING	041003225	D	1003	1003	225	04	00		D	225	4	04030	LAKE BOB SANDLIN	1098	450	315	272	275	324
547	MINING	041003225	D	1003	1003	225	04	01		D	225	4	22510	CARRIZO-WILCOX	1420	1420	1420	1420	1420	1420
548	MINING	041003225	D	1003	1003	225	03	01		D	225	3	22510	CARRIZO-WILCOX	254	121	61	30	10	0
549	LIVESTOCK	041005225	D	1005	1005	225	04	01		D	225	4	22510	CARRIZO-WILCOX	370	370	370	370	370	370
550	LIVESTOCK	041005225	D	1005	1005	225	03	01		D	225	3	22510	CARRIZO-WILCOX	355	355	355	355	355	355
551	LIVESTOCK	041005225	D	1005	1005	225	03	00		D	225	3	03997	LIVESTOCK LOCAL SUPPLY	133	133	133	133	133	133
552	BIG SANDY	040084000	D	0084	57	230	05	01		D	230	5	23010	CARRIZO-WILCOX	328	328	328	328	328	328
553	EAST MOUNTAIN	040262000	D	0262	860	230	05	01		D	230	5	23010	CARRIZO-WILCOX	62.9	62.9	62.9	62.9	62.9	62.9
554	GILMER	040341000	D	0341	236	230	04	00		D	230	4	04170	LAKE GILMER	5430	5430	5430	5430	5430	5430
555	GILMER	040341000	D	0341	236	230	04	01		D	230	4	23010	CARRIZO-WILCOX	1145	1145	1145	1145	1145	1145
556	GLADEWATER	040342000	D	0342	237	230	05	00		D	230	5	05090	LAKE GLADEWATER	499.4	796.3	796.3	796.3	796.3	796.3
557	ORECITY	040661000	D	0661	728	230	04	01		D	230	4	23010	CARRIZO-WILCOX	242.5	242.5	242.5	242.5	242.5	242.5
558	ORECITY	040661000	D	0661	728	230	04	03	60	D	158	4	04070	LAKE O' THE PINES	2690	2690	2690	2690	2690	2690
559	COUNTY OTHER	040996230	D	0996	757	230	05	00		D	230	5	22100	LAKE LOMA	400	400	400	400	400	400
560	COUNTY OTHER	040996230	D	0996	757	230	05	00		D	230	5	05080	BIG SANDY CREEK (ROR)	150	150	150	150	150	150
561	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	461	461	461	461	461	461
562	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	39.2	39.2	39.2	39.2	39.2	39.2
563	COUNTY OTHER	040996230	D	0996	757	230	05	00		D	230	5	05090	LAKE GLADEWATER	20.8	33.2	33.2	33.2	33.2	33.2
564	COUNTY OTHER	040996230	D	0996	757	230	05	03	327250	D	230	5	05090	LAKE GLADEWATER	23.8	0	0	0	0	0
565	COUNTY OTHER	040996230	D	0996	757	230	05	03	512010	D	092	5	05080	BIG SANDY CREEK (ROR)	19.2	0	0	0	0	0
566	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	433	433	433	433	433	433
567	COUNTY OTHER	040996230	D	0996	757	230	05	01		D	250	5	25010	CARRIZO-WILCOX	9	9	9	9	9	9
568	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	358	358	358	358	358	358
569	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	24.1	24.1	24.1	24.1	24.1	24.1
570	COUNTY OTHER	040996230	D	0996	757	230	05	01		D	230	5	23010	CARRIZO-WILCOX	502	502	502	502	502	502
571	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	270	270	270	270	270	270
572	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	27	27	27	27	27	27
573	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	27	27	27	27	27	27
574	COUNTY OTHER	040996230	D	0996	757	230	04	01		D	230	4	23010	CARRIZO-WILCOX	27	27	27	27	27	27

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
575	COUNTY OTHER	040996230	D	0996	757	230	05	01		D	230	5	23010	CARRIZO-WILCOX	249.5	249.5	249.5	249.5	249.5	249.5
576	MANUFACTURING	041001230	D	1001	1001	230	04	00		D	230	4	04170	GILMER LAKE	750	750	750	750	750	750
577	MANUFACTURING	041001230	D	1001	1001	230	04	01		D	230	4	23010	CARRIZO-WILCOX	215	232	241	243	277	314
578	MINING	041003230	D	1003	1003	230	04	01		D	230	4	23010	CARRIZO-WILCOX	1	1	1	1	1	0
579	IRRIGATION	041004230	D	1004	1004	230	05	00		D	230	5	22100	LAKE LOMA	200	200	200	200	200	200
580	LIVESTOCK	041005230	D	1005	1005	230	04	00		D	230	4	04997	LIVESTOCK LOCAL SUPPLY	1235	1235	1235	1235	1235	1235
581	LIVESTOCK	041005230	D	1005	1005	230	04	01		D	230	4	23010	CARRIZO-WILCOX	275	275	275	275	275	275
582	LIVESTOCK	041005230	D	1005	1005	230	05	01		D	230	5	23010	CARRIZO-WILCOX	55	55	55	55	55	55
583	LIVESTOCK	041005230	D	1005	1005	230	05	00		D	230	5	05997	LIVESTOCK LOCAL SUPPLY	363	363	363	363	363	363
584	CANTON	040143000	D	0143	94	234	05	00		D	234	5	05270	MILL CREEK LAKE	706	706	706	706	706	706
585	CANTON	040143000	D	0143	94	234	05	01		D	234	5	23410	CARRIZO-WILCOX	112	112	112	112	112	112
586	EDGEWOOD	040268000	D	0268	181	234	05	03	95	D	190	5	05010	LAKE TAWAKONI	840	840	0	0	0	0
587	EDGEWOOD	040268000	D	0268	181	234	05	00		D	234	5	05280	EDGEWOOD CITY LAKE	110	110	110	110	110	110
588	GRAND SALINE	040354000	D	0354	246	234	05	01		D	234	5	23410	CARRIZO-WILCOX	586	586	586	586	586	586
589	VAN	040924000	D	0924	618	234	05	01		D	234	6	23410	CARRIZO-WILCOX	30	30	30	30	30	30
590	VAN	040924000	D	0924	618	234	06	01		D	234	6	23410	CARRIZO-WILCOX	533.8	533.8	533.8	533.8	533.8	533.8
591	WILLS POINT	040974000	D	0974	656	234	05	03	90	D	190	5	05010	LAKE TAWAKONI	1105	1105	0	0	0	0
592	WILLS POINT	040974000	D	0974	656	234	08	03	90	D	190	5	05010	LAKE TAWAKONI	1105	1105	0	0	0	0
593	COUNTY OTHER	040996234	D	0996	757	234	6	01		D	234	6	23410	CARRIZO-WILCOX	212.4	212.4	212.4	212.4	212.4	212.4
594	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	32	32	32	32	32	32
595	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	139	139	139	139	139	139
596	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	106	106	106	106	106	106
597	COUNTY OTHER	040996234	D	0996	757	234	6	01		D	234	6	23410	CARRIZO-WILCOX	119	119	119	119	119	119
598	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	357.5	357.5	357.5	357.5	357.5	357.5
599	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	58	58	58	58	58	58
600	COUNTY OTHER	040996234	D	0996	757	234	06	01		D	234	6	23410	CARRIZO-WILCOX	186	186	186	186	186	186
601	COUNTY OTHER	040996234	D	0996	757	234	08	01		D	234	5	23410	CARRIZO-WILCOX	101	101	101	101	101	101
602	COUNTY OTHER	040996234	D	0996	757	234	05	03	90	D	190	5	05010	LAKE TAWAKONI	2106	2106	0	0	0	0
603	COUNTY OTHER	040996234	D	0996	757	234	08	03	90	D	190	5	05010	LAKE TAWAKONI	1053	1053	1053	0	0	0
604	COUNTY OTHER	040996234	D	0996	757	234	06	01		D	234	6	23410	CARRIZO-WILCOX	37.6	37.6	37.6	37.6	37.6	37.6
605	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	188	188	188	188	188	188
606	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	371	371	371	371	371	371
607	COUNTY OTHER	040996234	D	0996	757	234	6	01		D	234	6	23410	CARRIZO-WILCOX	196	196	196	196	196	196
608	COUNTY OTHER	040996234	D	0996	757	234	05	03	90	D	190	5	05010	LAKE TAWAKONI	558	558	0	0	0	0
609	COUNTY OTHER	040996234	D	0996	757	234	05	01		D	234	5	23410	CARRIZO-WILCOX	7	10	12	15	16	18
610	COUNTY OTHER	040996234	D	0996	757	234	6	01		D	234	6	23410	CARRIZO-WILCOX	257	257	257	257	257	257
611	MANUFACTURING	041001234	D	1001	1001	234	05	00		D	234	5	05010	LAKE TAWAKONI	164	228	280	335	392	450
612	MANUFACTURING	041001234	D	1001	1001	234	05	01		D	234	5	23410	CARRIZO-WILCOX	116	116	116	116	116	116
613	MINING	041003234	D	1003	1003	234	6	01		D	234	6	23410	CARRIZO-WILCOX	80	48	28	19	14	14
614	MINING	041003234	D	1003	1003	234	05	00		D	234	5	05999	LOCAL SUPPLY SOURCE	133	0	0	0	0	0
615	MINING	041003234	D	1003	1003	234	05	01		D	234	5	23410	CARRIZO-WILCOX	1100	1073	1026	1014	1025	1055
616	MINING	041003234	D	1003	1003	234	8	01		D	234	8	23410	CARRIZO-WILCOX	46	46	45	44	45	46
617	IRRIGATION	041004234	D	1004	1004	234	8	01		D	234	8	23410	CARRIZO-WILCOX	220	220	220	220	220	220
618	LIVESTOCK	041005234	D	1005	1005	234	6	00		D	234	6	06997	LIVESTOCK LOCAL SUPPLY	599	599	599	599	599	599
619	LIVESTOCK	041005234	D	1005	1005	234	6	01		D	234	6	23410	CARRIZO-WILCOX	58	58	58	58	58	58
620	LIVESTOCK	041005234	D	1005	1005	234	05	00		D	234	5	05997	LIVESTOCK LOCAL SUPPLY	1013	1013	1013	1013	1013	1013
621	LIVESTOCK	041005234	D	1005	1005	234	05	01		D	234	5	23410	CARRIZO-WILCOX	87	87	87	87	87	87
622	LIVESTOCK	041005234	D	1005	1005	234	8	00		D	234	8	08997	LIVESTOCK LOCAL SUPPLY	599	587	516	440	333	276
623	LIVESTOCK	041005234	D	1005	1005	234	8	01		D	234	8	23410	CARRIZO-WILCOX	25	37	108	184	291	348
624	HAWKINS	040385000	D	0385	701	250	05	01		D	250	5	25010	CARRIZO-WILCOX	1073	1073	1073	1073	1073	1073
625	MINEOLA	040599000	D	0599	406	250	05	01		D	250	5	25010	CARRIZO-WILCOX	890	890	890	890	890	890
626	QUITMAN	040731000	D	0731	490	250	05	03	90	D	250	5	05040	LAKE FORK	560	560	560	560	560	560

TABLE 5: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY CITY AND CATEGORY

1	WUG NAME	WUG ID	RWPG	SEQ NUM	CITY NUM	COUNTY NUM	BASIN NUM	SUPPLY SOURCE TYPE NUM	MWP NUM	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUM	SUPPLY SOURCE BASIN NUM	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000 (A-F)	S2010 (A-F)	S2020 (A-F)	S2030 (A-F)	S2040 (A-F)	S2050 (A-F)
627	QUITMAN	040731000	D	0731	490	250	05	01		D	250	5	25010	CARRIZO-WILCOX	69.3	69.3	69.3	69.3	69.3	69.3
628	WINNSBORO	040981000	D	0981	661	250	04	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	100	100	100	100		
629	WINNSBORO	040981000	D	0981	661	250	05	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	4208	4429	4429	4429		
630	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	45.7	45.7	45.7	45.7	45.7	45.7
631	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	240.3	240.3	240.3	240.3	240.3	240.3
632	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	4	4	4	4	4	4
633	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	102.7	102.7	102.7	102.7	102.7	102.7
634	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	68	68	68	68	68	68
635	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	77	77	77	77	77	77
636	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	161.3	161.3	161.3	161.3	161.3	161.3
637	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	147.9	147.9	147.9	147.9	147.9	147.9
638	COUNTY OTHER	040996250	D	0996	757	250	04	01		D	250	4	25010	CARRIZO-WILCOX	0	0	0	0	0	0
639	COUNTY OTHER	040996250	D	0996	757	250	04	03	50	D	080	4	04010	LAKE CYPRESS SPRINGS	70	70	70	70	0	0
640	COUNTY OTHER	040996250	D	0996	757	250	05	03		D	250	5	04010	LAKE CYPRESS SPRINGS	23	23	23	23	0	0
641	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	212	5	21210	CARRIZO-WILCOX	0	0	0	0	0	0
642	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	607	607	607	607	607	607
643	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	352.4	352.4	352.4	352.4	352.4	352.4
644	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	606	606	606	606	606	606
645	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	350	350	350	350	350	350
646	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	521.7	521.7	521.7	521.7	521.7	521.7
647	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	177.4	177.4	177.4	177.4	177.4	177.4
648	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	381.7	381.7	381.7	381.7	381.7	381.7
649	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	230	5	23010	CARRIZO-WILCOX	2.4	2.4	2.4	2.4	2.4	2.4
650	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	530	530	530	530	530	530
651	COUNTY OTHER	040996250	D	0996	757	250	04	01		D	250	5	25010	CARRIZO-WILCOX	139	139	139	139	139	139
652	COUNTY OTHER	040996250	D	0996	757	250	05	03	952800	D	250	5	04010	LAKE CYPRESS SPRINGS	221	0	0	0	0	0
653	COUNTY OTHER	040996250	D	0996	757	250	05	01		D	250	5	25010	CARRIZO-WILCOX	286	286	286	286	286	286
654	MANUFACTURING	041001250	D	1001	1001	250	05	01		D	250	5	25010	CARRIZO-WILCOX	244	290	341	391	468	544
655	STEAM ELECTRIC	041002250	D	1002	1002	250	05	03		D	250	5	05999	LOCAL SUPPLY SOURCE	0	7500	7500	7500	7500	7500
656	MINING	041003250	D	1003	1003	250	05	01		D	250	5	25010	CARRIZO-WILCOX	1128	1128	1128	1128	1128	1128
657	MINING	041003250	D	1003	1003	250	05	01		D	250	5	25024	QUEEN CITY	974	16456	16216	15979	14979	3513
658	IRRIGATION	041004250	D	1004	1004	250	04	01		D	250	4	25010	CARRIZO-WILCOX	119	119	119	119	119	119
659	IRRIGATION	041004250	D	1004	1004	250	05	01		D	250	5	25024	QUEEN CITY	226	226	226	226	226	226
660	IRRIGATION	041004250	D	1004	1004	250	05	01		D	250	5	25010	CARRIZO-WILCOX	9	9	9	9	9	9
661	LIVESTOCK	041005250	D	1005	1005	250	04	00		D	250	4	04997	LIVESTOCK LOCAL SUPPLY	202	202	202	202	202	202
662	LIVESTOCK	041005250	D	1005	1005	250	05	01		D	250	5	25010	CARRIZO-WILCOX	141	141	141	141	141	141
663	LIVESTOCK	041005250	D	1005	1005	250	05	00		D	250	5	05997	LIVESTOCK LOCAL SUPPLY	2219	2219	2219	2219	2219	2219

TABLE 6: CURRENT WATER SUPPLIES AVAILABLE TO THE RWPG BY MAJOR WATER PROVIDER OF MUNICIPAL AND MANUFACTURING WATER

MAJOR WATER PROVIDER NAME	MWP TWDB ALPHA NUMBER	WATER SUPPLY SOURCE TYPE NUMBER	MWP NUMBER SELLING TO MWP NAME	SUPPLY SOURCE REGIONAL WATER PLANNING GROUP	SUPPLY SOURCE COUNTY NUMBER	SUPPLY SOURCE BASIN NUMBER	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	S2000	S2010	S2020	S2030	S2040	S2050
CHEROKEE WATER COMPANY	110	00		I		05	05110	LAKE CHEROKEE	18,000	18,000	18,000	18,000	18,000	18,000
FRANKLIN COUNTY WATER DISTRICT	50	00		D		04	04500	CYPRESS (ROR)	11,710	11,710	11,710	11,710	11,710	11,710
NORTHEAST TEXAS MUNICIPAL WATER DISTRICT	60	00		D		04	04070	LAKE O' THE PINES	130,600	130,600	130,600	130,600	130,600	130,600
NORTHEAST TEXAS MUNICIPAL WATER DISTRICT	60	00		D		04	04030	LAKE BOB SANDLIN	12,000	12,000	12,000	12,000	12,000	12,000
NORTHEAST TEXAS MUNICIPAL WATER DISTRICT	60	00		D		04	04060	JOHNSON CREEK LAKE	6,700	6,700	6,700	6,700	6,700	6,700
NORTHEAST TEXAS MUNICIPAL WATER DISTRICT	60	00		D		04	04020	MONTICELLO LAKE	7,700	7,700	7,700	7,700	7,700	7,700
NORTHEAST TEXAS MUNICIPAL WATER DISTRICT	60	00		D		04	04040	WELSH RESERVOIR	4,500	4,500	4,500	4,500	4,500	4,500
SABINE RIVER AUTHORITY	95	00		D		05	05010	LAKE TAWAKONI	238,100	229,005	227,118	225,232	223,345	221,459
SABINE RIVER AUTHORITY	95	00		D		05	05040	LAKE FORK	188,600	187,776	187,590	187,403	187,217	187,031
TITUS COUNTY FRESHWATER SUPPLY DISTRICT NO. 1	70	00		D		04	04030	LAKE BOB SANDLIN	48,500	48,500	48,500	48,500	48,500	48,500
GREENVILLE	342340	00	95	D			05010	LAKE TAWAKONI	21,283	21,283	21,283	21,283	21,283	21,283
GREENVILLE	342340	00		D		05	05000	CITY LAKES	1,205	1,205	1,205	1,205	1,205	1,205
LONGVIEW	512010	00	110	D		05	05110	LAKE CHEROKEE	16,000	16,000	16,000	16,000	16,000	16,000
LONGVIEW	512010	00	60	D			04070	LAKE O' THE PINES	20,000	20,000	20,000	20,000	20,000	20,000
LONGVIEW	512010	00		D		05	05080	BIG SANDY CREEK	1,120	1,120	1,120	1,120	1,120	1,120
LONGVIEW	512010	00	95	D		05	05040	LAKE FORK	20,000	20,000	20,000	20,000	20,000	20,000
LONGVIEW	512010	00	95	D			05010	LAKE TAWAKONI	19,337	19,337	19,337	19,337	19,337	19,337
MARSHALL	538090	00		D			04010	LAKE CYPRESS SPRINGS	16,000	16,000	16,000	16,000	16,000	16,000
MT. PLEASANT	651250	00		D		04		LAKE TANKERSLEY	3,000	3,000	3,000	3,000	3,000	3,000
MT. PLEASANT	651250	00		D		04	04500	CYPRESS (ROR)	3,590	3,590	3,590	3,590	3,590	3,590
MT. PLEASANT	651250	00	70	D		04	04030	LAKE BOB SANDLIN	10,000	10,000	10,000	10,000	10,000	10,000
PARIS	651250	00		D		02	02290	PAT MAYSE LAKE	59,900	59,570	59,200	58,900	58,600	58,300
PARIS	651250	00		D		02	02300	CROOK LAKE	1,000	1,000	1,000	1,000	1,000	1,000
SULPHUR SPRINGS	828100	00		D		03	03010	COOPER RESERVOIR	16,034	15,935	15,726	15,717	15,608	15,608
SULPHUR SPRINGS	828100	00		D		03	03040	LAKE SULPHUR SPRINGS	7,800	7,800	7,800	7,800	7,800	7,800
TEXARKANA	848000	00		D		03	03080	WRIGHT PATMAN LAKE	108,661	108,661	108,661	108,661	108,661	108,661

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY														
								TABLE 7 in Acre-Feet						
	WUG NAME	WUG ID	RWPG LETTER	SEQUENCE NUMBER	CITY NUMBER	COUNTY NUMBER	RIVER BASIN NUMBER	2000	2010	2020	2030	2040	2050
1	DE KALB	040232019	D	0232	155	019	02	112	-126	-127	-132	-137	-144
2	DE KALB	040232019	D	0232	155	019	03	81	-126	-128	-131	-137	-144
4	HOOKS	040416019	D	0416	284	019	02	-69	-454	-465	-484	-495	-528
5	MAUD	040572019	D	0572	393	019	03	114	-138	-144	-149	-153	-157
6	NASH	040622019	D	0622	423	019	03	83	-300	-313	-324	-334	-341
7	NEW BOSTON	040628019	D	0628	429	019	02	-64	-232	-243	-256	-269	-285
8	NEW BOSTON	040628019	D	0628	429	019	03	-261	-932	-974	-1024	-1077	-1140
9	REDWATER	040740019	D	0740	945	019	03	0	-69	-74	-78	-81	-84
10	TEXARKANA	040889019	D	0889	601	019	02	0	-2	-4	-7	-10	-15
11	TEXARKANA	040889019	D	0889	601	019	03	12902	21071	20962	23358	19829	16068
12	WAKE VILLAGE	040937019	D	0937	628	019	03	-299	-690	-718	-743	-764	-781
13	COUNTY-OTHER	040996019	D	0996	757	019	03	-2798	-2982	-3320	-4034	-4214	-4450
14	COUNTY-OTHER	040996019	D	0996	757	019	02	-860	-1012	-1131	-1180	-1238	-1314
15	IRRIGATION	041004019	D	1004	1004	019	02	0	0	0	0	0	0
16	IRRIGATION	041004019	D	1004	1004	019	03	0	0	0	0	0	0
17	LIVESTOCK	041005019	D	1005	1005	019	03	0	0	0	0	0	0
18	LIVESTOCK	041005019	D	1005	1005	019	02	0	0	0	0	0	0
19	MANUFACTURING	041001019	D	1001	1001	019	03	0	0	0	0	0	0
20	MANUFACTURING	041001019	D	1001	1001	019	02	0	0	0	0	0	0
21	MINING	041003019	D	1003	1003	019	03	0	0	0	0	0	0
22	MINING	041003019	D	1003	1003	019	02	0	0	0	0	0	0
23	STEAM ELECTRIC POWER	041002019	D	1002	1002	019	03	0	0	0	0	0	0
24	STEAM ELECTRIC POWER	041002019	D	1002	1002	019	02	0	0	0	0	0	0
25	PITTSBURG	040701032	D	0701	469	032	04	1461	1426	1405	1365	1322	1268
26	COUNTY-OTHER	040996032	D	0996	757	032	04	559	306	290	282	274	269
27	IRRIGATION	041004032	D	1004	1004	032	04	0	0	0	0	0	0
28	LIVESTOCK	041005032	D	1005	1005	032	04	0	0	0	0	0	0
29	MANUFACTURING	041001032	D	1001	1001	032	04	0	-2232	-2232	-2232	-2232	-2232
30	MINING	041003032	D	1003	1003	032	04	0	0	0	0	0	0
31	STEAM ELECTRIC POWER	041002032	D	1002	1002	032	04	0	0	0	0	0	0
32	ATLANTA	040042034	D	0042	29	034	03	0	0	0	0	0	0
33	ATLANTA	040042034	D	0042	29	034	04	457	-1420	-1406	-1411	-1406	-1417
34	HUGHES SPRINGS	040423034	D	0423	288	034	04	4040	4032	4050	4122	4133	4135

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY													
								TABLE 7 in Acre-Feet					
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
35	LINDEN	040524034	D	0524	358	034	04	-95	-94	-96	-106	-111	-126
36	QUEEN CITY	040728034	D	0728	489	034	04	141	-15	-16	-20	-24	-31
37	QUEEN CITY	040728034	D	0728	489	034	03	164	-17	-20	-24	-29	-38
38	COUNTY-OTHER	040996034	D	0996	757	034	04	316.04	203.14	116.14	-21.06	-97.06	-160.06
39	COUNTY-OTHER	040996034	D	0996	757	034	03	-230.76	-305	-325	-341	-359	-373
40	IRRIGATION	041004034	D	1004	1004	034	04	0	0	0	0	0	0
41	IRRIGATION	041004034	D	1004	1004	034	03	0	0	0	0	0	0
42	LIVESTOCK	041005034	D	1005	1005	034	04	0	0	0	0	0	0
43	LIVESTOCK	041005034	D	1005	1005	034	03	0	0	0	0	0	0
44	MANUFACTURING	041001034	D	1001	1001	034	04	0	0	0	0	0	0
45	MANUFACTURING	041001034	D	1001	1001	034	03	0	0	0	0	0	0
46	MINING	041003034	D	1003	1003	034	03	0	0	0	0	0	0
47	MINING	041003034	D	1003	1003	034	04	0	0	0	0	0	0
48	STEAM ELECTRIC POWER	041002034	D	1002	1002	034	04	0	0	0	0	0	0
49	STEAM ELECTRIC POWER	041002034	D	1002	1002	034	03	0	0	0	0	0	0
50	COOPER	040200060	D	0200	132	060	03	569	581	596	1125	1136	1139
51	COUNTY-OTHER	040996060	D	0996	757	060	03	242	247	190	-396	-380	-363
52	IRRIGATION	041004060	D	1004	1004	060	03	0	0	0	0	0	0
53	LIVESTOCK	041005060	D	1005	1005	060	03	0	0	0	0	0	0
54	MANUFACTURING	041001060	D	1001	1001	060	03	9180	9180	9180	9180	9180	9180
55	MINING	041003060	D	1003	1003	060	03	0	0	0	0	0	0
56	STEAM ELECTRIC POWER	041002060	D	1002	1002	060	03	0	0	0	0	0	0
57	MOUNT VERNON	040614080	D	0614	417	080	03	2455	2406	2363	0	0	0
58	MOUNT VERNON		D					0	0	0	-707	-738	-780
59	WINNSBORO	040981080	D	0981	661	080	05	304	288	274	254	-25	-26
60	WINNSBORO	040981080	D	0981	661	080	04	0	0	0	0	-180	-191
61	COUNTY-OTHER	040996080	D	0996	757	080	05	0	0	0	0	0	0
62	COUNTY-OTHER	040996080	D	0996	757	080	04	2037	1922	1855	1767	-836	-893
63	COUNTY-OTHER	040996080	D	0996	757	080	03	-187	-263	-336	-434	-977	-1038
64	IRRIGATION	041004080	D	1004	1004	080	05	0	0	0	0	0	0
65	IRRIGATION	041004080	D	1004	1004	080	0'04	0	0	0	0	0	0
66	IRRIGATION	041004080	D	1004	1004	080	03	0	0	0	0	0	0
67	LIVESTOCK	041005080	D	1005	1005	080	03	0	0	0	0	0	0

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY													
								TABLE 7 in Acre-Feet					
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
68	LIVESTOCK	041005080	D	1005	1005	080	04	0	0	0	0	0	0
69	LIVESTOCK	041005080	D	1005	1005	080	05	0	0	0	0	0	0
70	MANUFACTURING	041001080	D	1001	1001	080	05	0	0	0	0	0	0
71	MANUFACTURING	041001080	D	1001	1001	080	03	0	0	0	0	0	0
72	MANUFACTURING	041001080	D	1001	1001	080	04	5634	5634	5634	5634	5634	5634
73	MINING	041003080	D	1003	1003	080	05	0	0	0	0	0	0
74	MINING	041003080	D	1003	1003	080	04	0	0	0	0	0	0
75	MINING	041003080	D	1003	1003	080	03	0	0	0	0	0	0
76	STEAM ELECTRIC POWER	041002080	D	1002	1002	080	05	0	0	0	0	0	0
77	STEAM ELECTRIC POWER	041002080	D	1002	1002	080	03	0	0	0	0	0	0
78	STEAM ELECTRIC POWER	041002080	D	1002	1002	080	04	0	0	0	0	0	0
79	CLARKSVILLE CITY	040172092	D	0172	844	092	05	198.4	-131	-138	-144	-148	-152
80	GLADEWATER	040342092	D	0342	237	092	05	-222	51	29	-15	-57	-110
81	KILGORE	040469092	D	0469	321	092	05	746.9	656.9	572.9	450.9	323.9	170.9
82	LAKEPORT	040502092	D	0502	893	092	05	12.2	-106.9	-112.9	-118.9	-122.9	-126.9
83	LIBERTY CITY	040522092	D	0522	715	092	05	-227.3	-238.3	-250.3	-272.3	-296.3	-321.3
84	LONGVIEW	040539092	D	0539	367	092	05	34604.4	20029.4	19458.4	18751.4	3551	-13247
85	WHITE OAK	040963092	D	0963	649	092	05	187	-870	-890	-928	-969	-1027
86	COUNTY-OTHER	040996092	D	0996	757	092	04	335.1	-235.9	-273.9	-350.9	-412.9	-487.9
87	COUNTY-OTHER	040996092	D	0996	757	092	05	348.7	-866.7	-934.7	-1223.7	-1469.7	-1758.7
88	IRRIGATION	041004092	D	1004	1004	092	04	0	0	0	0	0	0
89	IRRIGATION	041004092	D	1004	1004	092	05	0	0	0	0	0	0
90	LIVESTOCK	041005092	D	1005	1005	092	05	0	0	0	0	0	0
91	LIVESTOCK	041005092	D	1005	1005	092	04	0	0	0	0	0	0
92	MANUFACTURING	041001092	D	1001	1001	092	05	-10717	-9088	-10568	-12671	-15130	-17746
93	MANUFACTURING	041001092	D	1001	1001	092	04	0	0	0	0	0	0
94	MINING	041003092	D	1003	1003	092	04	0	0	0	0	0	0
95	MINING	041003092	D	1003	1003	092	05	0	0	0	0	0	0
96	STEAM ELECTRIC POWER	041002092	D	1002	1002	092	04	0	0	0	0	0	0
97	STEAM ELECTRIC POWER	041002092	D	1002	1002	092	05	3434.5	3934.5	3934.5	3934.5	3934.5	4934.5
98	HALLSVILLE	040374102	D	0374	260	102	05	128.3	-264	-275	-288	-301	-310
99	LONGVIEW	040539102	D	0539	367	102	05	24868.1	20132.1	20123.1	20106.1	20087.1	14783.1
100	MARSHALL	040566102	D	0566	388	102	05	8463	8267	8206	8001	7795	7467

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY													
								TABLE 7 in Acre-Feet					
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
101	MARSHALL	040566102	D	0566	388	102	04	446	435	432	421	411	393
102	WASKOM	040941102	D	0941	631	102	04	14	2	-1	-10	-21	-40
103	COUNTY-OTHER	040996102	D	0996	757	102	05	-454.9	-750.9	-649.9	-574.9	-510.9	-441.9
104	COUNTY-OTHER	040996102	D	0996	757	102	04	-174.87	-576.27	-776.27	-1149.4	-1326.4	-1478.4
105	IRRIGATION	041004102	D	1004	1004	102	05	0	0	0	0	0	0
106	IRRIGATION	041004102	D	1004	1004	102	04	0	0	0	0	0	0
107	LIVESTOCK	041005102	D	1005	1005	102	05	0	0	0	0	0	0
108	LIVESTOCK	041005102	D	1005	1005	102	04	0	0	0	0	0	0
109	MANUFACTURING	041001102	D	1001	1001	102	05	34903.4	14790	8763	3020	-9698	-23856
110	MANUFACTURING	041001102	D	1001	1001	102	04	53264	53264	53264	53263	53264	53264
111	MINING	041003102	D	1003	1003	102	05	520	520	520	520	520	520
112	MINING	041003102	D	1003	1003	102	04	0	0	0	0	0	0
113	STEAM ELECTRIC POWER	041002102	D	1002	1002	102	04	0	0	0	0	0	0
114	STEAM ELECTRIC POWER	041002102	D	1002	1002	102	05	23240	23240	23240	23240	23240	23240
115	COMO		D					41	41	41	41	41	41
116	COMO	040196112	D	0196	847	112	03	-38	-43	-47	-53	-59	-67
117	CUMBY	040221112	D	0221	852	112	05	32	27	24	17	12	4
118	CUMBY		D					0	0	0	0	0	0
119	SULPHUR SPRINGS	040869112	D	0869	586	112	03	15135	15703	15243	14905	14371	17110
120	COUNTY-OTHER	040996112	D	0996	757	112	05	305	-66	-221	-289	-349	-437
121	COUNTY-OTHER	040996112	D	0996	757	112	04	412	408	406	402	118	115
122	COUNTY-OTHER	040996112	D	0996	757	112	03	60	-286	-1162	-1251	-1405	-1523
123	IRRIGATION	041004112	D	1004	1004	112	03	0	0	0	0	0	0
124	IRRIGATION	041004112	D	1004	1004	112	04	0	0	0	0	0	0
125	IRRIGATION	041004112	D	1004	1004	112	05	0	0	0	0	0	0
126	LIVESTOCK	041005112	D	1005	1005	112	04	0	0	0	0	0	0
127	LIVESTOCK	041005112	D	1005	1005	112	05	0	0	0	0	0	0
128	LIVESTOCK	041005112	D	1005	1005	112	03	328	328	328	328	328	328
129	MANUFACTURING	041001112	D	1001	1001	112	03	14	15	15	16	17	17
130	MANUFACTURING	041001112	D	1001	1001	112	04	0	0	0	0	0	0
131	MANUFACTURING	041001112	D	1001	1001	112	05	0	-4	-4	-9	-13	-13
132	MINING	041003112	D	1003	1003	112	03	0	0	0	0	0	0
133	MINING	041003112	D	1003	1003	112	04	0	0	0	0	0	0

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY														
								TABLE 7 in Acre-Feet						
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
134	MINING	041003112	D	1003	1003	112	05	0	0	0	0	0	0
135	STEAM ELECTRIC POWER	041002112	D	1002	1002	112	05	0	0	0	0	0	0
136	STEAM ELECTRIC POWER	041002112	D	1002	1002	112	03	0	0	0	0	0	0
137	STEAM ELECTRIC POWER	041002112	D	1002	1002	112	04	0	0	0	0	0	0
138	CADDO MILLS	040135116	D	0135	685	116	05	14	2	-174	-183	-191	-197
139	CAMPBELL	040141116	D	0141	837	116	05	35	26	18	11	5	0
140	CELESTE	040153116	D	0153	839	116	05	41	32	24	17	11	6
141	COMMERCE	040195116	D	0195	129	116	03	2555	2549	2519	-2132	-2296	-2504
142	GREENVILLE	040361116	D	0361	250	116	05	17393	-4366	-4617	-4875	-5520	-6256
143	LONE OAK	040537116	D	0537	901	116	05	300	-87	-92	-97	-101	-105
144	QUINLAN	040729116	D	0729	736	116	05	11	-229	-243	-256	-267	-276
145	WEST TAWAKONI	040956116	D	0956	989	116	05	913	-219	-228	-244	-258	-275
146	WOLFE CITY	040983116	D	0983	663	116	03	6	-2	-9	-43	-56	-74
147	COUNTY-OTHER	040996116	D	0996	757	116	08	78	75	-31	69	64	63
148	COUNTY-OTHER	040996116	D	0996	757	116	05	4259	2618	-2151	-2822	-3827	-3979
149	COUNTY-OTHER	040996116	D	0996	757	116	03	-133	-331	-368	-402	-430	-455
150	IRRIGATION	041004116	D	1004	1004	116	05	0	0	0	0	0	0
151	IRRIGATION	041004116	D	1004	1004	116	08	0	0	0	0	0	0
152	IRRIGATION	041004116	D	1004	1004	116	03	0	0	0	0	0	0
153	LIVESTOCK	041005116	D	1005	1005	116	03	0	0	0	0	0	0
154	LIVESTOCK	041005116	D	1005	1005	116	05	0	0	0	0	0	0
155	LIVESTOCK	041005116	D	1005	1005	116	08	0	0	0	0	0	0
156	MANUFACTURING	041001116	D	1001	1001	116	03	0	0	0	0	0	0
157	MANUFACTURING	041001116	D	1001	1001	116	05	200	200	200	200	200	173
158	MANUFACTURING	041001116	D	1001	1001	116	08	0	0	0	0	0	0
159	MINING	041003116	D	1003	1003	116	05	0	0	0	0	0	0
160	MINING	041003116	D	1003	1003	116	03	0	0	0	0	0	0
161	MINING	041003116	D	1003	1003	116	08	0	0	0	0	0	0
162	STEAM ELECTRIC POWER	041002116	D	1002	1002	116	03	0	0	0	0	0	0
163	STEAM ELECTRIC POWER	041002116	D	1002	1002	116	05	284	-516	-516	-516	-516	-516
164	STEAM ELECTRIC POWER	041002116	D	1002	1002	116	08	0	0	0	0	0	0
165	BLOSSOM	040092139	D	0092	680	139	02	0	0	-236	-241	-245	-248
166	BLOSSOM		D					0	0	0	0	0	0

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY														
								TABLE 7 in Acre-Feet						
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
167	DEPORT	040242139	D	0242	857	139	03	0	-116	-119	-122	-124	-125
168	PARIS	040678139	D	0678	455	139	03	18137	17616	17096	19176	18409	17472
169	PARIS	040678139	D	0678	455	139	02	5985	5473	4966	7054	6300	5377
170	RENO	040743139	D	0743	738	139	02	0	0	-611	-656	-682	-707
171	RENO		D					0	0	0	0	0	0
172	ROXTON	040778139	D	0778	951	139	03	0	0	-99	-101	-102	-103
173	COUNTY-OTHER	040996139	D	0996	757	139	03	511	390	979	-1392	-1434	-1500
174	COUNTY-OTHER	040996139	D	0996	757	139	02	1481	1441	2183	-858	-879	-913
175	IRRIGATION	041004139	D	1004	1004	139	02	0	0	0	0	0	0
176	IRRIGATION	041004139	D	1004	1004	139	03	0	0	0	0	0	0
177	LIVESTOCK	041005139	D	1005	1005	139	03	0	0	0	0	0	0
178	LIVESTOCK	041005139	D	1005	1005	139	02	0	0	0	0	0	0
179	MANUFACTURING	041001139	D	1001	1001	139	03	0	0	0	0	0	0
180	MANUFACTURING	041001139	D	1001	1001	139	02	0	0	0	0	0	0
181	MINING	041003139	D	1003	1003	139	03	0	0	0	0	0	0
182	MINING	041003139	D	1003	1003	139	02	0	0	0	0	0	0
183	STEAM ELECTRIC POWER	041002139	D	1002	1002	139	03	0	0	0	0	0	0
184	STEAM ELECTRIC POWER	041002139	D	1002	1002	139	02	0	0	0	0	0	0
185	JEFFERSON	040446158	D	0446	306	158	04	10423	10411	10399	10380	10354	10322
186	COUNTY-OTHER	040996158	D	0996	757	158	04	629.94	600.94	575.94	555.94	540.94	530.94
187	IRRIGATION	041004158	D	1004	1004	158	04	0	0	0	0	0	0
188	LIVESTOCK	041005158	D	1005	1005	158	04	0	0	0	0	0	0
189	MANUFACTURING	041001158	D	1001	1001	158	04	0	0	0	0	0	0
190	MINING	041003158	D	1003	1003	158	04	0	0	0	0	0	0
191	STEAM ELECTRIC POWER	041002158	D	1002	1002	158	04	3832	3832	3832	3832	3832	3832
192	DAINGERFIELD	040224172	D	0224	148	172	04	9929	9950	9972	9989	10002	10002
193	HUGHES SPRINGS	040423172	D	0423	288	172	04	25.2	25.2	26.2	26.6	26.6	26.6
194	LONE STAR	040538172	D	0538	366	172	04	4574	4583	4592	4601	4611	4620
195	NAPLES	040621172	D	0621	422	172	04	2.6	-0.4	4.6	7.6	13.6	14.6
196	NAPLES	040621172	D	0621	422	172	03	0.3	0.3	1.3	2.3	3.3	4.3
197	OMAHA	040657172	D	0657	932	172	04	13.1	13.1	15.1	16.1	19.1	19.1
198	OMAHA		D					15.2	15.2	18.2	19.2	21.2	23.2
199	COUNTY-OTHER	040996172	D	0996	757	172	03	-316	-281	-249	-219	-190	-162

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY													
								TABLE 7 in Acre-Feet					
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
200	COUNTY-OTHER	040996172	D	0996	757	172	04	1001.6	908.6	906.6	891.2	892.2	894.2
201	IRRIGATION	041004172	D	1004	1004	172	04	0	0	0	0	0	0
202	IRRIGATION	041004172	D	1004	1004	172	03	0	0	0	0	0	0
203	LIVESTOCK	041005172	D	1005	1005	172	04	0	0	0	0	0	0
204	LIVESTOCK	041005172	D	1005	1005	172	03	0	0	0	0	0	0
205	MANUFACTURING	041001172	D	1001	1001	172	03	0	0	0	0	0	0
206	MANUFACTURING	041001172	D	1001	1001	172	04	0	0	0	0	0	0
207	MINING	041003172	D	1003	1003	172	04	0	0	0	0	0	0
208	MINING	041003172	D	1003	1003	172	03	0	0	0	0	0	0
209	STEAM ELECTRIC POWER	041002172	D	1002	1002	172	04	11952	11952	11952	11952	11952	11952
210	STEAM ELECTRIC POWER	041002172	D	1002	1002	172	03	0	0	0	0	0	0
211	EAST TAWAKONI	040263190	D	0263	861	190	05	445	435	-126	-138	-147	-160
212	EMORY	040282190	D	0282	191	190	05	896	873	853	-278	-302	-329
213	POINT	040706190	D	0706	939	190	05	114	102	-131	-141	-151	-164
214	COUNTY-OTHER	040996190	D	0996	757	190	05	64.52	-29.48	-379.48	-481.48	-591.48	-709.48
215	IRRIGATION	041004190	D	1004	1004	190	05	0	0	0	0	0	0
216	LIVESTOCK	041005190	D	1005	1005	190	05	0	0	0	0	0	0
217	MANUFACTURING	041001190	D	1001	1001	190	05	0	0	0	0	0	0
218	MINING	041003190	D	1003	1003	190	05	0	0	0	0	0	0
219	STEAM ELECTRIC POWER	041002190	D	1002	1002	190	05	0	0	0	0	0	0
220	BOGATA	040096194	D	0096	64	194	03	180	187	194	201	207	214
221	CLARKSVILLE	040171194	D	0171	113	194	03	85	115	146	168	176	182
222	DETROIT	040243194	D	0243	858	194	03	-46	-46	-44	-44	-45	-46
223	COUNTY-OTHER	040996194	D	0996	757	194	03	227	136	-157	-370	-343	-313
224	COUNTY-OTHER	040996194	D	0996	757	194	02	160	141	13	-105	-96	-89
225	IRRIGATION	041004194	D	1004	1004	194	03	0	0	0	0	0	0
226	IRRIGATION	041004194	D	1004	1004	194	02	0	0	0	0	0	0
227	LIVESTOCK	041005194	D	1005	1005	194	03	0	0	0	0	0	0
228	LIVESTOCK	041005194	D	1005	1005	194	02	0	0	0	0	0	0
229	MANUFACTURING	041001194	D	1001	1001	194	02	0	0	0	0	0	0
230	MANUFACTURING	041001194	D	1001	1001	194	03	0	0	0	0	0	0
231	MINING	041003194	D	1003	1003	194	03	0	0	0	0	0	0
232	MINING	041003194	D	1003	1003	194	02	0	0	0	0	0	0

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY														
								TABLE 7 in Acre-Feet						
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
233	STEAM ELECTRIC POWER	041002194	D	1002	1002	194	03	10000	6500	4500	1500	1500	1500
234	STEAM ELECTRIC POWER	041002194	D	1002	1002	194	02	0	0	0	0	0	0
235	LINDALE	040523212	D	0523	357	212	05	991	928	871	804	739	666
236	OVERTON	040662212	D	0662	445	212	05	0	0	0	0	0	0
237	TYLER	040918212	D	0918	613	212	05	0	0	0	0	0	0
238	COUNTY-OTHER	040996212	D	0996	757	212	06	49.6	49.6	49.6	49.6	49.6	49.6
239	COUNTY-OTHER	040996212	D	0996	757	212	05	-25.78	-130.78	-231.78	-386.78	-557.78	-785.78
240	IRRIGATION	041004212	D	1004	1004	212	05	0	0	0	0	0	0
241	LIVESTOCK	041005212	D	1005	1005	212	05	0	0	0	0	0	0
242	MANUFACTURING	041001212	D	1001	1001	212	05	0	0	0	0	0	0
243	MINING	041003212	D	1003	1003	212	05	0	0	0	0	0	0
244	STEAM ELECTRIC POWER	041002212	D	1002	1002	212	05	0	0	0	0	0	0
245	MOUNT PLEASANT	040613225	D	0613	416	225	04	7697	9017	9550	9391	8951	8421
246	TALCO	040880225	D	0880	968	225	03	467	462	458	454	450	448
247	COUNTY-OTHER	040996225	D	0996	757	225	03	-140	-702	-746	-782	-814	-841
248	COUNTY-OTHER	040996225	D	0996	757	225	04	1697	884	831	629	553	517
249	IRRIGATION	041004225	D	1004	1004	225	04	0	0	0	0	0	0
250	IRRIGATION	041004225	D	1004	1004	225	03	0	0	0	0	0	0
251	LIVESTOCK	041005225	D	1005	1005	225	04	0	0	0	0	0	0
252	LIVESTOCK	041005225	D	1005	1005	225	03	0	0	0	0	0	0
253	MANUFACTURING	041001225	D	1001	1001	225	03	0	0	0	0	0	0
254	MANUFACTURING	041001225	D	1001	1001	225	04	41163	41071	41000	40945	40818	40693
255	MINING	041003225	D	1003	1003	225	03	0	0	0	0	0	0
256	MINING	041003225	D	1003	1003	225	04	0	0	0	0	0	0
257	STEAM ELECTRIC POWER	041002225	D	1002	1002	225	04	16720	13720	13720	1020	1020	1020
258	STEAM ELECTRIC POWER	041002225	D	1002	1002	225	03	0	0	0	0	0	0
259	BIG SANDY	040084230	D	0084	57	230	05	97	89	91	81	68	56
260	EAST MOUNTAIN	040262230	D	0262	860	230	05	-72.1	-81.1	-82.1	-87.1	-93.1	-95.1
261	GILMER	040341230	D	0341	236	230	04	5221	5149	5158	5076	4982	4906
262	GLADEWATER	040342230	D	0342	237	230	05	51.4	330.3	337.3	314.3	287.3	263.3
263	ORE CITY	040661230	D	0661	728	230	04	2778.5	2773.5	2777.5	2770.5	2762.5	2755.5
264	COUNTY-OTHER	040996230	D	0996	757	230	04	-37.7	-107.7	-53.7	-73.7	-108.7	-87.7
265	COUNTY-OTHER	040996230	D	0996	757	230	05	333.3	186.7	122.7	40.7	-39.3	-94.3

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY													
								TABLE 7 in Acre-Feet					
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
266	IRRIGATION	041004230	D	1004	1004	230	05	0	0	0	0	0	0
267	IRRIGATION	041004230	D	1004	1004	230	04	0	0	0	0	0	0
268	LIVESTOCK	041005230	D	1005	1005	230	04	0	0	0	0	0	0
269	LIVESTOCK	041005230	D	1005	1005	230	05	0	0	0	0	0	0
270	MANUFACTURING	041001230	D	1001	1001	230	04	750	750	750	750	750	750
271	MANUFACTURING	041001230	D	1001	1001	230	05	0	0	0	0	0	0
272	MINING	041003230	D	1003	1003	230	05	0	0	0	0	0	0
273	MINING	041003230	D	1003	1003	230	04	0	0	0	0	0	0
274	STEAM ELECTRIC POWER	041002230	D	1002	1002	230	04	0	-5601	-5601	-5601	-5601	-5601
275	STEAM ELECTRIC POWER	041002230	D	1002	1002	230	05	0	0	0	0	0	0
276	CANTON	040143234	D	0143	94	234	05	124	61	4	-73	-133	-221
277	EDGEWOOD	040268234	D	0268	181	234	05	735	719	-138	-156	-171	-199
278	GRAND SALINE	040354234	D	0354	246	234	05	3	-50	-98	-163	-218	-294
279	VAN	040924234	D	0924	618	234	06	52.8	5.8	-36.2	-91.2	-141.2	-205.2
280	VAN	040924234	D	0924	618	234	05	0	-2	-5	-8	-10	-13
281	WILLS POINT	040974234	D	0974	656	234	05	1621	1595	-636	-664	-690	-728
282	WILLS POINT	040974234	D	0974	656	234	08	0	-27	-48	-76	-102	-139
283	COUNTY-OTHER	040996234	D	0996	757	234	05	2906.5	2699.5	-153.5	-1378.5	-1533.5	-1665.5
284	COUNTY-OTHER	040996234	D	0996	757	234	06	-195	-325	-440	-544	-632	-710
285	COUNTY-OTHER	040996234	D	0996	757	234	08	-867	-962	-1049	-1123	-1189	-1247
286	IRRIGATION	041004234	D	1004	1004	234	05	0	0	0	0	0	0
287	IRRIGATION	041004234	D	1004	1004	234	06	0	0	0	0	0	0
288	IRRIGATION	041004234	D	1004	1004	234	08	0	0	0	0	0	0
289	LIVESTOCK	041005234	D	1005	1005	234	08	0	0	0	0	0	0
290	LIVESTOCK	041005234	D	1005	1005	234	05	0	0	0	0	0	0
291	LIVESTOCK	041005234	D	1005	1005	234	06	0	0	0	0	0	0
292	MANUFACTURING	041001234	D	1001	1001	234	08	0	0	0	0	0	0
293	MANUFACTURING	041001234	D	1001	1001	234	05	0	0	0	0	0	0
294	MANUFACTURING	041001234	D	1001	1001	234	06	0	0	0	0	0	0
295	MINING	041003234	D	1003	1003	234	05	0	0	0	0	0	0
296	MINING	041003234	D	1003	1003	234	06	0	0	0	0	0	0
297	MINING	041003234	D	1003	1003	234	08	0	0	0	0	0	0
298	STEAM ELECTRIC POWER	041002234	D	1002	1002	234	06	0	0	0	0	0	0

TABLE 7: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY CITY AND CATEGORY														
								TABLE 7 in Acre-Feet						
	WUG NAME	**WUG ID**	**RWPG LETTER**	**SEQUENCE NUMBER**	**CITY NUMBER**	**COUNTY NUMBER**	**RIVER BASIN NUMBER**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
299	STEAM ELECTRIC POWER	041002234	D	1002	1002	234	08	0	0	0	0	0	0
300	STEAM ELECTRIC POWER	041002234	D	1002	1002	234	05	0	0	0	0	0	0
301	HAWKINS	040385250	D	0385	701	250	05	829	813	800	779	764	736
302	MINEOLA	040599250	D	0599	406	250	05	23	-39	-90	-167	-224	-319
303	QUITMAN	040731250	D	0731	490	250	05	237.3	206.3	179.3	145.3	112.3	69.3
304	WINNSBORO	040981250	D	0981	661	250	05	3815	4002	3969	3929	-616	-664
305	WINNSBORO	040981250	D	0981	661	250	04	0	-3	-4	-6	-32	-35
306	COUNTY-OTHER	040996250	D	0996	757	250	05	1838.5	1477.5	1318.5	1062.5	872.5	476.5
307	COUNTY-OTHER	040996250	D	0996	757	250	04	84	55	62	63	-8	-14
308	IRRIGATION	041004250	D	1004	1004	250	05	0	0	0	0	0	0
309	IRRIGATION	041004250	D	1004	1004	250	04	0	0	0	0	0	0
310	LIVESTOCK	041005250	D	1005	1005	250	04	0	0	0	0	0	0
311	LIVESTOCK	041005250	D	1005	1005	250	05	0	0	0	0	0	0
312	MANUFACTURING	041001250	D	1001	1001	250	05	0	0	0	0	0	0
313	MANUFACTURING	041001250	D	1001	1001	250	04	0	0	0	0	0	0
314	MINING	041003250	D	1003	1003	250	05	0	0	0	0	0	0
315	MINING	041003250	D	1003	1003	250	04	0	0	0	0	0	0
316	STEAM ELECTRIC POWER	041002250	D	1002	1002	250	04	0	0	0	0	0	0
317	STEAM ELECTRIC POWER	041002250	D	1002	1002	250	05	0	0	0	0	0	-7500

TABLE 8: COMPARISON OF WATER DEMANDS WITH CURRENT WATER SUPPLIES BY MAJOR PROVIDER OF MUNICIPAL AND MANUFACTURING WATER DIFFERENCE, in ac-ft

MAJOR WATER PROVIDER NAME	MWP TWDB ALPHA NUMBER	COUNTY NUMBER FOR WATER USER GROUP	BASIN NUMBER FOR WATER USER GROUP	2000	2010	2020	2030	2040	2050
CHEROKEE WATER COMPANY	110	092	5	0	0	0	0	0	0
FRANKLIN COUNTY WATER DISTRICT	50	080	4	210	210	210	210	210	210
NORTHEAST TEXAS MUNICIPAL WATER DISTRICT	60	034	4	472	472	472	472	472	472
SABINE RIVER AUTHORITY	95		5	340,203	330,284	328,211	330,053	327,980	325,908
TITUS COUNTY FRESHWATER SUPPLY DISTRICT NO. 1	70	225	4	0	0	0	0	0	0
CITY OF GREENVILLE	342340	116	5	14,131	13,654	13,227	12,618	11,963	11,214
CITY OF LONGVIEW	512010	092	5	47,880	45,517	43,963	42,220	39,990	37,355
CITY OF MARSHALL	538090	102	4	10,749	10,524	10,444	10,241	9,987	9,628
CITY OF MT. PLEASANT	651250	225	4	7,470	7,922	7,764	7,501	6,946	6,325
CITY OF PARIS	651250	139	2	28,993	27,705	26,462	25,186	23,556	21,818
CITY OF SULPHUR SPRINGS	828100	060	3	7,130	6,084	5,450	4,835	4,479	3,918
CITY OF TEXARKANA	848000	034	3	12,724	14,642	13,234	14,031	9,961	5,358
TOTAL				**469,962**	**457,014**	**449,437**	**447,367**	**435,544**	**422,206**

Table 9.50 - Social and Economic Impacts of Not Meeting Needs by Region, 2050						
RWPG Letter, Water User Group Identifier, Name	**Value of Need (ac-ft)**	**Impact of Need on Employment**	**Impact of Need on Gross Business Output in 1999 US Dollars (Millions)**	**Impact of Need on Population**	**Impact of Need on School Enrollment**	**Impact of Need on Income in 1999 US Dollars (Millions)**
D 040232019 DE KALB	-288	370	28	810	210	12
D 040416019 HOOKS	-528	677	51	1,483	386	22
D 040572019 MAUD	-157	201	15	440	115	6
D 040622019 NASH	-341	438	33	959	250	14
D 040628019 NEW BOSTON	-1,425	2,256	157	4,851	1,268	68
D 040740019 REDWATER	-84	108	8	237	62	3
D 040889019 TEXARKANA	-15	25	2	68	19	1
D 040937019 WAKE VILLAGE	-781	1,236	86	2,645	692	37
D 040996019 COUNTY-OTHER	-5,764	5,293	452	11,327	2,964	191
D 041001032 MANUFACTURING	-2,232	4,060	487	8,688	2,274	133
D 040042034 ATLANTA	-1,417	2,243	156	4,800	1,256	68
D 040524034 LINDEN	-126	162	12	355	92	5
D 040728034 QUEEN CITY	-69	89	7	240	66	3
D 040996034 COUNTY-OTHER	-533	490	42	1,073	280	18
D 040996060 COUNTY-OTHER	-363	333	28	729	190	12
D 040614080 MOUNT VERNON	-780	1,001	75	2,142	561	32
D 040981080 WINNSBORO	-217	344	24	772	202	10
D 040996080 COUNTY-OTHER	-1,931	1,773	151	3,883	1,010	64
D 040172092 CLARKSVILLE CITY	-152	195	15	427	111	6
D 040342092 GLADEWATER	-110	174	12	381	99	5
D 040502092 LAKEPORT	-127	163	12	357	93	5
D 040522092 LIBERTY CITY	-321	412	31	902	235	13
D 040539092 LONGVIEW	-13,247	21,795	1,496	46,641	11,987	650
D 040963092 WHITE OAK	-1,027	1,626	113	3,480	911	49
D 040996092 COUNTY-OTHER	-2,247	2,063	176	4,437	1,159	75
D 041001092 MANUFACTURING	-17,746	55,934	6,715	119,699	30,764	1,828
D 041001102 MANUFACTURING	-23,856	20,925	2,512	44,780	11,509	684

Table 9.50 - Social and Economic Impacts of Not Meeting Needs by Region, 2050						
RWPG Letter, Water User Group Identifier, Name	**Value of Need (ac-ft)**	**Impact of Need on Employment**	**Impact of Need on Gross Business Output in 1999 US Dollars (Millions)**	**Impact of Need on Population**	**Impact of Need on School Enrollment**	**Impact of Need on Income in 1999 US Dollars (Millions)**
D 041001112 MANUFACTURING	-13	27	3	73	20	1
D 040374102 HALLSVILLE	-310	398	30	872	227	13
D 040941102 WASKOM	-40	51	4	138	38	2
D 040996102 COUNTY-OTHER	-1,920	1,763	151	3,795	991	64
D 040196112 COMO	-67	86	6	232	64	3
D 040996112 COUNTY-OTHER	-1,960	1,800	154	3,872	1,012	65
D 040135116 CADDO MILLS	-197	253	19	554	144	8
D 040195116 COMMERCE	-2,504	5,031	326	10,766	2,817	143
D 040361116 GREENVILLE	-6,256	16,098	983	34,450	8,854	434
D 040537116 LONE OAK	-105	135	10	296	77	4
D 040729116 QUINLAN	-276	354	26	775	202	11
D 040956116 WEST TAWAKONI	-275	353	26	773	201	11
D 040983116 WOLFE CITY	-74	95	7	257	70	3
D 040996116 COUNTY-OTHER	-4,434	4,072	348	8,735	2,284	147
D 041002116 STEAM ELECTRIC POWER	-516	36	6	97	27	2
D 040092139 BLOSSOM	-248	318	24	696	181	10
D 040242139 DEPORT	-125	160	12	350	91	5
D 040743139 RENO	-707	1,119	78	2,395	627	34
D 040778139 ROXTON	-103	132	10	289	75	4
D 040996139 COUNTY-OTHER	-2,413	2,216	189	4,782	1,249	80
D 040996172 COUNTY-OTHER	-162	149	13	326	85	5
D 041002172 STEAM ELECTRIC POWER	-48	3	1	8	2	0
D 040263190 EAST TAWAKONI	-160	205	15	449	117	7
D 040282190 EMORY	-329	422	31	924	241	14
D 040706190 POINT	-164	210	16	460	120	7
D 040996190 COUNTY-OTHER	-709	652	56	1,428	372	24
D 040243194 DETROIT	-46	59	4	159	44	2

Table 9.50 - Social and Economic Impacts of Not Meeting Needs by Region, 2050						
RWPG Letter, Water User Group Identifier, Name	**Value of Need (ac-ft)**	**Impact of Need on Employment**	**Impact of Need on Gross Business Output in 1999 US Dollars (Millions)**	**Impact of Need on Population**	**Impact of Need on School Enrollment**	**Impact of Need on Income in 1999 US Dollars (Millions)**
D 040996194 COUNTY-OTHER	-402	369	32	850	225	13
D 040662212 OVERTON	-22	28	2	76	21	1
D 040918212 TYLER	-3	5	0	14	4	0
D 040996212 COUNTY-OTHER	-786	722	62	1,581	412	26
D 040996225 COUNTY-OTHER	-841	772	66	1,691	440	28
D 040262230 EAST MOUNTAIN	-95	122	9	267	70	4
D 040996230 COUNTY-OTHER	-182	167	14	454	124	6
D 041002230 STEAM ELECTRIC POWER	-5,601	386	70	845	220	19
D 040143234 CANTON	-221	350	24	767	200	11
D 040268234 EDGEWOOD	-199	255	19	558	145	8
D 040354234 GRAND SALINE	-294	465	32	1,018	265	14
D 040924234 VAN	-218	280	21	622	163	9
D 040974234 WILLS POINT	-867	1,373	95	2,949	771	41
D 040996234 COUNTY-OTHER	-3,623	3,327	284	7,150	1,869	120
D 040599250 MINEOLA	-319	505	35	1,106	288	15
D 040981250 WINNSBORO	-699	1,107	77	2,398	630	33
D 040996250 COUNTY-OTHER	-14	13	1	35	10	0
D 041002250 STEAM ELECTRIC POWER	-7,500	517	94	1,132	295	26
Grand Total	**-121,931**	**171,346**	**16,380**	**368,070**	**95,149**	**5,492**

TABLE 11: POTENTIALLY FEASIBLE WATER MANAGEMENT STRATEGIES

																TOTAL ANNUAL COST ($)						VALUE DURING DROUGHT OF RECORD CONDITIONS (ac-ft/yr)					
MAJOR WATER PROVIDER NAME	WATER USER GROUP NAME	MWP NUMBER	WATER USER GROUP ID	RWPG LETTER	SEQUENCE NUMBER	CITY NUMBER	COUNTY NUMBER	BASIN NUMBER	WATER SUPPLY TYPE	SUPPLY SOURCE RWPG LETTER	SUPPLY SOURCE COUNTY NUMBER	SUPPLY SOURCE BASIN NUMBER	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	CAPITAL COST ($)	2000	2010	2020	2030	2040	2050	2000	2010	2020	2030	2040	2050
	MANUFACTURING		041001032	D	1001	1001	032	4																			
	BLOOMBURG WSC		040996034	D	0996	757	034	4	4C	D	034	4	03410	CARRIZO-WILCOX	221,994	0	0	0	0	24,176	24,176	0	0	0	0	62	62
	CITY OF LINDEN		040524034	D	0524	358	034	4	4C	D	158	4	60	NETMWD (LAKE O' THE PINES)	1,424,805	145,014	145,014	145,014	145,014	145,014	145,014	95	104	116	136	151	176
	BEN FRANKLIN WSC		040996060	D	0996	757	060	3	4C	D	060	3		DELTA COUNTY MUD	176,648	46,711	46,711	46,711	46,711	46,711	46,711	32	31	30	29	29	29
	CITY OF PECAN GAP		040996060	D	0996	757	060	3	4C	D	060	3		DELTA COUNTY MUD	1,454,618	145,845	145,845	145,845	145,845	145,845	145,845	38	38	38	38	38	38
	CITY OF GLADEWATER		040342092	D	0342	237	092	5	4A	D	092	5			221,880	112,163	112,163	112,163	112,163	112,163	112,163	47	84	117	107	104	112
	CITY OF GLADEWATER		040342092	D	0342	237	092	5	4C	D	230	5	5090	LAKE GLADEWATER	773,815	275,020	275,020	275,020	275,020	275,020	275,020	1,679	1,679	1,679	1,679	1,679	1,679
	LIBERTY CITY WSC		040996092	D	0996	757	092	5	4A	D	092	5			70,020	30,731	30,731	30,731	30,731	30,731	30,731	13	25	34	32	34	36
	LIBERTY CITY WSC		040996092	D	0996	757	092	5	4C	D	092	5	09210	CARRIZO-WILCOX	1,130,716	143,413	143,413	143,413	143,413	143,413	143,413	470	470	470	470	470	470
	LIBERTY CITY WSC		040996092	D	0996	757	092	5	4C	D	092	5	465800	CITY OF KILGORE	0	147,694	147,694	147,694	147,694	147,694	147,694	74	74	74	74	74	74
	MANUFACTURING		041001092	D	1001	1001	092	5	4C	D	092	5	050A0	LONGVIEW SYSTEM	0	5,360,032	5,360,032	5,360,032	5,360,032	5,360,032	5,360,032	12,653	12,653	12,653	12,653	12,653	12,653
	WEST GREGG WSC		040996092	D	0996	757	092	5	4A	D	092	5			60,720	22,696	27,496	32,296	37,096	41,896	46,696	9	24	20	32	30	34
	WEST GREGG WSC		040996092	D	0996	757	092	5	4C	D	092	5	09210	CARRIZO-WILCOX	1,337,993	149,701	149,701	149,701	149,701	149,701	149,701	403	403	403	403	403	403
	BLOCKER-CROSSROADS WSC		040996102	D	0996	757	102	5	4C	D	102	5	10210	CARRIZO-WILCOX	203,001	0	0	23,147	23,147	23,147	23,147	0	0	65	65	65	65
	CADDO LAKE WSC		040996102	D	0996	757	102	4	4C	D	102	4	10210	CARRIZO-WILCOX	278,537	0	0	29,613	29,613	29,613	29,613	0	0	72	72	72	72
	CITY OF WASKOM		040941102	D	0941	631	102	4	4C	D	102	4	10210	CARRIZO-WILCOX	224,805	0	0	27,815	27,815	27,815	27,815	0	0	88	88	88	88
	ELYSIAN FIELDS WSC		040996102	D	0996	757	102	5	4C	D	102	5	10210	CARRIZO-WILCOX	176,135	0	0	0	0	19,305	19,305	0	0	0	0	50	50
	HARLETON WSC		040996102	D	0996	757	102	4	4C	D	102	4	10210	CARRIZO-WILCOX	1,661,164	0	160,899	160,899	160,899	160,899	160,899	0	309	309	309	309	309
	HARLETON WSC		040996102	D	0996	757	102	4	4C	D	158	4	60	NETMWD (LAKE O' THE PINES)	2,890,805	0	353,604	353,604	353,604	353,604	353,604	0	168	203	239	274	309
	NORTH HARRISON WSC		040996102	D	0996	757	102	4	4C	D	102	4	10210	CARRIZO-WILCOX	254,202	0	0	27,216	27,216	27,216	27,216	0	0	67	67	67	67
	WASKOM RURAL WSC # 1		040996102	D	0996	757	102	4	4C	D	102	4	10210	CARRIZO-WILCOX	278,537	0	0	35,640	35,640	35,640	35,640	0	0	59	59	59	118
	WEST HARRISON WSC		040996102	D	0996	757	102	4	4C	D	102	4	10210	CARRIZO-WILCOX	254,202	0	0	32,472	32,472	32,472	32,472	0	0	108	108	108	108
	CITY OF COMO		040196112	D	0196	847	112	3	4C	D	112	3	11210	CARRIZO-WILCOX	155,922	0	17,098	17,098	17,098	17,098	17,098	0	46	46	46	46	46
	PICKTON WSC		040996112	D	0996	757	112	5	4C	D	112	5	11210	CARRIZO-WILCOX	206,532	0	0	0	0	20,338	20,338	0	0	0	0	41	41
	SHIRLEY WSC		040996112	D	0996	757	112	5	4C	D	112	5	11210	CARRIZO-WILCOX	319,964	0	0	0	35,219	35,219	35,219	0	0	0	46	46	92
	CITY OF WOLFE CITY		040983116	D	0983	663	116	3	4C	D	116	3	11629	WOODBINE	828,714	0	70,591	70,591	70,591	70,591	70,591	0	80	80	80	80	80
	TRI-COUNTY WSC																										
	PETTY WSC		040996139	D	0996	757	139	3	4C	D	139	2	482989	LAMAR COUNTY WSD	38,583	0	0	16,349	16,349	16,349	16,349	0	0	18	18	18	17
	KELLYVILLE-BEREA WSC		040996158	D	0996	757	158	4	4A	D	158	4			32,430	16,826	16,826	16,826	16,826	16,826	16,826	3	7	12	6	9	10
	KELLYVILLE-BEREA WSC		040996158	D	0996	757	158	4	4C	D	158	4	15810	CARRIZO-WILCOX	665,782	0	62,353	62,353	62,353	62,353	62,353	0	108	108	108	108	108
	KELLYVILLE-BEREA WSC		040996158	D	0996	757	158	4	4C	D	158	4	60	NETMWD	285,022	0	45,272	45,272	45,272	45,272	45,272	0	16	43	67	88	108
	PINE HARBOR WATER SYSTEM		040996158	D	0996	757	158	4	4C	D	158	4	15810	CARRIZO-WILCOX	152,242	0	0	0	25,070	25,070	25,070	0	0	0	108	108	108
	SHADY SHORES WSC		040996158	D	0996	757	158	4	4C	D	158	4	15810	CARRIZO-WILCOX	201,844	0	20,611	20,611	20,611	20,611	20,611	0	46	46	46	46	46
	BRIGHT STAR-SALEM WSC		040996190	D	0996	757	190	5	4C	D	190	5	19010	CARRIZO-WILCOX	202,052	20,664	20,664	20,664	0	0	0	46	46	46	0	0	0
	BRIGHT STAR-SALEM WSC		040996190	D	0996	757	190	5	4C	D	116	5	95	SABINE RIVER AUTHORITY	1,378,389	0	0	0	227,796	227,796	227,796	0	0	0	560	560	560
	CITY OF DETROIT		040243194	D	0243	858	194	3	4C	D	139	2	482989	LAMAR COUNTY WSD	665,936	128,129	128,129	128,129	128,129	128,129	128,129	106	106	106	106	106	106
	TOWN OF ENGLISH		040996194	D	0996	757	194	2	4C	D				RED RIVER WSC (LAKE WRIGHT	72,873	12,133	12,133	12,133	12,133	12,133	12,133	7	7	7	7	7	7
	ENCHANTED LAKES WATER CO.		040996212	D	0996	757	212	5	4A	D	212	5			28,020	10,168	10,168	10,168	10,168	10,168	10,168	3	7	11	11	10	9
	ENCHANTED LAKES WATER CO.		040996212	D	0996	757	212	5	4C	D	212	5	21210	CARRIZO-WILCOX	254,133	26,579	26,579	26,579	26,579	26,579	26,579	62	62	62	62	62	62
	LINDALE RURAL WSC		040996212	D	0996	757	212	5	4A	D	212	5			169,920	129,688	129,688	129,688	129,688	129,688	129,688	35	88	133	137	146	152
	LINDALE RURAL WSC		040996212	D	0996	757	212	5	4C	D	212	5	21210	CARRIZO-WILCOX	771,157	0	0	133,073	133,073	133,073	133,073	0	0	591	591	591	591
	LINDALE RURAL WSC		040996212	D	0996	757	212	5	4C	D	212	5		CITY OF TYLER	20,000	0	0	173,848	173,848	173,848	173,848	0	0	132	132	132	132
	STAR MOUNTAIN WSC		040996212	D	0996	757	212	5	4A	D	212	5			51,600	31,185	31,185	31,185	31,185	31,185	31,185	8	21	31	32	35	36
	STAR MOUNTAIN WSC		040996212	D	0996	757	212	5	4C	D	212	5	21210	CARRIZO-WILCOX	2,192,735	201,240	201,240	201,240	201,240	201,240	201,240	323	323	323	323	323	323
	CITY OF EAST MOUNTAIN		040262230	D	0262	860	230	5	4C	D	230	5	23010	CARRIZO-WILCOX	403,204	51,569	51,569	51,569	51,569	51,569	51,569	187	187	187	187	187	187
	STEAM ELECTRIC																										
	DIANA WSC		040996230	D	0996	757	230	5	4C	D	230	5	23010	CARRIZO-WILCOX	240,769	0	26,730	26,730	26,730	26,730	26,730	0	71	71	71	71	71
	DIANA WSC		040996230	D	0996	757	230	5	4C	D	158	4	60	NETMWD	0	0	0	216,182	216,182	216,182	216,182	0	0	248	248	248	248
	HARMONY ISD		040996230	D	0996	757	230	4	4C	D	230	4	23010	CARRIZO-WILCOX	785,916	198,017	198,017	198,017	198,017	198,017	198,017	154	154	154	154	154	154
	PRITCHETT WSC		040996230	D	0996	757	230	5	4C	D	158	4	60	NETMWD	0	464,645	464,645	464,645	464,645	464,645	464,645	532	532	532	532	532	532
	UNION GROVE WSC		040996230	D	0996	757	230	5	4C	D	230	5	23010	CARRIZO-WILCOX	411,212	0	0	51,580	51,580	51,580	51,580	0	0	167	167	167	167
	UNION GROVE WSC		040996230	D	0996	757	230	5	4C	D	230	5	327250	CITY OF GLADEWATER	562,361	0	0	110,907	110,907	110,907	110,907	0	0	107.5	107.5	107.5	107.5
	BEN WHEELER WSC		040996234	D	0996	757	234	6	4C	D	234	6	23410	CARRIZO-WILCOX	326,871	0	0	41,251	41,251	41,251	41,251	0	0	134	134	134	134
	CITY OF CANTON		040143234	D	0143	94	234	5	4C	D	234	5	23410	CARRIZO-WILCOX	262,193	0	0	0	33,052	33,052	33,052	0	0	0	108	216	216
	CITY OF GRAND SALINE		040354234	D	0354	246	234	5	4C	D	234	5	23410	CARRIZO-WILCOX	439,509	0	73,959	73,959	73,959	73,959	73,959	0	323	323	323	323	323
	CITY OF VAN		040924234	D	0924	618	234	6	4C	D	234	6	23410	CARRIZO-WILCOX	447,768	0	0	67,548	67,548	67,548	67,548	0	0	269	269	269	269
	CORINTH WSC		040996234	D	0996	757	234	5	4C	D	234	5	23410	CARRIZO-WILCOX	117,117	0	0	22,519	22,519	22,519	22,519	0	0	108	108	108	108
	CROOKED CREEK WSC		040996234	D	0996	757	234	5	4C	D	234	5	23410	CARRIZO-WILCOX	177,565	0	0	26,907	26,907	26,907	26,907	0	0	108	108	108	108
	CROOKED CREEK WSC		040996234	D	0996	757	234	5	4C	D	234	5	0143	CITY OF CANTON	106,723	0	0	170,693	170,693	170,693	170,693	0	0	108	108	108	108
	EDOM WSC		040996234	D	0996	757	234	6	4C	D	234	6	23410	CARRIZO-WILCOX	286,572	0	0	0	26,762	26,762	26,762	0	0	0	46	92	92
	EDOM WSC		040996234	D	0996	757	234	6	4C	D	234	6		CITY OF TYLER	368,955	0	0	0	66,732	66,732	66,732	0	0	0	30	30	30
	FRUITVALE WSC		040996234	D	0996	757	234	5	4C	D	234	5	23410	CARRIZO-WILCOX	1,052,253	0	111,433	111,433	111,433	111,433	111,433	0	269	269	269	269	269
	LITTLE HOPE-MOORE WSC		040996234	D	0996	757	234	6	4C	D	234	6		CITY OF TYLER	281,655	0	256,967	256,967	256,967	0	0	0	145	145	145	0	0
	CITY OF MINEOLA		040599250	D	0599	406	250	5	4A	D	250	5			168,840	0	0	88,278	88,278	88,278	88,278	0	0	323	323	323	323
	CITY OF MINEOLA		040599250	D	0599	406	250	5	4C	D	250	5	25010	CARRIZO-WILCOX	224,805	0	0	58,371	58,371	58,371	58,371	0	0	323	323	323	323
	FOUKE WSC		040996250	D	0996	757	250	5	4C	D	250	5	25010	CARRIZO-WILCOX	210,540	0	0	0	0	0	29,302	0	0	0	0	0	108
	LAKE FORK WSC		040996250	D	0996	757	250	5	4C	D	250	5	25010	CARRIZO-WILCOX	1,504,665	165,306	165,306	165,306	165,306	165,306	165,306	430	430	430	430	430	430

TABLE 12: RECOMMENDED MANAGEMENT STRATEGIES BY CITY AND CATEGORY

																SUPPLY VALUE (ac-ft/yr)					
WATER USER GROUP NAME	WATER USER GROUP ID	RWPG LETTER	SEQUENCE NUMBER	CITY NUMBER	COUNTY NUMBER	BASIN NUMBER	WATER MANAGEMENT STRATEGY NAME	WATER SUPPLY TYPE	MAJOR WATER PROVIDER NUMBER	SUPPLY SOURCE RWPG LETTER	SUPPLY SOURCE COUNTY NUMBER	SUPPLY SOURCE BASIN NUMBER	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	CAPITAL COST ($)	2000	2010	2020	2030	2040	2050
MANUFACTURING	041001032	D	1001	1001	032	4															
BLOOMBURG WSC	040996034	D	0996	757	034	4		4C		D	034	4	03410	CARRIZO-WILCOX	221,994	0	0	0	0	62	62
CITY OF LINDEN	040524034	D	0524	358	034	4		4C		D	158	4	60	NETMWD (LAKE O' THE PINE	1,424,805	95	104	116	136	151	176
BEN FRANKLIN WSC	040996060	D	0996	757	060	3		4C		D	060	3		DELTA COUNTY MUD	176,648	32	31	30	29	29	29
CITY OF PECAN GAP	040996060	D	0996	757	060	3		4C		D	060	3		DELTA COUNTY MUD	1,454,618	38	38	38	38	38	38
CITY OF GLADEWATER	040342092	D	0342	237	092	5		4C		D	230	5	5090	LAKE GLADEWATER	773,815	1,679	1,679	1,679	1,679	1,679	1,679
LIBERTY CITY WSC	040996092	D	0996	757	092	5		4C		D	092	5	09210	CARRIZO-WILCOX	1,130,716	470	470	470	470	470	470
MANUFACTURING	041001092	D	1001	1001	092	5		4C		D	092	5	050A0	LONGVIEW SYSTEM	0	12,653	12,653	12,653	12,653	12,653	12,653
WEST GREGG WSC	040996092	D	0996	757	092	5		4C		D	092	5	09210	CARRIZO-WILCOX	1,337,993	403	403	403	403	403	403
BLOCKER-CROSSROADS WSC	040996102	D	0996	757	102	5		4C		D	102	5	10210	CARRIZO-WILCOX	203,001	0	0	65	65	65	65
CADDO LAKE WSC	040996102	D	0996	757	102	4		4C		D	102	4	10210	CARRIZO-WILCOX	278,537	0	0	72	72	72	72
CITY OF WASKOM	040941102	D	0941	631	102	4		4C		D	102	4	10210	CARRIZO-WILCOX	224,805	0	0	88	88	88	88
ELYSIAN FIELDS WSC	040996102	D	0996	757	102	5		4C		D	102	5	10210	CARRIZO-WILCOX	176,135	0	0	0	0	50	50
HARLETON WSC	040996102	D	0996	757	102	4		4C		D	158	4	60	NETMWD (LAKE O' THE PINE	2,890,805	0	168	203	239	274	309
NORTH HARRISON WSC	040996102	D	0996	757	102	4		4C		D	102	4	10210	CARRIZO-WILCOX	254,202	0	0	67	67	67	67
WASKOM RURAL WSC # 1	040996102	D	0996	757	102	4		4C		D	102	4	10210	CARRIZO-WILCOX	278,537	0	0	59	59	59	118
WEST HARRISON WSC	040996102	D	0996	757	102	4		4C		D	102	4	10210	CARRIZO-WILCOX	254,202	0	0	108	108	108	108
CITY OF COMO	040196112	D	0196	847	112	3		4C		D	112	3	11210	CARRIZO-WILCOX	155,922	0	46	46	46	46	46
PICKTON WSC	040996112	D	0996	757	112	5		4C		D	112	5	11210	CARRIZO-WILCOX	206,532	0	0	0	0	41	41
SHIRLEY WSC	040996112	D	0996	757	112	5		4C		D	112	5	11210	CARRIZO-WILCOX	319,964	0	0	0	46	46	92
CITY OF WOLFE CITY	040983116	D	0983	663	116	3		4C		D	116	3	11629	WOODBINE	828,714	0	80	80	80	80	80
TRI-COUNTY WSC																					
PETTY WSC	040996139	D	0996	757	139	3		4C		D	139	2	482989	LAMAR COUNTY WSD	38,583	0	0	18	18	18	17
KELLYVILLE-BEREA WSC	040996158	D	0996	757	158	4		4C		D	158	4	60	NETMWD	285,022	0	16	43	67	88	108
PINE HARBOR WATER SYSTEM	040996158	D	0996	757	158	4		4C		D	158	4	15810	CARRIZO-WILCOX	152,242	0	0	0	108	108	108
SHADY SHORES WSC	040996158	D	0996	757	158	4		4C		D	158	4	15810	CARRIZO-WILCOX	201,844	0	46	46	46	46	46
BRIGHT STAR-SALEM WSC	040996190	D	0996	757	190	5		4C		D	190	5	19010	CARRIZO-WILCOX	202,052	46	46	46	0	0	0
BRIGHT STAR-SALEM WSC	040996190	D	0996	757	190	5		4C		D	116	5	95	SABINE RIVER AUTHORITY	1,378,389	0	0	0	560	560	560
CITY OF DETROIT	040243194	D	0243	858	194	3		4C		D	139	2	482989	LAMAR COUNTY WSD	665,936	106	106	106	106	106	106
TOWN OF ENGLISH	040996194	D	0996	757	194	2		4C		D				RED RIVER WSC (LAKE WRI	72,873	7	7	7	7	7	7
ENCHANTED LAKES WATER CO.	040996212	D	0996	757	212	5		4C		D	212	5	21210	CARRIZO-WILCOX	254,133	62	62	62	62	62	62
LINDALE RURAL WSC	040996212	D	0996	757	212	5		4C		D	212	5	21210	CARRIZO-WILCOX	771,157	0	0	591	591	591	591
STAR MOUNTAIN WSC	040996212	D	0996	757	212	5		4C		D	212	5	21210	CARRIZO-WILCOX	2,192,735	323	323	323	323	323	323
CITY OF EAST MOUNTAIN	040262230	D	0262	860	230	5		4C		D	230	5	23010	CARRIZO-WILCOX	403,204	187	187	187	187	187	187
STEAM ELECTRIC																					
DIANA WSC	040996230	D	0996	757	230	5		4C		D	230	5	23010	CARRIZO-WILCOX	240,769	0	71	71	71	71	71
HARMONY ISD	040996230	D	0996	757	230	4		4C		D	230	4	23010	CARRIZO-WILCOX	785,916	154	154	154	154	154	154
PRITCHETT WSC	040996230	D	0996	757	230	5		4C		D	158	4	60	NETMWD	0	532	532	532	532	532	532
UNION GROVE WSC	040996230	D	0996	757	230	5		4C		D	230	5	23010	CARRIZO-WILCOX	411,212	0	0	167	167	167	167
BEN WHEELER WSC	040996234	D	0996	757	234	6		4C		D	234	6	23410	CARRIZO-WILCOX	326,871	0	0	134	134	134	134
CITY OF CANTON	040143234	D	0143	94	234	5		4C		D	234	5	23410	CARRIZO-WILCOX	262,193	0	0	0	108	216	216
CITY OF GRAND SALINE	040354234	D	0354	246	234	5		4C		D	234	5	23410	CARRIZO-WILCOX	439,509	0	323	323	323	323	323
CITY OF VAN	040924234	D	0924	618	234	6		4C		D	234	6	23410	CARRIZO-WILCOX	447,768	0	0	269	269	269	269
CORINTH WSC	040996234	D	0996	757	234	5		4C		D	234	5	23410	CARRIZO-WILCOX	117,117	0	0	108	108	108	108
CROOKED CREEK WSC	040996234	D	0996	757	234	5		4C		D	234	5	23410	CARRIZO-WILCOX	177,565	0	0	108	108	108	108
EDOM WSC	040996234	D	0996	757	234	6		4C		D	234	6	23410	CARRIZO-WILCOX	286,572	0	0	0	46	92	92
FRUITVALE WSC	040996234	D	0996	757	234	5		4C		D	234	5	23410	CARRIZO-WILCOX	1,052,253	0	269	269	269	269	269
LITTLE HOPE-MOORE WSC	040996234	D	0996	757	234	6		4C		D	234	6		CITY OF TYLER	281,655	0	145	145	145	0	0
CITY OF MINEOLA	040599250	D	0599	406	250	5		4C		D	250	5	25010	CARRIZO-WILCOX	224,805	0	0	323	323	323	323
FOUKE WSC	040996250	D	0996	757	250	5		4C		D	250	5	25010	CARRIZO-WILCOX	210,540	0	0	0	0	0	108
LAKE FORK WSC	040996250	D	0996	757	250	5		4C		D	250	5	25010	CARRIZO-WILCOX	1,504,665	430	430	430	430	430	430

TABLE 13: RECOMMENDED MANAGEMENT STRATEGIES BY MAJOR WATER PROVIDER OF MUNICIPAL AND MANUFACTURING WATER																		
MAJOR WATER PROVIDER NAME	MWP NUMBER	BASIN NUMBER	TYPE OF WATER SUPPLY	SUPPLY SOURCE RWPG	SUPPLY SOURCE COUNTY NUMBER	SUPPLY SOURCE BASIN NUMBER	WATER MANAGEMENT SRATEGY NAME	SPECIFIC SOURCE ID	SPECIFIC SOURCE NAME	CAPITAL COSTS	2000 SUPPLY	2010 SUPPLY	2020 SUPPLY	2030 SUPPLY	2040 SUPPLY	2050 SUPPLY	EXCEPTION FROM MEETING NEEDS	SCENARIO NUMBER
SABINE RIVER AUTHORITY	95		4i	D	92	05	SURFACE WATER		PRAIRIE CREEK RESERVOIR	$29,032,200	17,215	17,215	17,215	17,215	17,215	17,215		1

SUMMARY INFORMATION FOR ENTITIES WITH ACTUAL SHORTAGES

BOWIE COUNTY

CAMP COUNTY

Water User Group: Camp County Manufacturing	2000	2010	2020	2030	2040	2050
Population	0	0	0	0	0	0
Water Demand (ac-ft/yr)	10	2242	2242	2242	2242	2242
Current Supply (ac-ft/yr)	10	10	10	10	10	10
Supply – Demand (ac-ft/yr)	0	**-2232**	**-2232**	**-2232**	**-2232**	**-2232**
Recommended Strategy: Groundwater (ac-ft/yr)		2232	2232	2232	2232	2232

CASS COUNTY

Water User Group: Bloomburg WSC	2000	2010	2020	2030	2040	2050
Population	543	702	863	1023	1183	1343
Water Demand (ac-ft/yr)	70	87	103	118	131	143
Current Supply (ac-ft/yr)	123	123	123	123	123	123
Supply – Demand (ac-ft/yr)	+53	+36	+20	+5	**-8**	**-20**
Recommended Strategy: Groundwater (ac-ft/yr)					62	62

Water User Group: City of Linden	2000	2010	2020	2030	2040	2050
Population	2465	2635	2806	2976	3146	3317
Water Demand (ac-ft/yr)	326	325	327	337	342	357
Current Supply (ac-ft/yr)	231	221	211	201	191	181
Supply – Demand (ac-ft/yr)	**-95**	**-104**	**-116**	**-136**	**-151**	**-176**
Recommended Strategy: Surface Water (ac-ft/yr)	95	104	116	136	151	176

DELTA COUNTY

Water User Group: Ben Franklin WSC	2000	2010	2020	2030	2040	2050
Population	241	241	241	241	241	241
Water Demand (ac-ft/yr)	94	93	92	29	28	27
Current Supply (ac-ft/yr)	85	85	85	0	0	0
Supply – Demand (ac-ft/yr)	**-9**	**-8**	**-7**	**-29**	**-28**	**-27**
Recommended Strategy: Surface Water (ac-ft/yr)	32	31	30	29	29	29

Water User Group: City of Pecan Gap	2000	2010	2020	2030	2040	2050
Population	286	286	286	286	286	286
Water Demand (ac-ft/yr)	65	63	61	59	56	55
Current Supply (ac-ft/yr)	50	50	50	50	49	49
Supply – Demand (ac-ft/yr)	**-15**	**-13**	**-11**	**-9**	**-7**	**-6**
Recommended Strategy: Surface Water (ac-ft/yr)	38	38	38	38	38	38

FRANKLIN COUNTY

GREGG COUNTY

Water User Group: City of Gladewater	2000	2010	2020	2030	2040	2050
Population	6896	7576	8102	8733	9395	9987
Water Demand (ac-ft/yr)	1835.7	1877.7	1892.7	1960.7	2029.7	2107.7
Current Supply (ac-ft/yr)	1679	1679	1679	1679	1679	1679
Supply – Demand (ac-ft/yr)	**-156.7**	**-198.7**	**-213.7**	**-281.7**	**-350.7**	**-428.7**
Recommended Strategy: Surface Water (ac-ft/yr)	1,679	1,679	1,679	1,679	1,679	1,679

Water User Group: Manufacturing in Gregg County	2000	2010	2020	2030	2040	2050
Population	0	0	0	0	0	0
Water Demand (ac-ft/yr)	16538	18576	20934	23507	26515	29716
Current Supply (ac-ft/yr)	5821	9488	10366	10836	11385	11970
Supply – Demand (ac-ft/yr)	**-10717**	**-9088**	**-10568**	**-12671**	**-15130**	**-17746**
Recommended Strategy: Surface Water (ac-ft/yr)	10,717	9,088	10,568	12,671	15,130	17,746

Water User Group: Liberty City WSC	2000	2010	2020	2030	2040	2050
Population	3600	4208	4816	5423	6031	6639
Water Demand (ac-ft/yr)	596	649	693	773	841	923
Current Supply (ac-ft/yr)	461.8	461.8	461.8	461.8	461.8	461.8
Supply – Demand (ac-ft/yr)	**-134.2**	**-187.2**	**-231.2**	**-311.2**	**-379.2**	**-461.2**
Recommended Strategy: Groundwater (ac-ft/yr) (wells)	188	188	282	376	470	470

Water User Group: West Gregg WSC	2000	2010	2020	2030	2040	2050
Population	2291	2985	3681	4376	5070	5764
Water Demand (ac-ft/yr)	334	409	471	558	630	719
Current Supply (ac-ft/yr)	333.8	333.8	333.8	333.8	333.8	333.8
Supply – Demand (ac-ft/yr)	**-0.2**	**-75.2**	**-137.2**	**-224.2**	**-296.2**	**-385.2**
Recommended Strategy: Groundwater (ac-ft/yr) (wells)	80.6	80.6	161.2	241.8	322.4	403.0

HARRISON COUNTY

Water User Group: Blocker-Crossroads WSC	2000	2010	2020	2030	2040	2050
Population	677	877	1077	1277	1477	1677
Water Demand (ac-ft/yr)	91	114	135	154	172	188
Current Supply (ac-ft/yr)	128	128	128	128	128	128
Supply – Demand (ac-ft/yr)	+37	+14	**-7**	**-26**	**-44**	**-60**
Recommended Strategy: Groundwater (ac-ft/yr)			64	64	64	64

Water User Group: Caddo Lake WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	838	998	1158	1318	1478	1638
Water Demand (ac-ft/yr)	113	130	145	159	172	183
Current Supply (ac-ft/yr)	143.4	143.4	143.4	143.4	143.4	143.4
Supply – Demand (ac-ft/yr)	+30.4	+13.4	**-1.6**	**-15.6**	**-28.6**	**-39.6**
Recommended Strategy: Groundwater (ac-ft/yr)			36	36	36	72

Water User Group: City of Waskom	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	2301	2529	2703	3056	3096	3292
Water Demand (ac-ft/yr)	332	348	354	365	379	399
Current Supply (ac-ft/yr)	352	352	352	352	352	352
Supply – Demand (ac-ft/yr)	+20	+4	**-2**	**-13**	**-27**	**-47**
Recommended Strategy: Groundwater (ac-ft/yr)			44	44	44	88

Water User Group: Elysian Fields WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	452	532	612	692	772	852
Water Demand (ac-ft/yr)	61	69	77	84	90	95
Current Supply (ac-ft/yr)	89.4	89.4	89.4	89.4	89.4	89.4
Supply – Demand (ac-ft/yr)	+28.4	+20.4	+12.4	+5.4	**-0.6**	**-5.6**
Recommended Strategy: Groundwater (ac-ft/yr)					50	50

Water User Group: Harleton WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	1808	2528	3248	3968	4688	5408
Water Demand (ac-ft/yr)	242	327	406	477	543	602
Current Supply (ac-ft/yr)	299.3	299.3	299.3	299.3	299.3	299.3
Supply – Demand (ac-ft/yr)	+57.3	**-27.7**	**-106.7**	**-177.7**	**-243.7**	**-302.7**
Recommended Strategy: Surface Water (ac-ft/yr)		168	203	239	274	309

Water User Group: North Harrison WSC	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	696	906	1116	1326	1536	1746
Water Demand (ac-ft/yr)	94	118	140	160	179	196
Current Supply (ac-ft/yr)	134.3	134.3	134.3	134.3	134.3	134.3
Supply – Demand (ac-ft/yr)	+40.3	+16.3	**-5.7**	**-25.7**	**-44.7**	**-61.7**
Recommended Strategy: Groundwater (ac-ft/yr)			67	67	67	67

Water User Group: Waskom Rural WSC #1	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Population	506	746	986	1224	1466	1706
Water Demand (ac-ft/yr)	68	97	124	148	171	191
Current Supply (ac-ft/yr)	117.1	117.1	117.1	117.1	117.1	117.1
Supply – Demand (ac-ft/yr)	+49.1	+20.1	**-6.9**	**-30.9**	**-53.9**	**-73.9**
Recommended Strategy: Groundwater (ac-ft/yr)			59	59	59	118

Water User Group: West Harrison WSC	2000	2010	2020	2030	2040	2050
Population	922	1132	1342	1552	1762	1972
Water Demand (ac-ft/yr)	124	147	168	188	205	221
Current Supply (ac-ft/yr)	161.5	161.5	161.5	161.5	161.5	161.5
Supply – Demand (ac-ft/yr)	+37.5	+14.5	**-6.5**	**-26.5**	**-43.5**	**-59.5**
Recommended Strategy: Groundwater (ac-ft/yr)			108	108	108	108

HOPKINS COUNTY

Water User Group: City of Como	2000	2010	2020	2030	2040	2050
Population	643	713	783	853	923	992
Water Demand (ac-ft/yr)	100	105	109	115	121	129
Current Supply (ac-ft/yr)	0	0	0	0	0	0
Supply – Demand (ac-ft/yr)	2	2	6	12	18	26
Recommended Strategy: Groundwater (ac-ft/yr)		46	46	46	46	46

Water User Group: Pickton WSC	2000	2010	2020	2030	2040	2050
Population	503	558	612	667	721	776
Water Demand (ac-ft/yr)	84	89	93	98	103	110
Current Supply (ac-ft/yr)	98	98	98	98	98	98
Supply – Demand (ac-ft/yr)	+14	+9	+5	0	**-5**	**-12**
Recommended Strategy: Groundwater (ac-ft/yr)					41	41

Water User Group: Shirley WSC	2000	2010	2020	2030	2040	2050
Population	1394	1573	1752	1932	2111	2290
Water Demand (ac-ft/yr)	239	259	276	298	318	344
Current Supply (ac-ft/yr)	278	278	278	278	278	278
Supply – Demand (ac-ft/yr)	+39	+19	+3	**-20**	**-40**	**-66**
Recommended Strategy: Groundwater (ac-ft/yr)				46	46	92

HUNT COUNTY

Water User Group: City of Wolfe City	2000	2010	2020	2030	2040	2050
Population	1633	1820	2007	2194	2381	2568
Water Demand (ac-ft/yr)	214	222	229	243	256	274
Current Supply (ac-ft/yr)	220	220	220	220	220	220
Supply – Demand (ac-ft/yr)	+6	**-2**	**-9**	**-43**	**-56**	**-74**
Recommended Strategy: Groundwater (ac-ft/yr)		80	80	80	80	80

Water User Group: Tri-County Water Corporation	2000	2010	2020	2030	2040	2050
Population	1357	1458	1458	1458	1458	1458
Water Demand (ac-ft/yr)	190	196	190	180	175	167
Current Supply (ac-ft/yr)	158	158	158	158	158	158
Supply – Demand (ac-ft/yr)	-32	-38	-32	-22	-17	-9
Recommended Strategy: Surface Water (ac-ft/yr)	38	38	38	38	38	38

LAMAR COUNTY

Water User Group: Petty WSC	2000	2010	2020	2030	2040	2050
Population	114	122	130	137	137	137
Water Demand (ac-ft/yr)	18	18	18	18	18	17
Current Supply (ac-ft/yr)	18	18	0	0	0	0
Supply – Demand (ac-ft/yr)	0	0	**-18**	**-18**	**-18**	**-17**
Recommended Strategy: Surface Water (ac-ft/yr)			18	18	18	17

MARION COUNTY

Water User Group: Kellyville-Berea WSC	2000	2010	2020	2030	2040	2050
Population	581	831	1081	1331	1581	1831
Water Demand (ac-ft/yr)	75	103	130	154	175	195
Current Supply (ac-ft/yr)	87	87	87	87	87	87
Supply – Demand (ac-ft/yr)	+12	**-16**	**-43**	**-67**	**-88**	**-108**
Surface Water (ac-ft/yr)		16	43	67	88	108

Water User Group: Pine Harbor WSC	2000	2010	2020	2030	2040	2050
Population	692	922	1152	1382	1612	1842
Water Demand (ac-ft/yr)	89	115	138	159	179	196
Current Supply (ac-ft/yr)	153.24	153.24	153.24	153.24	153.24	153.24
Supply – Demand (ac-ft/yr)	+64.24	+38.24	+15.24	**-5.76**	**-25.76**	**-42.76**
Recommended Strategy: Groundwater (ac-ft/yr)				108	108	108

Water User Group: Shady Shores WSC	2000	2010	2020	2030	2040	2050
Population	308	378	448	518	588	658
Water Demand (ac-ft/yr)	40	47	54	60	65	70
Current Supply (ac-ft/yr)	45.7	45.7	45.7	45.7	45.7	45.7
Supply – Demand (ac-ft/yr)	+5.3	**-1.3**	**-8.3**	**-14.3**	**-19.3**	**-24.3**
Groundwater (ac-ft/yr)		46	46	46	46	46

MORRIS COUNTY

RAINS COUNTY

Water User Group: Bright Star-Salem WSC	2000	2010	2020	2030	2040	2050
Population	2692	3096	3500	3904	4308	4713
Water Demand (ac-ft/yr)	455	523	583	654	720	800
Current Supply (ac-ft/yr)	586	586	586	586	586	586
Supply – Demand (ac-ft/yr)	+131	+63	+3	**-68**	**-134**	**-214**
Recommended Short Term Strategy: Groundwater (ac-ft/yr)	46	46	46			
Recommended Long Term Strategy: Surface Water (ac-ft/yr)				560	560	560

RED RIVER COUNTY

Water User Group: City of Detroit	2000	2010	2020	2030	2040	2050
Population	822	853	868	901	950	998
Water Demand (ac-ft/yr)	106	106	104	104	105	106
Current Supply (ac-ft/yr)	60	60	60	60	60	60
Supply – Demand (ac-ft/yr)	**-46**	**-46**	**-44**	**-44**	**-45**	**-46**
Recommended Strategy: Surface Water (ac-ft/yr)	106	106	106	106	106	106

Water User Group: Town of English	2000	2010	2020	2030	2040	2050
Population	163	161	155	150	145	130
Water Demand (ac-ft/yr)	21	20	19	17	16	14
Current Supply (ac-ft/yr)	14	14	14	14	14	14
Supply – Demand (ac-ft/yr)	**-7**	**-6**	**-5**	**-3**	**-2**	0
Recommended Strategy: Surface Water (ac-ft/yr)	7	7	7	7	7	7

SMITH COUNTY

Water User Group: Enchanted Lakes Water Corporation	2000	2010	2020	2030	2040	2050
Population	434	600	768	868	868	868
Water Demand (ac-ft/yr)	66	86	104	113	111	110
Current Supply (ac-ft/yr)	62	62	62	62	62	62
Supply – Demand (ac-ft/yr)	**-4**	**-24**	**-42**	**-51**	**-49**	**-48**
Recommended Strategy: Groundwater (ac-ft/yr)	62	62	62	62	62	62

Water User Group: Lindale Rural WSC	2000	2010	2020	2030	2040	2050
Population	5164	7147	9130	11114	13098	15079
Water Demand (ac-ft/yr)	786	1022	1233	1452	1668	1905
Current Supply (ac-ft/yr)	1086	1086	1086	1086	1086	1086
Supply – Demand (ac-ft/yr)	+300	+64	**-147**	**-366**	**-582**	**-819**
Recommended Strategy: Groundwater (ac-ft/yr)			591	591	591	1,182

Water User Group: Star Mountain WSC	2000	2010	2020	2030	2040	2050
Population	1220	1688	2156	2624	3094	3562
Water Demand (ac-ft/yr)	186	241	291	343	394	450
Current Supply (ac-ft/yr)	108	108	108	108	108	108
Supply – Demand (ac-ft/yr)	**-78**	**-133**	**-183**	**-235**	**-286**	**-342**
Recommended Strategy: Groundwater (ac-ft/yr)	108	216	216	323	323	323

TITUS COUNTY

UPSHUR COUNTY

Water User Group: City of East Mountain	2000	2010	2020	2030	2040	2050
Population	1237	1453	1608	1805	2014	2195
Water Demand (ac-ft/yr)	168	190	201	221	239	255
Current Supply (ac-ft/yr)	80.6	80.6	80.6	80.6	80.6	80.6
Supply – Demand (ac-ft/yr)	**-87.4**	**-109.4**	**-120.4**	**-140.4**	**-158.4**	**-174.4**
Recommended Strategy: Groundwater (ac-ft/yr)	107	187	187	187	187	187

Water User Group: Diana WSC	2000	2010	2020	2030	2040	2050
Population	3061	3941	4821	5701	6581	7461
Water Demand (ac-ft/yr)	396	492	579	660	733	797
Current Supply (ac-ft/yr)	498	498	498	498	498	498
Supply – Demand (ac-ft/yr)	+102	+6	**-81**	**-162**	**-235**	**-299**
Recommended Strategy:						
Groundwater (ac-ft/yr)		71	71	71	71	71
Surface Water (ac-ft/yr)			248	248	248	248
Total (ac-ft/yr)			319	319	319	319

Water User Group: Harmony ISD	2000	2010	2020	2030	2040	2050
Population	200	330	460	590	720	850
Water Demand (ac-ft/yr)	26	41	55	68	80	90
Current Supply (ac-ft/yr)	24.1	24.1	24.1	24.1	24.1	24.1
Supply – Demand (ac-ft/yr)	**-1.9**	**-16.9**	**-30.9**	**-43.9**	**-55.9**	**-65.9**
Recommended Strategy: Groundwater (ac-ft/yr)	24	24	48	48	73	73

Water User Group: Pritchett WSC	2000	2010	2020	2030	2040	2050
Population	4660	5662	6672	7682	8692	9702
Water Demand (ac-ft/yr)	599	704	800	886	964	1033
Current Supply (ac-ft/yr)	504.4	504.4	504.4	504.4	504.4	504.4
Supply – Demand (ac-ft/yr)	**-94.6**	**-199.6**	**-295.6**	**-381.6**	**-459.6**	**-528.6**
Recommended Strategy: Surface Water (ac-ft/yr)	532	532	532	532	532	532

Water User Group: Steam Electric in Upshur County	2000	2010	2020	2030	2040	2050
Population	0	0	0	0	0	0
Water Demand (ac-ft/yr)	0	5601	5601	5601	5601	5601
Current Supply (ac-ft/yr)	0	0	0	0	0	0
Supply – Demand (ac-ft/yr)	0	**-5601**	**-5601**	**-5601**	**-5601**	**-5601**
Recommended Strategy: Surface Water (ac-ft/yr)	0	5,601	5,601	5,601	5,601	5,601

Water User Group: Union Grove WSC	2000	2010	2020	2030	2040	2050
Population	1637	1977	2317	2657	2997	3337
Water Demand (ac-ft/yr)	211	246	278	307	332	355
Current Supply (ac-ft/yr)	249.5	249.5	249.5	249.5	249.5	249.5
Supply – Demand (ac-ft/yr)	+38.5	+3.5	**-28.5**	**-57.5**	**-82.5**	**-105.5**
Recommended Strategy: Groundwater (ac-ft/yr)			83.5	83.5	83.5	167

VAN ZANDT COUNTY

Water User Group: City of Canton	2000	2010	2020	2030	2040	2050
Population	3559	4094	4628	5163	5698	6232
Water Demand (ac-ft/yr)	694	757	814	891	951	1039
Current Supply (ac-ft/yr)	818	818	818	818	818	818
Supply – Demand (ac-ft/yr)	+124	+61	+4	**-73**	**133**	**-221**
Recommended Strategy: Groundwater (ac-ft/yr)				108	216	216

Water User Group: City of Grand Saline	2000	2010	2020	2030	2040	2050
Population	3010	3462	3914	4366	4818	5270
Water Demand (ac-ft/yr)	583	636	684	749	804	880
Current Supply (ac-ft/yr)	586	586	586	586	586	586
Supply – Demand (ac-ft/yr)	+3	**-50**	**-98**	**-163**	**-218**	**-294**
Recommended Strategy: Groundwater (ac-ft/yr)		161	161	323	323	323

Water User Group: City of Van	2000	2010	2020	2030	2040	2050
Population	2255	2594	2932	3271	3610	3949
Water Demand (ac-ft/yr)	511	560	605	663	715	782
Current Supply (ac-ft/yr)	575	575	575	575	575	575
Supply – Demand (ac-ft/yr)	+64	+15	**-30**	**-88**	**-140**	**-207**
Recommended Strategy: Groundwater (ac-ft/yr)			269	269	269	269

Water User Group: Ben Wheeler WSC	2000	2010	2020	2030	2040	2050
Population	1417	1630	1842	2054	2267	2479
Water Demand (ac-ft/yr)	183	203	221	237	252	264
Current Supply (ac-ft/yr)	214.5	214.5	214.5	214.5	214.5	214.5
Supply – Demand (ac-ft/yr)	+31.5	+11.5	**-6.5**	**-22.5**	**-37.5**	**-49.5**
Recommended Strategy: Groundwater (ac-ft/yr)			134	134	134	134

Water User Group: Corinth WSC	2000	2010	2020	2030	2040	2050
Population	678	958	1237	1517	1796	2074
Water Demand (ac-ft/yr)	87	119	148	175	199	221
Current Supply (ac-ft/yr)	139	139	139	139	139	139
Supply – Demand (ac-ft/yr)	+52	+20	**-9**	**-36**	**-60**	**-82**
Recommended Strategy: Groundwater (ac-ft/yr)			108	108	108	108

Water User Group: Crooked Creek WSC	2000	2010	2020	2030	2040	2050
Population	541	764	986	1208	1431	1653
Water Demand (ac-ft/yr)	70	95	118	139	159	176
Current Supply (ac-ft/yr)	106	106	106	106	106	106
Supply – Demand (ac-ft/yr)	+36	+11	**-12**	**-33**	**-53**	**-70**
Recommended Strategy: Groundwater (ac-ft/yr)			108	108	108	108

Water User Group: Edom WSC	2000	2010	2020	2030	2040	2050
Population	795	1122	1450	1777	2105	2433
Water Demand (ac-ft/yr)	102	140	174	205	233	259
Current Supply (ac-ft/yr)	183	183	183	183	183	183
Supply – Demand (ac-ft/yr)	+81	+43	+9	**-22**	**-50**	**-76**
Recommended Strategy: Groundwater (ac-ft/yr)				46	92	92

Water User Group: Fruitvale WSC	2000	2010	2020	2030	2040	2050
Population	2324	3282	4239	5196	6153	7111
Water Demand (ac-ft/yr)	299	408	508	599	682	757
Current Supply (ac-ft/yr)	358	358	358	358	358	358
Supply – Demand (ac-ft/yr)	+58.5	**-50.5**	**-150.5**	**-241.5**	**-324.5**	**-399.5**
Recommended Strategy: Groundwater (ac-ft/yr)		54	161	269	377	430

Water User Group: Little Hope-Moore WSC	2000	2010	2020	2030	2040	2050
Population	1282	1810	2338	2865	3394	3922
Water Demand (ac-ft/yr)	165	225	280	331	376	417
Current Supply (ac-ft/yr)	186	186	186	186	186	186
Supply – Demand (ac-ft/yr)	+21	**-39**	**-94**	**-145**	**-190**	**-231**
Recommended Strategy: Surface Water From City of Tyler (ac-ft/yr)		145	145	145		

WOOD COUNTY

Water User Group: City of Mineola	2000	2010	2020	2030	2040	2050
Population	5128	5747	6366	6985	7604	8223
Water Demand (ac-ft/yr)	908	967	1006	1092	1148	1243
Current Supply (ac-ft/yr)	967	967	967	967	967	967
Supply – Demand (ac-ft/yr)	+5.9	0	**-49**	**-125**	**-181**	**-276**
Recommended Strategy: Groundwater (ac-ft/yr)			323	323	323	323

Water User Group: Fouke WSC	2000	2010	2020	2030	2040	2050
Population	2837	3367	3897	4427	4957	5487
Water Demand (ac-ft/yr)	402	445	484	535	574	643
Current Supply (ac-ft/yr)	616	616	616	616	616	616
Supply – Demand (ac-ft/yr)	+214	+171	+132	+81	+42	**-27**
Recommended Strategy: Groundwater (ac-ft/yr)						108

Water User Group: Lake Fork WSC	2000	2010	2020	2030	2040	2050
Population	1396	2116	2836	3556	4276	4996
Water Demand (ac-ft/yr)	198	280	352	430	495	587
Current Supply (ac-ft/yr)	182	182	182	182	182	182
Supply – Demand (ac-ft/yr)	**-16**	**-98**	**-170**	**-248**	**-313**	**-405**
Recommended Strategy: Groundwater (ac-ft/yr)	161	161	430	430	430	430

1.0 EXECUTIVE SUMMARY

This report presents the results of a Reservoir Site Assessment Study prepared as background information for the North East Texas Regional Water Plan. The report presents information on key hydrologic, engineering, and environmental characteristics associated with 17 potential reservoir sites located within the North East Texas Regional Water Planning Area.

For the purposes of this study, three of the 17 potential reservoir sites were examined in somewhat greater detail as "proposed" projects. This designation was applied to the George Parkhouse II and Marvin Nichols I reservoir sites solely because of their status as recommended projects in the current (1997) State Water Plan. Also, the Prairie Creek reservoir and pipeline project was evaluated as a "proposed" site by virtue of its status as a recommended project in the recently completed Sabine Comprehensive Watershed Management Plan.

The 17 reservoir sites examined in this study are:

Proposed Sites:

- George Parkhouse II (Delta and Lamar Counties)
- Marvin Nichols I (Franklin, Morris, Titus, and Red River Counties)
- Prairie Creek (Gregg and Smith Counties)

Potential Sites:

- Barkman (Bowie County)
- Black Cypress (Cass and Marion Counties)
- Big Pine (Lamar and Red River Counties)
- Big Sandy (Wood and Upshur Counties)
- Caddo Lake Enlargement (Marion and Harrison Counties)
- Carl Estes (Van Zandt County)
- Carthage (Harrison County)
- Kilgore (Gregg and Smith Counties)
- Liberty Hill (Bowie County)
- Little Cypress (Harrison County)
- Parkhouse I (Delta and Hopkins Counties)
- Pecan Bayou (Red River County)
- Waters Bluff (Wood County)

This study was performed to properly evaluate and assess the potential and proposed reservoirs with regards to their location; impoundment size and volume; site geology and topography; dam type and size; hydrology and hydraulics; water quality; project yield for water supply; other potential benefits (e.g., flood control; hydro power generation, recreation); land acquisition and easement requirements; potential land use conflicts; local, state, and federal permitting requirements; cost estimates; and potential environmental impacts.

This study was performed as part of the development of the North East Texas Regional Water Plan. The primary objective of the assessment is to identify unique sites for reservoir construction that may be considered as a water management strategy. Subsequent to the development of this study, the North East Texas Regional Water Planning Group designated two sites as proposed for the 2000 Water Plan, and the remaining sites as potential. The proposed sites are Marvin Nichols I, and Prairie Creek. In making this recommendation, the group noted that; (1) should Marvin Nichols I not be feasible, the group recommend its replacement with Marvin Nichols II, Parkhouse I and Parkhouse II, and (2) should the current conservation easement problems with Waters Bluff site be resolved, that reservoir should replace Prairie Creek as a proposed site.

1.1 RESULTANT COSTS

Table 1.1-1 Annualized Costs

		PROJECT COSTS		*O&M[1]*			
Reservoir	***Yield (ac-ft/yr)***	***Total***	***Annualized***		***Total Annual***	***Cost/ac-ft***	***Cost/1000 gal***
Prairie Creek w/o diversion	17,215	$56,403,000	$3,993,500	$435,490	$4,428,990	$257.28	$0.79
Prairie Creek w/diversion	29,685	$68,307,000	$4,836,400	$564,780	$5,401,180	$181.95	$0.56
Prairie Creek w/pipeline	115,000	$174,553,000	$12,681,000	$6,498,167	$19,179,234	$166.78	$0.51
Marvin Nichols I	550,842	$446,518,000	$31,614,800	$2,187,170	$33,801,970	$61.37	$0.19
George Parkhouse II	131,850	$160,022,000	$11,330,100	$966,020	$12,296,120	$93.26	$0.29
Carl L. Estes	95,630	$374,852,000	$26,540,600	$2,198,340	$28,738,940	$300.53	$0.93
Big Sandy	46,600	$79,647,000	$5,639,300	$538,730	$6,178,030	$132.58	$0.41
Carthage	537,000	$462,402,000	$32,739,400	$2,101,520	$34,840,920	$64.89	$0.20
Kilgore[3]	5,500	--	--	--	--	--	--
Waters Bluff	324,000	$466,549,000	$33,033,100	$2,397,200	$35,430,300	$109.36	$0.34
Big Pine	35,840	$52,416,000	$3,711,200	$786,240	$4,497,440	$125.49	$0.39
Pecan Bayou	1,866	$13,858,000	$981,200	$207,870	$1,189,070	$637.23	$1.96
Black Cypress	176,770	$350,631,000	$24,825,700	$1,506,690	$26,332,390	$148.97	$0.46
Little Cypress	144,900	$290,759,000	$20,586,600	$1,240,840	$21,827,440	$150.64	$0.47
Caddo Lake Enlargement[2]	94,160	$213,752,000	$15,134,300	$3,206,280	$18,340,580	$194.79	$0.60
George Parkhouse I	113,500	$224,726,000	$15,911,300	$1,171,820	$17,083,120	$150.52	$0.47
Liberty Hills[3]	--	--	--	--	--	--	--
Barkman[3]	--	--	--	--	--	--	--
Marvin Nichols II	280,100	$250,316,000	--	--	--	--	--

Notes
1. Operation & Maintenance equals 1.5% of total capital cost
2. Caddo Lake Enlargement supply yield does not include existing yield
3. Complete information for Kilgore, Liberty Hills and Barkman Reservoirs is not available.
4. Estimated mitigation costs are based solely on land costs for each reservoir. Specific mitigation requirements would be determined for the reservoir sites that are selected for development.

TABLE OF CONTENTS

2.0 INTRODUCTION

2.1 SCOPE OF SERVICES

Texas Water Development Board (TWDB) rules for the preparation of regional water supply plans provide that regional water planning groups (RWPGs) "…may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation and expected beneficiaries of the water supply to be developed at the site."

Pursuant to TWDB rules, the approved scope of work for the preparation of the North East Texas Regional Water Plan includes a subtask to "…determine which sites for future reservoir development to include in the regional water plan."

As input into the development of the Regional Water Plan for the North East Texas Region, TC&B Inc. and ECI Inc. performed a reconnaissance-level reservoir site assessment study, using available information, for the two reservoir sites (George Parkhouse II and Marvin Nichols I) proposed for development in the 1997 state water plan; the proposed Prairie Creek Reservoir site; and, for 14 additional potential reservoir sites. The primary elements of the study included data collection and review; a results summary; yield studies for the proposed sites; cost estimates; and environmental analyses. The need for the potential or proposed sites as a source of water supply is not addressed in this study. Each of these aspects of the report is discussed below.

2.2 DATA COLLECTION AND REVIEW

An extensive literature search and review was conducted to identify existing, readily available documents and reports of past studies on the proposed and potential reservoir sites in the North East Texas Region. Information sources included the TWDB, the Texas Natural Resource Conservation Commission (TNRCC), the Texas Parks and Wildlife Department (TPWD), the U.S. Army Corps of Engineers, the USDA Natural Resources Conservation Service, the U.S. Fish and Wildlife Service (USFWS), and any studies sponsored by cities, water suppliers, or water conservation and reclamation districts operating within or having interests in water supply development in the North East Texas Region.

2.3 RESULTS SUMMARIES

Based upon a review of the collected information, the results of the past studies were summarized for each of the proposed and potential reservoir sites (ECI) with respect to:

- Location;
- Impoundment size and volume;
- Site geology and topography;
- Dam type and size;
- Hydrology and hydraulics;
- Water quality;
- Project yield for water supply;
- Other potential benefits (e.g., flood control, hydro power generation, recreation);
- Land acquisition and easement requirements;
- Potential land use conflicts;
- Local, state, and federal permitting requirements; and,
- Project costs updated to second quarter 1999 price levels using the *Engineering News Record* Construction Cost Index.

2.4 YIELD STUDIES

Estimates of the project yield for water supply for each of the three proposed reservoirs were determined. For the potential reservoirs, a summary of the previous yield determinations was prepared. The Firm Yield Simulation Criteria for a New Site as described in Exhibit B of the contract between the TWDB and the Northeast Texas Municipal Water District regarding the preparation of the Regional Water Plan were adhered to. The estimates of the project yield for water supply includes appropriate consideration of reservoir pass-through and/or release requirements as described in the Consensus Environmental Planning Guidelines.

Yield simulations for the two proposed reservoirs in the Sulphur Basin were performed using the TNRCC Sulphur Basin Water Availability Model and the TWDB daily flow model SYMDLYBE. The yield simulation for the proposed Prairie Creek reservoir was performed using SYMDLYBE.

2.5 COST ESTIMATES

Cost estimates for each of the proposed and potential reservoir projects were developed. TWDB requirements of the contract between the TWDB and the Northeast Texas Municipal Water District were adhered to, except that costs were estimated only in terms of the total capital costs and annual costs for raw water supply from each project. These costs include estimates of costs associated with mitigation for environmental impacts. Costs associated with the delivery and treatment of the water supply for end user requirements were not developed.

2.6 ENVIRONMENTAL OVERVIEW AND REPORT SECTION

A reconnaissance-level environmental overview of the proposed and potential reservoir sites was performed. The overview identifies the potential environmental impacts associated with each of the proposed and potential sites. The development of the environmental report section was based on readily available information contained in the existing documents and reports that were obtained during the data collection process, and other sources (e.g., USFWS federally listed endangered and threatened species, USFWS National Wetland Inventory Maps, TPWD Natural Heritage Program, etc.). The environmental overview of the proposed reservoir sites is more extensive than that of the potential reservoir sites.

3.0 PURPOSE AND NEED FOR NEW RESERVOIRS IN REGION D

The North East Texas Region is blessed with abundant surface water supplies, much of which is not currently being utilized. Table 3.1-1 presents a breakdown by river basin of the approximate surface water supply of the region. It is anticipated that a portion of this available surface supply will be necessary to meet interregional needs either to replace diminishing groundwater supplies to meet future needs not currently available in the region or because of the location of communities in relation to existing reservoirs.

3.1 SURFACE WATER AVAILABILITY

Considerable interest has been expressed in portions of the remaining undeveloped supply by entities in Region C. Although most of the more attractive reservoir sites in the North East Texas Region have been previously studied, many of the studies are several years old and do not consider current requirements with regard to environmental permitting regulations, such as ecologically unique stream segments, Department of the Army permits, National Pollutant Discharge Elimination System requirements, and environmental flow requirements.

Table 3.1-1 Surface Water Availability from Future Reservoirs

Basin	*Drainage Area Within Region (sq. mi.)*	*Average Annual Discharge (acre-feet)*	*Minimum Annual Discharge (acre-feet)*	*Currently Permitted* (acre-feet)*
Sulphur River	3,600	2.5 million **	550,000 **	400,000
Cypress (Creek) River	2,812	1.6 million ***	N/A	255,000
Sabine River	3,600	1.7 million ***	N/A	443,000
Red River	1,400	1.0 million ***	N/A	61,000
Total	11,412	6.8 million		1,159,000

* Texas Water Plan, 1997[1]

** Water availability modeling for the Sulphur River Basin for the TNRCC by R.J. Brandes Company dated June, 1999[2]

*** Estimated from USGS records[3]

TWDB rules for the preparation of regional water supply plans provide that regional water planning group (RWPGs) "… may recommend sites of unique value for construction of reservoirs by including descriptions of the sites, reasons for the unique designation and expected beneficiaries of the water supply to be developed at the site." TWDB rules further specify that the following criteria are to be applied to determine whether a site is unique for reservoir construction:

1. "site-specific reservoir development is recommended as a specific water management strategy or in an alternative long-term scenario in an adopted regional water plan;
2. the location, hydrologic, geologic, topographic, water availability, water quality, environmental, cultural, and current development characteristics or other pertinent factors make the site uniquely suited for:
   A. reservoir development to provide water supply for the current planning period; or
   B. where it might reasonably be needed to meet needs beyond the 50-year planning period."

The 1997 State Water Plan recommends development of two new reservoirs within the North East Texas Region – the George Parkhouse II reservoir project and the Marvin Nichols I reservoir project, both of which are located within the Sulphur River Basin. It is noted in the 1997 state water plan that development of the Marvin Nichols I reservoir could offset or significantly delay the need for the George Parkhouse II reservoir. Also, the recently completed *Comprehensive Sabine Watershed Management Plan* includes a recommendation that the Sabine River Authority develop the Prairie Creek Reservoir in Gregg and Smith Counties to supply projected water supply needs within that portion of the North East Texas Region.

In addition to the reservoirs recommended for development, fourteen other reservoir sites within the North East Texas Region are designated as "potential sites." These are:

- Enlargement of Caddo Lake (Marion and Harrison Counties)
- Big Pine (Lamar and Red River Counties)
- Pecan Bayou (Red River County)
- Liberty Hill (Bowie County)
- Barkman (Bowie County)
- Black Cypress (Cass and Marion Counties)
- Little Cypress (Harrison County)
- Carl Estes (Van Zandt County)
- Carthage (Harrison County)
- Waters Bluff (Wood County)

- Kilgore (Gregg and Smith Counties)
- Parkhouse I (Delta and Hopkins Counties)
- Big Sandy (Wood and Upshur Counties)
- Marvin Nichols I (Morris and Titus Counties)

3.2 SURFACE WATER QUALITY

The quality of surface water supplies is a key consideration in water resources planning. Water quality degradation from either natural or man-made sources affects the feasibility of using those supplies for certain uses. For example, naturally occurring chloride levels in the Red River have limited the use of water from that source and the costs to treat the water to acceptable standards may be excessive. These types of water quality problems and their implications for water supply development and use will be considered in the development of the regional water plan for North East Texas.

3.3 FUTURE INTERBASIN TRANSFERS WITHIN AND FROM THE NORTH EAST TEXAS REGION

The North East Texas Region currently supplies water to other areas of the state through interbasin transfers and is identified in the current state water plan as a likely source of additional future water supply for various entities in the Dallas/Fort Worth (D/FW) Metroplex. Specifically, the 1997 state water plan includes recommendations that one or more new reservoirs be constructed in the Sulphur River Basin as a source of future water supply for the D/FW Metroplex. In addition to water transfers from the region, there may also be water management strategies for meeting needs within the North East Texas Region that will involve conveyance of supplies from one river basin to another.

A common view about potential future interbasin transfers from the North East Texas Region is that future water needs within the region must be understood and satisfied before additional supplies are transferred. Related to this view are concerns that current TWDB water demand projections understate the long-term water needs of the region. Many of those offering comments on this issue are supportive of future reservoir development and interbasin transfers provided the basin of origin's long-term water demands are met and provided there are tangible benefits for the North East Texas Region.

Among it's many provisions, S.B. 1 includes provisions (Texas Water Code, Section 11.085) requiring the TNRCC to weigh the benefits of a proposed new interbasin transfer to the receiving basin against the detriments to the basin supplying the water. S.B. 1 also established the following criteria to be used by the TNRCC in its evaluation of proposed interbasin transfers:

- The need for the water in the basin-of-origin and in the receiving basin.
- Factors identified in the applicable regional water plan(s).
- The amount and purposes of use in the receiving basin.
- Any feasible and practicable alternative supplies in the receiving basin.
- Water conservation and drought contingency measures proposed in the receiving basin.
- The projected economic impact that is expected to occur in each basin.
- The projected impacts on existing water rights, instream uses, water quality, aquatic and riparian habitat, and bays and estuaries.
- Proposed mitigation and compensation to the basin-of-origin.

TWDB rules require that the evaluation of interbasin transfer options include consideration of "… the need for water in the basin of origin and in the proposed receiving basin" [30 TAC 357.7(a)(7)(G)]. In addition, many of the other statutory "considerations" listed above can be examined at least at a reconnaissance-level within the context of the evaluation criteria for water management strategies contained in TWDB rules [30 TAC 357.7 (a)(7)]. Several of these considerations apply to a "receiving basin" and should therefore be addressed in the regional water plan for that basin or area. In any case, detailed analyses of interbasin transfer options at a level sufficient for project financing and permitting is beyond the scope of the regional water planning process.

Table 3.3-1summarizes the currently stated requirements of the water supply entities serving the D/FW Region C.

Table 3.3-1 Stated Water Supply Needs of DFW Area from Region D (Sulphur River Basin)

Entity	*Annual Demand (Ac-ft.)*
City of Dallas (DWU)	100,000 *
Tarrant Regional Water District	187,000 **
North Texas Municipal Water District	154,000 ***
Total	441,000

* Draft Water Supply Study for DWU (2000)[4]

** Water Management Plan for Tarrant Regional Water District by HDR Engineering, Inc. and Alan Plummer Associates, Inc. dated June 1999.[5]

*** Preliminary Sources of Additional Water Supply for North Texas Municipal Water District by Freese and Nichols, Inc., dated May 1996.[6]

The third proposed reservoir site, the Prairie Creek site in the Sabine River Basin had been previously sized to serve the City of Longview's long term additional demand of approximately 38,000 acre-feet/year. This, of course, is an in basin need. The total yield of this site could be expanded significantly to potentially serve out of basin needs of a pipeline from Toledo Bend Reservoir proposed by the Sabine River Authority as included in the Prairie Creek project plan.

3.4 REGIONAL WATER-RELATED PROBLEMS AND NEEDS

In many areas of the region, shallow groundwater has high concentrations of iron and is acidic, making the water undesirable for municipal use and most manufacturing processes. The problems can be solved, for the most part, by completing wells in deeper water-bearing zones or by treatment of the water from the shallower wells. Surface water, and good quality groundwater, are potentially available to meet projected water needs for the region, if projects are planned and developed on schedule. Dissolved oxygen content of streams is periodically low due to low streamflow and low natural reaeration rates. Also, flooding is a major problem in many areas of the region.

3.5 LOCAL WATER-RELATED PROBLEMS AND NEEDS

A brief narrative of the TWDB's evaluation of the water resources of the major cities and large water utility suppliers in the region is described below. Also included are other entities that could affect the water resources of the region. Data on other cities and supplies may be obtained from the TWDB's files.

3.5.1 Sulphur River Municipal Water District (SRMWD)

The Sulphur River Municipal Water District was created in 1955 and serves Delta, Hopkins and Hunt counties. The SRMWD owns 26.282 percent of the water stored in Cooper Lake and will use that water to fulfill the needs of its customer cities (Cooper, Commerce and Sulphur Springs). During the next 50 years, the member cities could have excess supplies in Cooper Lake. In fact, the Upper Trinity Regional Water District has entered into an agreement with the City of Commerce for the temporary, interim, purchase of water from Commerce's share of Cooper Lake water. Any excess water the district's member cities have could be used in the D/FW Metroplex.

3.5.2 Northeast Texas Municipal Water District (NETMWD)

Northeast Texas MWD was created in 1953 and serves Marion, Upshur, Morris, Cass, and Camp counties. The District owns storage rights in the Lake O' the Pines Reservoir and supplies water to its customer cities, as well as industrial and steam-electric power plants in the Cypress and Sabine River basins. The District currently supplies water to the Brandy Branch cooling lake which is located in the Sabine River Basin and has contracted to supply up to 20,000 acre feet to the City of Longview in the Sabine Basin. The District has excess supplies that can be used to meet demands in the Cypress or Sabine River basins.

3.5.3 Sabine River Authority (SRA)

The Sabine River Authority was created by the Texas Legislature in 1949 as a conservation and reclamation district to control, store, preserve, and distribute the waters of the Sabine River and its tributaries for the beneficial purposes. The service area of the SRA includes all or parts of 21 counties within the Sabine River Basin. The SRA owns and operates three reservoirs, two (Lake Fork and Lake Tawakoni) within the Northeast Texas Region, while the third (Toledo Bend Reservoir) lies within the East Texas Region. The SRA has contracted to provide water supplies to numerous municipalities, water supply corporations, and industrial users in the region. In addition, the SRA has contracted to provide Dallas Water Utilities (in the Trinity River Basin) over 300,000 acre-feet per year from Lake Fork and Lake Tawakoni.

3.5.4 Tyler

Water needs for the City are met by surface water from Lake Tyler and groundwater from wells completed in the Carrizo-Wilcox Aquifer. It is anticipated that ground water withdrawals will remain at the approximate present levels, while future needs will be met by increased use of Lake Tyler. The City also holds contracts for water from Lake Palestine if needed. It is anticipated that the City will be able to meet its future water needs through the year 2050 by using its present supplies.

3.5.5 Longview

The City of Longview holds contracts for water in Lake Cherokee and Lake Fork, as well as having water rights to flows in the Sabine River and Big Sandy Creek. In general, the majority of their water needs in the past have been met by Lake Cherokee and the Sabine River. The City also holds contracts with NETMWD for water from Lake O' the Pines in the Cypress Creek Basin (and has authorization for the associated interbasin transfer). Longview has not yet needed to use water from this source, but plans to in the future. The City should be able to meet its future water needs through the year 2050 for its present water supplies.

3.5.6 Texarkana

The water needs for the City of Texarkana are supplied by Lake Wright Patman (formerly Lake Texarkana). The City also serves as a water supplier for several communities and water supply companies located in Bowie and Red River counties, and in Miller County, Arkansas. Interbasin transfers have been authorized, where required, for these supplies. It is anticipated that the City will be able to meet its water needs, as well as those of its customers, through the 2050 planning year.

3.5.7 Paris

Water needs for the City of Paris are met from Lake Crook and from Lake Pat Mayse (and involves an authorized interbasin transfer from the Red River Basin). Future water needs, through the year 2050, are expected to be met by using these existing supplies.

3.5.8 Marshall

The City of Marshall has water rights to flows in Big Cypress Creek. The diversion point for the City is in the backwater of Caddo Lake, and diversions from the lake occur when flow in the creek is low. Projections indicate the City will meet its water needs through the planing year 2050 from existing supplies.

3.5.9 Kilgore

The City of Kilgore meets its water needs from ground-water wells completed in the Carrizo-Wilcox Aquifer and from water obtained from the City of Longview. The City also purchases water from the Sabine River Authority. It is anticipated that the City will continue to meet its needs through the 2050 planning year from these existing supplies.

The proposal that led to current prime contract may be affecting per capita water use. A widely held concern is that the TWDB projections for small communities (i.e., less than 1,000 population) and for rural areas do not reflect current and future growth trends and changing water use characteristics. Inasmuch as approximately 70 percent of the region’s population falls into the “county other” category, there is concern that the future water supply needs of small communities and rural areas are underestimated.

As a result of these concerns, Task 4 of the scope of work for development of the North East Regional Water Plan includes a significant effort to obtain additional information from other state, federal, and local sources to compare with TWDB projections and, as appropriate, to document the need for adjustments in the TWDB projections. The analysis of this data will focus on three critical elements of TWDB’s population and municipal water demand projections: (1) the estimated starting or “baseline” population of the region for the year 2000; (2) the rate of population growth through the 2050 planning horizon; and (3) current and future rates of water use on a per capita basis. Data will also be gathered and analyzed from local sources with regard to current and projected water demands for other categories of water use (e.g., manufacturing, irrigation, steam electric, etc.)

3.6 WATER CONSERVATION

Water conservation is viewed by many as an important component of both local and regional water resources management. However, based on the results of the water supplier survey, only about 20 percent of the 116 respondents indicated that they currently have a water conservation plan. While some level of conservation is expected to occur as a result of existing state and local policies and programs, there is a need to investigate the degree to which an "“enhanced" regional water conservation effort can contribute to meeting future water supply needs.

3.7 DROUGHT CONTINGENCY PLANNING

Current drought conditions underscore the need for preparing local and regional plans for responding to drought. While few water suppliers in the region have experienced actual water shortages, many have water treatment, storage, and distribution system constraints and experience problems meeting higher than normal water demands during drought. Based on the results of the water supplier survey, only about 25 percent of the respondents indicated that they have a drought contingency plan. S.B. 1 requires all public water systems to develop such plans. However, many water systems, particularly small systems, will require technical assistance with the preparation of drought contingency plans.

3.8 ENVIRONMENTAL FLOW REQUIREMENTS

TWDB rules for regional water planning require that the effects of future water supply development on environmental resources be fully considered. In particular, attention must be given to the impacts of future surface water development on instream flows and associated aquatic and riparian ecological resources. Also, the potential impacts on water-based recreation and downstream navigation should be considered. For any proposed new direct diversion from a river or stream and for new reservoirs, these potential impacts must be investigated using either available site-specific studies or the state's planning criteria for environmental flows. The effects of any instream flow requirements on the yields and costs of future water projects also must be identified.

3.9 NEEDS OF SMALL RURAL COMMUNITIES AND WATER SUPPLY CORPORATIONS

Many concerns have been expressed about the current and future water related needs of small rural communities and rural water supply corporations. These needs and problems have many dimensions and include:

- access to ground and surface water supplies for future growth;
- inadequate water storage and distribution infrastructure;
- costs and affordability of new supplies;
- access to funding for water system improvements and new supply development;
- compliance with state and federal laws and regulations; and
- the technical, managerial, and financial capabilities of small water systems.

In developing a water plan for the North East Texas Region, it is essential that the needs and problems of rural areas be recognized, fully understood, and appropriately addressed. In particular, strategies for addressing the water supply problems of rural areas must be developed with consideration to the limited financial capabilities of many small rural water systems and their needs for both technical and financial assistance. Also, as previously noted, some dimensions of this issue are of more of a policy nature and must be addressed accordingly. For example, the water supply facility needs of small systems generally cannot be addressed through the S.B. 1 regional planning process except insofar as there are important issues of public policy (e.g., financing needs, role of the state in providing financial assistance, regionalization, etc.).

3.10 GROUNDWATER AVAILABILITY

While many water suppliers in the region rely solely on local groundwater supplies, and many suppliers have indicated an intent to develop additional groundwater supplies, in some areas groundwater supplies may not be adequate to meet future needs or, available groundwater resources may not be of a suitable quality. In such areas, it will be necessary to investigate options for accessing surface water supplies and/or advanced treatment methods for poor quality groundwater supplies (e.g., desalination).

3.11 CONVERSION FROM GROUNDWATER TO SURFACE WATER

As indicated previously, many water systems in the North East Texas Region currently rely solely on local groundwater sources. In some areas, these groundwater sources may not be adequate or suitable for future use and conversion to surface water sources will be necessary. There are a number of issues that must be considered when looking at options for conversion from ground to surface water sources. These include access to and the cost of supplies from existing sources, costs and impacts of developing new water sources, and the potential for regional approaches.

3.12 REGIONALIZATION OF WATER SUPPLY SYSTEMS

Regionalization of water supply systems often offers the potential for significant cost savings in acquiring new water supplies and for improving the reliability of supplies. Regionalization can take many forms. It can include the development of regional water supply facilities, the physical consolidation or interconnection of two or more existing water systems, or the management of two or more independent systems by a single entity. However, a number of impediments often exist to regionalization and must be considered on a case by case basis when evaluating regional approaches. These include issues of local control and accountability versus regional cooperation, costs and cost-sharing arrangements, financing, and affordability.

3.13 DRINKING WATER SUPPLY TREATMENT AND DISTRIBUTION

Approximately 35 percent of the water suppliers surveyed during the scope development phase indicated that they have had or expect to experience problems of inadequate storage and distribution facilities for potable water. Many local water suppliers also expressed concern about existing state and federal regulatory requirements for public water systems and the limited public funding available for water infrastructure improvements. Through the collection of data from local water suppliers (North East Texas Regional Water Plan Development Task 2) it will be possible to develop a better understanding of these problems and funding needs in North East Texas.

3.14 VOLUNTARY REDISTRIBUTION OF EXISTING SURFACE WATER SUPPLIES

In the development of a regional water plan, it is required that all existing water rights, contracts, and agreements be honored. However, TWDB rules for regional water planning also require consideration of strategies for the ”voluntary redistribution of water resources”: between willing parties. These include sales and transfers of water rights, option agreements, leases, subordination agreements, establishment of regional water banks, and interim use of water supplies that are not presently needed. These “market-based” approaches to water allocation may offer potential in some situations for solving current or future water supply problems. However, these approaches not only require the consent of the parties directly involved in the transaction but also consideration of potential third party impacts (e.g., impacts on other water rights holders, environmental impacts, etc.).

3.15 PRIVATIZATION OF PUBLIC WATER SYSTEMS

One respondent to the survey of water suppliers expressed concern about the possible future privatization of publicly-owned water systems in North East Texas. Recently, investor-owned for-profit companies have begun acquiring water systems in Texas. This privatization offers potential benefits including improved management, access to funding for needed improvements, and improved reliability of water service. However, privatization of publicly-owned water systems also raises issues of local control and accountability and the potential for increases in water rates.

3.16 FUTURE RESERVOIR DEVELOPMENT

The 1997 state water plan includes recommendations for two new reservoirs in the Sulphur River Basin (the Parkhouse and Nichols reservoirs) and notes the potential for future development of a new reservoir in the Sabine River Basin (Prairie Creek Reservoir). In addition to recommended reservoirs, there are also a number of other potential sites for future reservoir construction. These recommended and potential reservoir sites will be examined (North East Texas Regional Water Plan Development Task 12) and included in the regional water plan for North East Texas, if appropriate. Issues to be evaluated with regard to new reservoir construction include the yield and cost of each project, environmental impacts and mitigation requirements, socioeconomic impacts (benefits and costs), and project financing.

3.17 ENVIRONMENTAL MITIGATION IMPACTS ON PROPOSED AND POTENTIAL RESERVOIR SITES

An issue identified by various entities and individuals from the Sabine River Basin is the potential impacts of current and future set-asides of lands for environmental mitigation in the sites of potential future reservoirs. Of particular concern is the recent establishment of several wetlands mitigation banks in areas of the upper Sabine Basin and the possibility that these mitigation banks will preclude future reservoir development in that area. A related concern is the potential for mitigation of environmental impacts in one basin from new reservoirs developed in another basin.

3.18 WATER COSTS

A common theme running through many of the issues described above is the cost of meeting future water supply needs and the impacts of various water management strategies on the affordability of water service. It is therefore important to identify "least-cost" strategies for addressing identified water supply problems.

---

[1] Texas Water Development Board, Water for Texas. August 1997.

[2] R. J. Brandes Company (1999). Water Availability Modeling for the Sulphur River Basin for TNRCC. June.

[3] USGS Records

[4] Draft Water Supply Study for DWU (2000)

[5] Water Management Plan for Tarrant Regional Water District by HDR Engineering, Inc. and Alan Plummer Associates, Inc. dated June 1999.

[6] Preliminary Sources of Additional Water Supply for North Texas Municipal Water District by Freese and Nichols, Inc., dated May 1908.

4.0 PROPOSED RESERVOIR SITES

The purpose of this study is to provide a summarized technical database developed from documents and reports of previous studies conducted for proposed and potential reservoir sites in the northeast Texas region. The strengths and weaknesses of the respective sites can be used for evaluation to help in determining implementation priorities. This work includes a search of available data, documents and reports of studies conducted by entities having interests in water supply development in the northeast Texas region. The three (3) proposed reservoir sites included in this study also have a revised yield analysis that was conducted using the most recent available data and computer programs.

This section summarizes key engineering and environmental data based on previous studies with respect to:

- *Location*
- *Impoundment size and volume*
- *Site geology and topography*
- *Geotechnical conditions and limitations*
- *Construction materials*
- *Dam type and size*
- *Hydrology and Hydraulics*
- *Water Quality*
- *Project yield for water supply*
- *Other potential benefits (e.g., flood control, irrigation, hydro power generation, recreation)*
- *Land Acquisition and Easement Requirements*
- *Potential land use conflicts*
- *Updated Project Costs (Engineering News Record Construction Cost Index,2nd Qtr. 1999)*
- *Local, state, and federal permitting requirements*
- *Geological Elements*
- *Hydrological Elements*
- *Biological Elements*
- *Ecologically Unique Stream Segments*
- *Wetlands*
- *Wetland Mitigation Banks*
- *Bottomland Hardwoods*
- *Conservation Easements*
- *Social and Economic Conditions*
- *Historical or Archeological Resources*
- *Land Use*
- *Regulated Materials*

4.1 GEORGE PARKHOUSE II

4.1.1 Summary of Prior Studies

4.1.1.1 Location

Figure 4.1-1 Location of George Parkhouse II within the Region D Planning Region

The George Parkhouse II site is located 110 miles east of Fort Worth on the North Sulphur River at River Mile 5.0 on the south border of Lamar County, the north border of Delta County and upstream of Lake Wright Patman (Figure 4.1-1). The North Sulphur River is a tributary that joins the South Sulphur River at the borders of Red River and Franklin counties upstream of the potential Marvin Nichols I and II reservoirs. Existing major water supply reservoirs in the area are Lake Sulphur Springs, Lake Wright Patman and Lake Cooper. If developed, George Parkhouse II would be the first major impoundment on the North Sulphur river *(See Appendix, Exhibit B,George Parkhouse II).*

4.1.1.2 Impoundment Size and Volume

At the conservation pool elevation of 401.0 feet msl, the storage capacity and surface area of George Parkhouse II is 243,600 acre-feet and 12,300 acres respectively.[1] At the probable maximum flood (PMF) elevation of 415.7 feet msl, the reservoir surface area is 17,400 acres.[2] During the 100-year flood event, a surface area of 12,800 acres will be inundated to an elevation of 402.3 ft msl.[2] Reservoir area and capacity relationships shown below are taken from previous reports[1] and are based on planimeter and digitizer measurements of surface areas and corresponding elevations from U.S. Geological Survey 1:24,000 contour maps.

4.1.1.3 Site Geology and Topography

The George Parkhouse II damsite is in the Sulphur River Basin in the Coastal Plain physiographic province. It is characterized by low elevations and relief, with wide and extremely flat floodplains.

Two notable structural features are in the vicinity but south of the damsite: the East Texas Syncline, and the Mexia-Talco Fault System. The East Texas Syncline trends northeast-southwest and has affected the regional dip of the strata. The Mexia-Talco Fault System is composed of a series of en echelon grabens; individual faults having steep dips and near-surface displacements of several hundred feet.

The sediments of interest underlying the site are of Quaternary and Cretaceous ages. Bedrock is covered by deposits of alluvial terraces, and recent alluvial deposits in the valley bottom.

Alluvial terrace material is widespread in the area of the proposed dam. It consists of an upper zone of stiff hard clays and sandy clays, overlying but gradational with a zone of clayey, silty sands with pockets or layers of coarse sand and/or gravel. This lower sandy zone may terminate somewhere beneath the left abutment. Terrace materials were found to be about 40 to 60 feet thick along the proposed dam axis.

The recent alluvial deposits in the river valley have been estimated at 30 to 40 ft thick. They are reported to consist of medium to hard clays that become sandier with depth. The lower part of the alluvium consists predominantly of sandy clays or clayey silts. A lower zone of silty sand or fine sand is not present to the extent that it is typically present at other locations in the Sulphur River Basin.[3] Gravel, concretions, and shell fragments appeared in borings marking the contact with the underlying bedrock.

Bedrock consists of either the Marlbrook formation of the Taylor Group or the undifferentiated Navarro Group deposits. COE discusses the materials using soil characteristics and terminology, although others[4] describe the materials as bedrock. Boring log descriptions indicate that the materials are fissile shales. Degree of fissility and plasticity could not be evaluated from the information reviewed.

4.1.1.3.1 Geotechnical Conditions and Limitations

The recent alluvium and terrace deposits should be treated as sources for potential modes of failure with regard to embankment settlement, differential settlement, and slope stability. Adequate investigation is required to evaluate these materials for dam design. Loading upon the underlying bedrock and potential development of positive pore pressures therein should be considered to preclude potential slope stability issues.

COE states that settlement has been evaluated by others based on a few consolidation tests. The study reports that settlement would not be uniform and that the maximum amount of settlement expected (80 in, or 6.7 feet, occurring over the alluvial deposits and including both embankment and foundation settlement) would not be excessive. This is a large amount of settlement, especially considering that settlement is expected to be significantly less over the abutment terrace deposits.

COE reports that the terrace deposits may provide a significant path for seepage, particularly the terrace on the right abutment, between the North and South Sulphur Rivers. The recent alluvial deposits are not expected to provide a significant path for seepage based on the thick impervious upper zone and the limited quantity of relatively permeable materials underneath. Should they be required, seepage countermeasures could include cutoff walls.

The project is in seismic zone 1, a zone of minor seismic hazard. It lies north of the Mexia-Talco Fault System that has reportedly been inactive during Recent times, and is not considered to be an issue for a well-designed and constructed dam.[3] The site should be evaluated using modern seismic analyses methods to study dam performance under design earthquake loading.

River diversion studies have not been performed to date.

4.1.1.3.2 Construction Materials

No borrow materials investigation is known to have been conducted for the project. Available boring logs do not indicate the presence of significant sources of clean sands, sands that could easily be produced on-site, or gravels, materials that would be needed for construction of filters, drains, and concrete. The materials would be available from commercial producers along the Red River and Texarkana areas, at haul distances estimated at 60 to 80 miles. Stone suitable for rip-rap is reportedly not available in the area (1990) but would be available from commercial producers in southern Oklahoma at haul distances estimated at 40 to 80 miles.

It is anticipated that dam core and shell construction materials could be produced from alluvial and terrace deposits within the reservoir.

4.1.1.4 Dam Type and Size

The proposed spillway appears to be a gated ogee shaped spillway with the crest elevation at 390.0 ft msl. During the probable maximum flood, the proposed spillway will convey the peak discharge through eight 40 ft gated bays with approximately 5 ft of freeboard from the maximum water surface elevation to the top of dam elevation.[2]

4.1.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the proposed George Parkhouse II reservoir damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

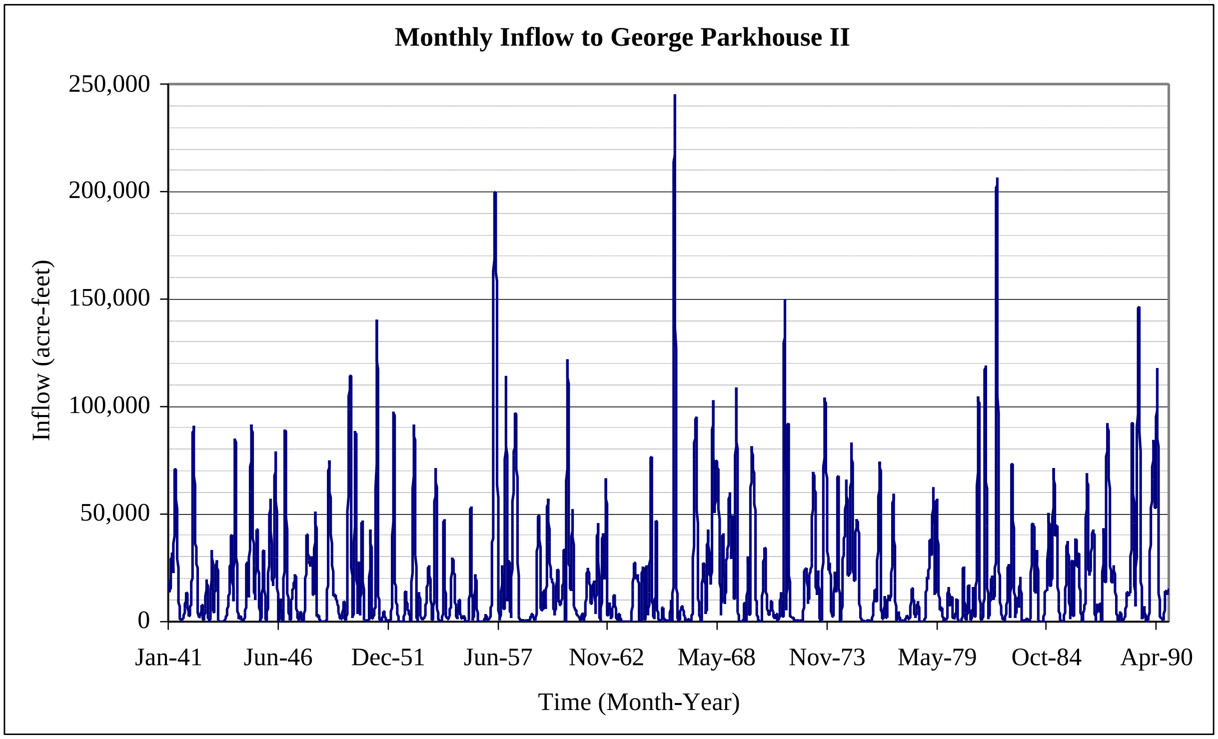
4.1.1.5.1 Reservoir Inflows

Daily reservoir inflows are developed from U.S. Geological Survey (USGS) historical flows originating below major reservoirs upstream of the proposed George Parkhouse II site. To derive the naturalized flows from the historical flows, daily flows are converted to monthly flows, and adjustments are made to these to account for diversions for upstream water rights and monthly spills from upstream major reservoirs. The adjusted monthly inflows are converted back to daily values using the historical pattern of flow from nearby USGS gauges.[5]

Figure 4.1-2 depicts the reservoir inflow from the 1996 North Texas Municipal Water District for the period from January 1941 through April 1990 prepared by Freese and Nichols. This period of record may be expanded to capture more recent inflow data. For George Parkhouse II, the reservoir inflow equations assume no other new reservoirs are constructed. Inflow equations are based on drainage area ratios which vary depending on the location and size of the proposed reservoir and the corresponding location and size of the nearby U.S. Geological Survey (USGS) gaging station. Reservoir inflow values are similar to previously reported values from the 1990 Freese and Nichols study that are updated to include:

- A longer period of record (extended from 1986 through 1990).
- Changes to water rights since the previous studies were completed.
- The impact on yield of the Environmental Water Needs Criteria adopted by the Texas Water Development Board, the Texas Department of Parks and Wildlife, and the Texas Natural Resource Conservation Commission.

Figure 4.1-2 Daily Reservoir Inflow Curve



4.1.1.5.2 Firm Yield

The TWDB 31 TAC 357.7(a)(3) as shown in Exhibit B requires "an evaluation of adequacy of current water supplies available to the regional water planning area for use during drought of record. This evaluation shall consider surface water and groundwater data from the State Water Plan, existing water rights, contracts and option agreements, other planning and water supply studies, and analysis of water supplies currently available to the regional water planning area. Analysis of surface water available during drought of record from reservoirs shall be based on firm yield analysis of reservoirs."[6]

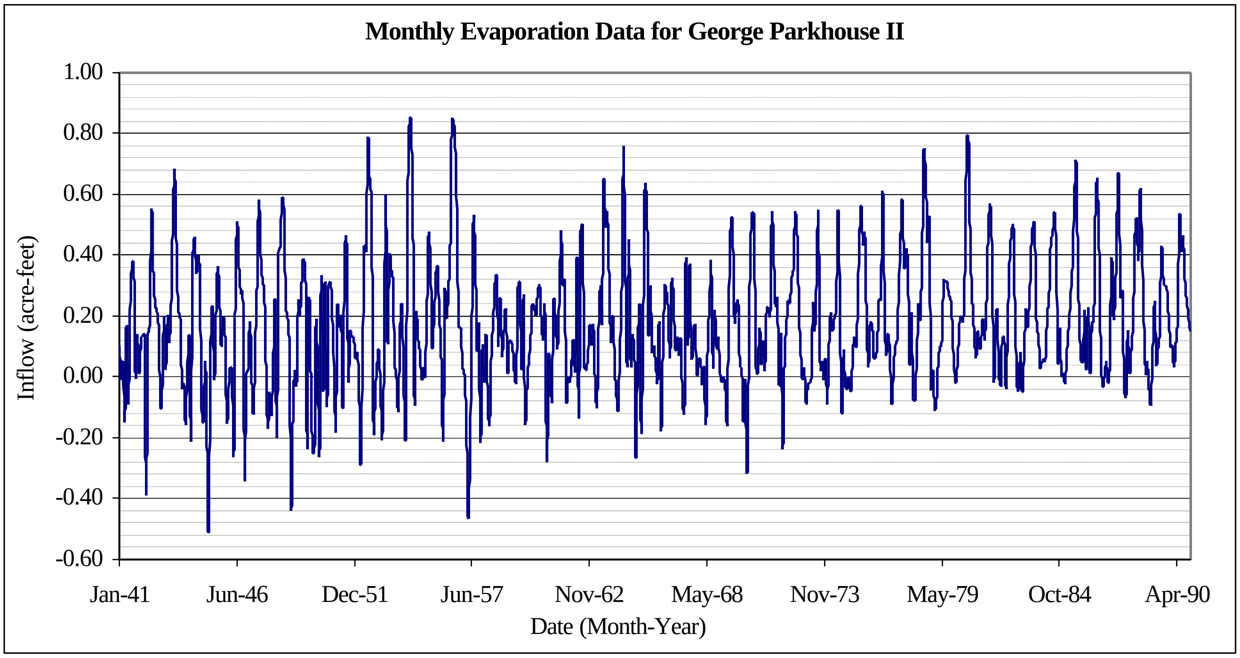
Firm yield studies are summarized for George Parkhouse II in the section below entitled, "Project Yield for Water Supply."

4.1.1.5.3 Reservoir Evaporation

Reservoir evaporation data was estimated by Freese & Nichols in the 1990 Regional Water Supply Plan using guidelines published by the Texas Water Development Board. The net evaporation used in the reservoir operation studies have been calculated as the difference between gross reservoir evaporation and precipitation, with positive values representing conditions when evaporation exceeds precipitation. Daily evaporation values are assumed to be constant within each month. See

Figure 4.1-3 for the monthly evaporation rates curve.

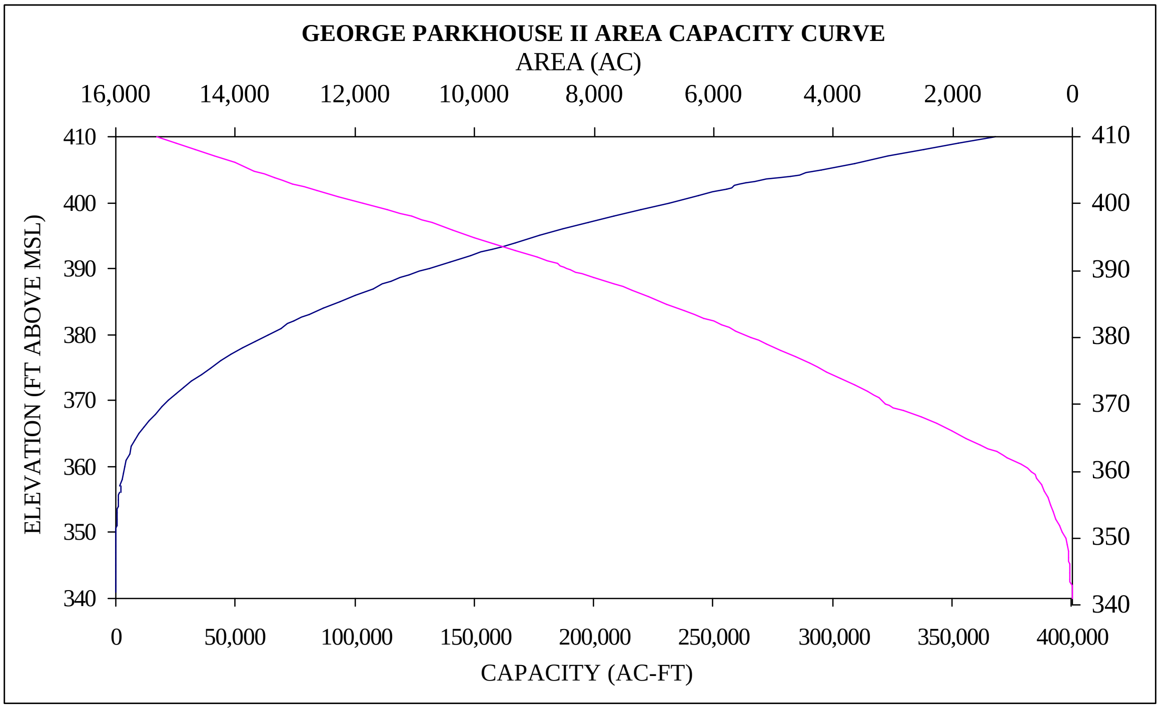
Figure 4.1-3 Monthly Evaporation Rates Curve



4.1.1.5.4 Area Capacity Data

The elevation-area-capacity relationship (also referred to as an area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. The relationship is based on the topographic characteristics of the land to be inundated by the reservoir. Reservoir area and capacity relationships shown below are summarized from previous reports[1] and are based on planimeter and digitizer measurements of area and elevation from U.S. Geological Survey 1:24,000 contour maps. During the life of the reservoir, sediment deposition within the reservoir typically alters that relationship and reduces the capacity of the reservoir. Sediment deposition is distributed in various zones of a reservoir at differing rates, depending on the shape of the reservoir and other factors such as the type of sediment from the tributary basin. Previous studies have apparently not considered sedimentation reductions in their area-capacity studies as shown in Figure 4.1-4.[1]

Figure 4.1-4 Area Capacity Curve



4.1.1.6 Water Quality

The examination of water quality is based upon existing water quality and streamflow data provided by the U.S. Geological Survey (USGS) and the Texas Water Commission (TWC). Water quality data for George Parkhouse II was recorded at a single location in the North Sulphur River near Cooper, Texas from 10/79 to 07/87. The water quality analyses include an evaluation of inorganic parameters and biological contaminants, if available. The water quality standards considered are taken from the following agencies: EPA National Primary Drinking Water Regulations, EPA Secondary Drinking Water Regulations, 1986 EPA Quality Criteria for Water, Texas Department of Health Primary and Secondary Drinking Water Regulations, and 1988 Texas Surface Water Quality Standards (TSWQS). The comparison provides an indication of the degree of treatment required for the George Parkhouse II water source. Table 4.1-1 provides a comparison of historical water quality data with Texas Water Quality Standards necessary to reservoir development.

Table 4.1-1 Water Quality Data

Parameter	*Unit*	*1988 Texas Surface Water Quality Standards*	*Historical Physical and Chemical Water Quality Data*	
			Flow Weighted Average	*Range of Data*
Arsenic	(µg/l)	360/190	–	–
Barium	(µg/l)	–	–	–
Cadmium	(µg/l)	32.9/1.12	–	–
Calcium	(mg/l as $CaCO_3$)	–	96.5	105–473
Chloride	(mg/l)[c]	190	5.6	3.1-260
Chromium	(µg/l)	1,708/203	–	–
Copper	(µg/l)	18.8/12.6	–	–
Dissolved Oxygen	(mg/l)[a]	5.0	–	–
Fecal Coliform	(# / 100 ml)[b]	200	–	–
Fluoride	(mg/l)	–	0.15	0.1-0.7
Iron	(mg/l)	–	–	–
Langelier Index[f]		–	–	Moderate
Lead	(µg/l)	79.6/3.1	–	–
Magnesium	(mg/l)	–	2.3	1.9-30
Manganese	(mg/l)	–	–	–
Mercury	(µg/l)	2.4/0.012	–	–
Nickel	(µg/l)	1,394/155	–	–
Nitrate	(mg/l)	–	–	–
pH		6 – 8.5	–	7.7–8.1
Selenium	(µg/l)	260/35	–	–
Silver	(µg/l)	3.92/0.49	–	–
Sodium	(mg/l)	–	10.5	8.2-230
Sulfate	(mg/l)[c]	475	30	19-750
Total Alkalinity	(mg/l as $CaCO_3$)	–	93	54-200
Total Dissolved Solids	(mg/l)[c]	1320	160	143-1500
Total Hardness	(mg/l as $CaCO_3$)	–	107	99-590
Turbidity	(NTU)	–	–	–
Zinc	(µg/l)	115/104	–	–

Notes:
(a) No measurements should fall below this value.
(b) Thirty-day geometric mean not to exceed this value.
(c) Annual average not to exceed this value.
(d) Standards for arsenic and subsequent parameters are expressed as acute limit/chronic limit.
(e) Indicates the tendency of the raw water to become corrosive during cold weather.
mg/l = ppm (parts per million)
µg/l = ppb (parts per billion)
(f) Data in this report is based on analyses done at the time the reservoir was initially evaluated and the water quality evaluations were based on a comparison with standards that may have since changed.

Water quality data and standards reprinted from the 1990 Regional Water Supply Plan, by Freese and Nichols, Inc. and Alan Plummer and Associates, Inc. Contaminants of greatest concern include Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel, Selenium, Silver and Zinc. On occasions, the standards for some physical and inorganic parameters are violated for pH, chloride, sulfate, TDS, fecal coliform bacteria and dissolved oxygen, but those of greatest concern remain acceptable. The flow-weighted averages indicate the water supply would be acceptable for reservoir development to meet probable long-range receiving water and water supply criteria.

4.1.1.7 Project Yield for Water Supply

Firm yield as described in the SB1 Regional Water Plan by the State of Texas is "the maximum amount of water supply, based upon simulation, that a reservoir could have produced each year if it had been in place during the drought of record. Firm yield analyses reported in the 1997 Water for Texas and any other equivalent existing analyses are acceptable. All water availability based on firm yield must satisfy full utilization of senior water rights. Where special conditions exist, such as the Rio Grande Project, water available based on operating procedures during the drought of record conditions will be used in place of reservoir firm yield analysis. In performing a simulation for firm yield determination for a new site, the following criteria must be met".[1]

The basic procedures required in analyzing water availability in the river basin involve simulating on a monthly basis the ability of individual water rights to satisfy their authorized diversions or storage quantities under historical, but naturalized characteristics. By taking into account the wide range of historical naturally occurring streamflow conditions, the results provide a meaningful indication of the water available for the future. The Texas Water Development Board has criteria for determining firm yield analyses as outlined in Exhibit B of SB1 Regional Water Plan.

4.1.1.7.1 Reservoir Operation Summary

From the 1990 "Regional Water Supply Plan" developed by Freese and Nichols, Inc. & Alan Plummer and Associates, Inc.:

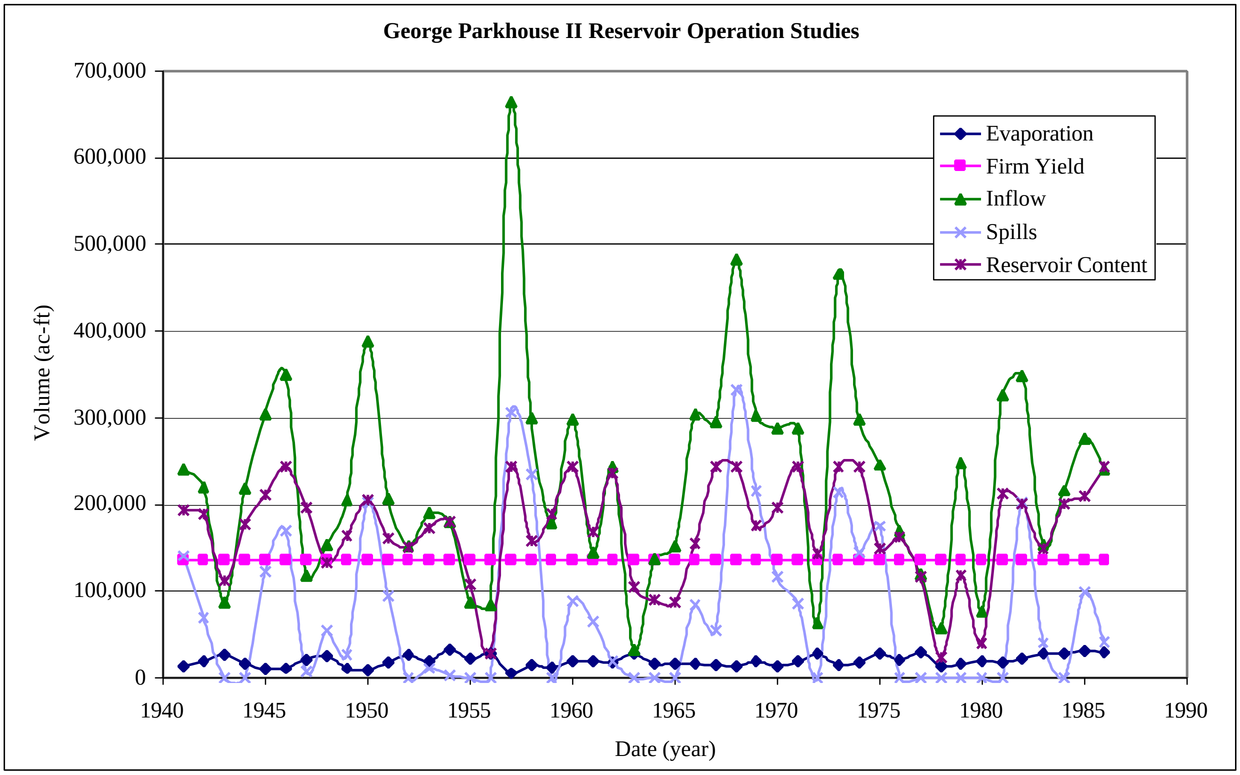
The yield available from the George Parkhouse II reservoir was calculated by computer operation studies using the following hydrologic data and operating assumptions:

- area and capacity characteristics
- runoff
- evaporation data
- Cooper Reservoir and Lake Sulphur Springs are operated at their full, permitted diversions. Spills from these reservoirs are available for use downstream.
- Releases are made from the reservoirs immediately upstream from Lake Wright Patman to keep the yield from that reservoir at its current level of 160,800 acre-feet per year.
- Other existing water rights are assumed to make full use of available flows to the extent of their permits.

Reservoir studies were completed using these assumptions to determine the additional yield made available. In addition, reservoir studies are the result of modeling the basin for George Parkhouse II with no other new reservoirs in place.[5]

The annual firm yield from George Parkhouse II under the operating assumptions above is 136,700 ac-ft/year (122.0 mgd). Figure 4.1-5 shows the summary of the reservoir operation studies reproduced in graphical format. Pass-through flows to satisfy environmental requirements were not included in the initial reservoir operation analysis.

Figure 4.1-5 Reservoir Operation Summary



4.1.1.7.2 Modified Reservoir Operation Study

A more recent study from the 1996 "North Texas Municipal Water District" by Freese and Nichols, Inc. shows the following assumptions and yield results to include pass-through flows:

The yields for the proposed project under various assumptions are determined by daily reservoir operation studies with pass-throughs of inflow as specified in the "Environmental Water Needs Criteria".[1] The pass-through requirements as used in the reservoir operation studies are shown in the following Table 4.1-2.

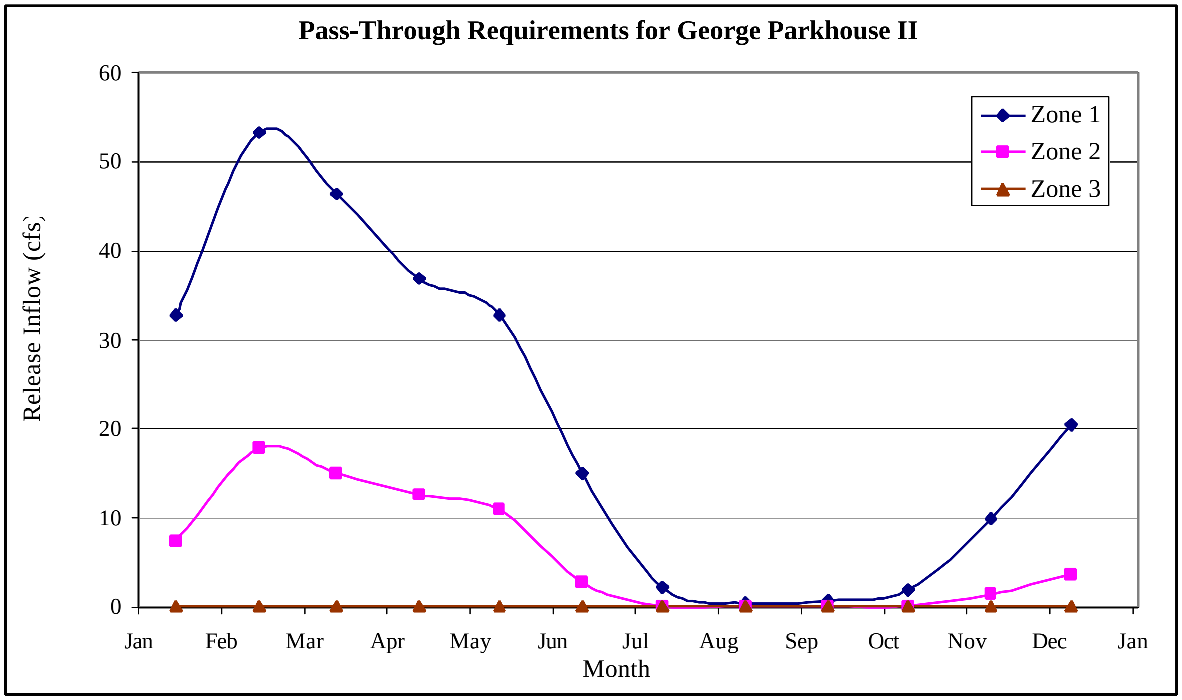
Table 4.1-2 Environmental Flow Requirements

Zone	*Goal*	*Content (%)*	*Content (af)*
1	Median	>80%	>194,890
2	25%	50-80%	121,807 – 194,890
3	7Q2	<50%	<121,807

The flushing flow (1.5 year event) is 13,123 cfs.
Note: 0.1 cfs is used for the actual 7Q2 value of 0.0 cfs, as in TNRCC Published values.

The amount of flow released for pass-through requirements varies by month and reservoir content level as shown in Figure 4.1-6.

Figure 4.1-6 Pass-Through Flows



The modified reservoir operating assumptions studied are as follows:

- Capturing all Inflow
- Releases for Downstream Rights to Protect Wright Patman Diversions
- Releases for Downstream Rights to Protect Wright Patman Diversions and Environmental Flow Criteria
- Releases for Downstream Rights to Protect Wright Patman Elevation
- Releases for Downstream Rights to Protect Wright Patman Elevation and Environmental Flow Criteria

Table 4.1-3 lists by row and column the effects the above mentioned alternate reservoir operating assumptions have on the average annual yield. Increased downstream protection rights result in decreased reservoir yields. The estimated decreases in the annual yield due to the downstream protection right are based upon a 141,150 acre-ft per year (126 mgd) yield, noted in the updated 1996 Freese and Nichols, Inc. report. This is an increase from the earlier noted annual yield of 136,700 acre-ft per year (122 mgd).

Table 4.1-3 Annual Yield from George Parkhouse II under the Operating Assumptions Above

Operation Study	***Yield***
Capturing all Inflow	126 mgd (141,147 af/y)
Releases for Downstream Rights to Protect Wright Patman Diversions	119.5 mgd (133,866 af/y)
Releases for Downstream Rights to Protect Wright Patman Diversions and Environmental Flow Criteria	115.7 mgd (129,609 af/y)
Releases for Downstream Rights to Protect Wright Patman Reservoir Elevation	104.7 mgd (117,287 af/y)
Releases for Downstream Rights to Protect Wright Patman Reservoir Elevation and Environmental Flow Criteria	97.9 mgd (109,669 af/y)

The updated 1996 study shows a reduction in yield from the previous 1990 study due to the inclusion of the environmental flow requirements.

4.1.1.7.3 Updated Yield Studies

Additional yield studies were performed for purposes of this Reservoir Site Assessment. The recently completed TNRCC Water Availability Model (WAM) of the Sulphur River Basin and the Daily Reservoir Analysis Model, SIMDLYBE[7] were used to re-analyze the firm yield of the previously described reservoir configuration. The WAM model utilized the Water Rights Analysis Package (WRAP) computer program developed by the Texas Water Resources Institute of Texas A & M University. The WAM/WRAP model was used to develop monthly inflows to the reservoir and the SIMDLYBE model was then used to calculate the firm yield based on daily inflows distributed from the WAM monthly inflows. Specific steps followed in the calculation of the updated firm yield are listed below.

1. Add a control point to the dataset of the Sulphur River Basin WAM model at the location of the proposed dam. Execute the WRAP program to obtain monthly naturalized and regulated inflows for the damsite location.

2. Distribute both the naturalized and regulated monthly inflows into daily inflows using daily flows recorded at U.S. Geological Streamflow gauges which are most nearly representative of the flow at the damsite. In the case of George Parkhouse II, the stream gauge and time periods are presented in Table 4.1-4.

3. Conduct a statistical analysis of the naturalized daily flows to determine the environmental pass-through requirements in accordance with the Consensus Environmental Guidelines Planning Criteria of the State Water Plan.[8] The results of this statistical analysis are presented in Table 4.1-5. The seven-day/two year flows (7Q2) presented in this table are based on the records of Gauge No. 7343000.

4. Create a SIMDLYBE model of the proposed reservoir site using the regulated daily flows developed as described in Task 2 and the environmental pass-through (releases) obtained as described in Task 3. Execute this model for conditions with and without the environmental pass-through assumptions to calculate the firm yield of the proposed reservoir.

Table 4.1-5 presents the results of the updated firm yield analysis and a comparison of the most recent previous analysis with environmental pass-through.

Table 4.1-4 Pass-through (Release) Requirements for George Parkhouse II (cubic feet/second).

Zone	*Goal*	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
1	Median	42.4	55.0	47.4	47.3	41.6	18.5	3.3	0.7	1.1	4.3	17.8	27.4
2	25%	11.1	20.4	16.5	18.6	13.8	4.3	0.2	0.1	0.1	0.1	1.7	4.1
3	7Q2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

This Space Intentionally Left Blank

Table 4.1-5 Updated Firm Yield for George Parkhouse II.

Updated FIRM Yield				*Previous Analysis (FNI, 1996)*			
W/O Environmental Releases		***WITH Environmental Releases***		*WITH Environmental Releases (Protecting Wright Patman Diversion)*		*WITH Environmental Releases (Protecting Wright Patman Storage)*	
Acre Feet/Year	***MGD****	***Acre Feet/Year***	***MGD****	*Acre Feet/Year*	*MGD**	*Acre Feet/Year*	*MGD**
133,478	**119.2**	**131,850**	**117.7**	129,736	115.7	109,630	97.9

* Million Gallons per Day

** Updated firm yield with Environmental Releases has comparable assumptions to the previous analysis with Environmental Releases and Protecting Wright Patman Storage.

The updated study shows an increase in yield from the previous 1996 study. This can be attributed to the use of the Sulphur Basin WAM model which was not available in 1996. Other factors which will probably reduce the final yield are the exclusion of return flows from the design runoff in accordance with recent TNRCC guidelines and accounting for watershed runoff from the reservoir area in evaporation computations.

4.1.1.8 Other Potential Benefits

Other potential benefits may include hydropower generation, flood control, irrigation and recreation. No studies have been conducted to evaluate additional benefits.[2]

4.1.1.9 Land Acquisition and Easement Requirements

The acquisition of land and easement requirements includes land in the conservation pool to elevation 401.0 ft msl and flood easements for land above the conservation pool to elevation 406.0 ft msl. The take area for the reservoir system for purposes of this study is approximately 14,000 ac.

4.1.1.9.1 Potential Land Use Conflicts

This section discusses the results of field reconnaissance studies made to locate potential conflicts in terms of roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. The following shows the costs associated for the reservoir development conflicts. The costs are based on December 1989 prices.[2]

Table 4.1-6 Reservoir Conflicts Table

Roadway Conflicts	*Pipeline Conflicts*	*Cemetery Conflicts*	*Oil Field Conflicts*	*Miscellaneous Conflicts*	*Total*
$2,594,560	$0	$1,076,160	$0	$0	$3,670,720

The breakdown of the associated conflicts showing each roadway and cemetery conflicts was not available from the source data.

4.1.1.9.2 Local, State, and Federal Permitting Requirements

The 1996 study by Freese and Nichols discusses the need for the following four permits: 1) Water rights permits from the Texas Water Commission, 2) Section 404 permit from the U.S. Army Corps of Engineers, including all NEPA compliance, 3) Antiquities Permit from the Texas Antiquities Committee, and 4) Sand and Gravel Permit from the Texas Parks and Wildlife Department.

Table 4.1-7 Permitting Requirements

Permit	*Issuing Agency*	*Summary of Requirements*
Water Rights	Texas Water Commission	Engineering report; environmental effects report on water quality and fish and wildlife; water conservation plan; public hearing; may include mitigation requirements.
Section 404*/Section 10	U.S. Army Corps of Engineers	Description of proposed fill activities; preparation of environmental impact statement; may require special studies by applicant, including archeological survey, water quality studies, ecological studies and NEPA compliance; may include mitigation requirements.
Antiquities Permit	Texas Antiquities Committee	Archeological survey, testing and evaluation, and mitigation of important sites.
Sand and Gravel Permit	Texas Parks and Wildlife Department	$0.20 per cubic yard of sand, gravel or marl excavated from river channel

* Includes Section 401 Certification of Water Quality from State Agency (TWC)

No hydroelectric facilities are proposed for George Parkhouse II, therefore a license from the Federal Energy Regulatory Commission (FERC) is not required.

4.1.1.10 Updated Project Costs

Opinions of probable project cost for the George Parkhouse II Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1989.[5] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

Reservoir cost estimates that did not include an Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.

- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher cost estimate than the initial analysis, which estimated the project cost at $160,022,000. Please refer to

Table 4.1-8 for the Updated Project Cost and Table 4.1-9 for the Construction Cost.

4.1.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in

This Space Intentionally Left Blank

Table 4.1-8. The assumed average developed cost per acre of land for the reservoir was $550/ac. and the easement cost was $412.50/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 12,250 acres plus the additional surface area attained for easement, which together is approximately 14,000 ac.

4.1.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in

This Space Intentionally Left Blank

Table 4.1-8.

4.1.1.10.3 Construction Costs

As shown in Table 4.1-9, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

This Space Intentionally Left Blank

Table 4.1-8 Updated Project Costs

Description	***Quantity***	***Unit***	***Unit Price ($)***	***Cost ($)***	***Total Cost ($)***
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$59,792,100
Relocations (conflict resolution)		L.S.			$4,609,000
Construction Capital Costs (CCC) Subtotal:					**$64,401,100**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$22,540,400
Land Cost					$10,587,500
Land Purchase	12,250	Ac.	$550.00	$6,737,500	
Easements	1,750	Ac.	$412.50	$721,875	
Acquisition (15% of land)		L.S.		$1,010,625	
Contingencies (25% of land + easements + acquisition)		L.S.		$2,117,500	
Studies, Mitigation, Permitting					$14,125,500
Environmental Studies		L.S.		$200,000	
Archeological Studies	17,400	Ac.	$10.00	$174,000	
Geotechnical Studies		L.S.		$1,019,000	
Mitigation Costs (equal to land cost)		L.S.		$10,587,500	
Permitting		L.S.		$2,145,000	
Interest During Construction					$9,666,000
Other Project Costs Subtotal:					**$56,919,400**
			Jan. 1989 Subtotal:		$121,320,500
20-City Average Escalation Factor	31.9%				$38,701,240
OPINION OF PROBABLE PROJECT COST					**$160,022,000**

Notes:
1. Original cost estimates were taken from F&N, 1989.
2. The 35% engineering fee used in the cost estimate update covers the engineering design costs listed in the original estimate.
3. Mitigation costs were included.
4. Dam instrumentation cost was included with the construction costs.

Table 4.1-9 Construction Costs

Item #	*Description*	*Quantity*	*Unit*	*Unit Price ($)*	*Total Cost ($)*
	Excavation				
1	Approach Channel	107,400	C.Y.	$1.31	$ 140,690
2	Discharge Channel	114,600	C.Y.	$1.31	$ 150,130
3	Spillway	472,200	C.Y.	$1.20	$ 566,640
	Fill				
4	Impervious	1,107,200	C.Y.	$1.75	$ 1,937,600
5	Random	4,790,900	C.Y.	$1.75	$ 8,384,080
6	Filter, 1 & 2 (Foundation Drainage)	558,600	C.Y.	$10.00	$ 5,586,000
7	Bridge	390	L.F.	$720.00	$ 280,800
8	Roadway	96,067	S.Y.	$4.60	$ 441,910
9	Cutoff SlurryTrench	1,092,500	S.F.	$3.50	$ 3,823,750
10	Soil Cement	324,340	C.Y.	$16.00	$ 5,189,440
11	Elevator	1	ea.	$100,000.00	$ 100,000
12	Barrier Warning System	936	L.F.	$12.00	$ 11,230
	Gates				
13	Gate & Anchor (Install/paint)	4,480	S.F.	$155.00	$ 694,400
14	Stop Gate & List Beam	160	L.F.	$1,450.00	$ 232,000
15	Hoist	8	ea.	$118,000.00	$ 944,000
16	Electrical		L.S.		$ 320,000
17	Power Drop		L.S.		$ 144,000
18	Low Flow System		L.S.		$ 1,000,000
19	Monorail System	390	L.F.	$640.00	$ 249,600
20	Embankment Internal Drainage	39,300	L.F.	$38.00	$ 1,493,400
21	Guardrail	780	L.F.	$18.00	$ 14,040
22	Grassing	28	Ac.	$3,700.00	$ 103,600
23	Concrete (mass)	97,000	C.Y.	$125.00	$ 12,125,000
24	Concrete (walls)	7,000	C.Y.	$200.00	$ 1,400,000
25	Dam Instrumentation		L.S.		$ 1,000,000
26	Land Clearing	950	Ac.	$535.00	$ 508,250
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$ 46,840,600**
	Mobilization (5% of BCS)				$ 2,342,030
	Clearing/Grubbing, care of water (6% of Subtotal)				$ 2,810,440
				Subtotal:	$ 51,993,070
	OH & P (15% of Subtotal)				$ 7,798,970
	Construction Capital Cost Subtotal (CCC)				**$ 59,792,100**

4.1.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 131,850 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $192,027,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For George Parkhouse II Reservoir, the O&M is $966,020 and the annualized debt service is $11,330,100. The firm yield is then divided into the total annualized cost of

$12,296,120 to yield a unit cost of $93.26 per acre-foot ($0.29/1,000 gal) of firm yield. These annualized costs are summarized in contained in the executive summary.

4.1.2 Environmental Overview –Affected Environment and Environmental Consequences

4.1.2.1 Geological Elements

4.1.2.1.1 Physiography

The proposed reservoir is located within the Blackland Prairies. The Blackland Prairie covers approximately 12.6 million acres of land. It averages 30-45 inches of precipitation annually with 230 to 280 frost-free days. The topography is nearly level to rolling with an elevation of 250 to 700 feet above mean sea level (msl). The Blackland Prairie area intermingles with the Post oak Savannah in the southwest and has division known as the San Antonio and Fayette Prairies. This rolling and well-dissected prairie represents the southern extension of the true prairie that occurs from Texas to Canada.

The upland Blacklands are dark, calcareous shrink-swell clayey soils, changing gradually with depth to light marls or chalks. Bottomland soils are generally reddish brown to dark gray, slightly acid to calcareous, loamy to clayey and alluvial. The soils are inherently productive and fertile, but many have lost productivity through erosion and continuous cropping.

The Blackland Prairie is characterized by little relief and dark, thick, plastic clay soils. All outcropping strata are generally classified as sedimentary. The exposed bedrock is composed of nearshore and shoreline marine sediment deposited at the edge of the Gulf Coast Embayment by a shallow Cretaceous sea existing approximately 100 million years ago. Sediment deposited in this sea consists of sand, silt, and clay and formed layers that incline eastward toward the embayment at an average rate of 45 feet per mile.

4.1.2.1.2 Geology

The area of the proposed reservoir was formed during the upper cretaceous period. The area is composed of Navarro Group undivided, Marlbrook Marl, Fluviatile terrace deposits and Alluvium.

The upper part of the Navarro Group is mostly clay, silty, and in parts sandy, which increases downward. This portion is calcareous, glauconitic, with calcareous concretions common with some cone-in-cone. It is medium gray to bluish gray. The weathers are light yellowish gray and medium greenish gray. Marine megafossils are scarce. The lower part is mostly sand, silty, clayey, weakly coherent, light to medium gray. The weathers are light yellowish gray. Marine megafossils are abundant locally. It is indistinctly to thinly bedded. It has a thickness of 500-775 feet.

Marlbrook Marl is slightly glauconitic in the upper part and highly plastic when wet. It is strikingly uniform throughout and is medium bluish gray to yellowish gray. The weathers are light gray to white and forms smooth, rolling topography. Marine megafossils are scarce. It has a thickness of 150 to 450 feet and thins eastward.

Fluviatile terrace deposits are mostly sand, silt, and some clay. It is moderately well bedded, mostly red to tan in color. It is surface scrools with immature soils and a weakly developed or locally not recognizable B-horizon. Fresh-water and terrestrial molluscan faunas are sparse. The maximum thickness if 30 feet.

Alluvium are 100 year floodplain deposits. It is found within the Red River drainage system and includes low terrace deposits not readily distinguishable on high altitude aerial photographs. The top surface is 8 +/ - 3 feet above the floodplain.

4.1.2.1.3 Soils

The proposed reservoir footprint would be located within fourteen major soil associations.[9] Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.)generally associated with the location where the soil types are found, within the projected site.

Annona

The Annona series consists of very deep, moderately well-drained, very slowly permeable soils formed in clayey alluvial terrace sediments. These soils are on nearly level to moderately sloping Pleistocene terraces ranging from 0 to 8 percent. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the projected reservoir site. Thornthwaite annual P-E index ranges from 64 to 78. A saturated zone is perched above the Bt horizon for short periods following heavy rains. Almost all of this soil is in pasture and woodland. Forests are mixed hardwood and pine. Major hardwood species are red oak, post oak, sweetgum, and hickory. Needleleaf trees are predominantly shortleaf and loblolly pine. Pastures include improved bermudagrass, common bermudagrass, bahiagrass, with arrowleaf clover, crimson clover, and vetch overseeded. Some areas are used for growing corn, soybeans, grain sorghum, wheat, or hay crops.

Ashford

The Ashford series consists of very deep, poorly drained, very slowly permeable soils that formed in clayey alluvium on terraces of Pleistocene age. Slopes range from 0 to 1 percent. Mean annual precipitation ranges from 42 to 55 inches. The mean annual temperature ranges from 63 to 67 degrees F. Elevation ranges from 225 to 275 feet above msl. Frost-free days range from 235 to 270. Thornthwaite P-E indexes exceed 64. Ashford soils are ponded for long periods during the rainy season. The majority of this soil is woodland. Native vegetation includes red oak, water oak, willow oak, post oak, hickory, and green ash. Understory vegetation is mainly longleaf uniola, broomsedge bluestem, rushes, sedges and hawthorn. Some areas are cleared and farmed to soybeans and rice. A few areas are used for pasture.

Bernaldo

The Bernaldo series consists of very deep, well-drained, moderately permeable soils that formed in loamy alluvial deposits. The soils are on nearly level to moderately sloping stream terraces. Slopes are dominantly less than 5 percent but range from 0 to 8 percent. Bernaldo soils are on nearly level to moderately sloping areas about 10 to 130 feet above present streams. The average annual precipitation ranges from 40 to 48 inches and the mean annual temperature ranges from 64 to 68 degrees F. Frost-free days range from 240 to 260 and elevation ranges from 200 to 550 feet above msl. Thornthwaite annual P-E indexes range from 64 to 84. Most acreage is in woodland with dominant pine species of loblolly and shortleaf and many oak species and other southern hardwoods. Some areas are in pasture. Pastures are mainly in improved or common bermudagrass, bahiagrass, overseeded with legumes of crimson and arrowleaf clovers, vetch or singletary peas. Small areas are farmed to corn, small grains for grazing, sorghum for grazing and hay, and truck crops.

Derly

The Derly series consists of very deep, poorly drained, very slowly permeable soils mainly on Pleistocene Age Terraces formed in loamy and clayey sediments about 30 to 80 feet above present floodplains. Slopes range from 0 to 1 percent. The average annual temperature ranges from 63 to about 68 degrees

F.; the average annual rainfall ranges from 36 to 46 inches. Frost-free days ranges from 230 to 275, and the elevation ranges from 150 to 400 feet above msl. Thornthwaite P-E index ranges from 60 to 68. Water is ponded on the surface for brief to long periods during the winter and spring seasons of most years. Most of the acreage is in pasture and woodland. Native vegetation is an overstory of elm, post oak, willow oak, and water oak. Grasses include such species as beaked panicum, longleaf uniola, and sedges. Bermudagrass, dallisgrass, and fescuegrass are the dominant pasture plants.

Eylau

The Eylau series consists of deep, moderately well-drained, moderately slowly permeable soils that formed in thick loamy Coastal Plain sediments on uplands. Slopes are dominantly 1 to 2 percent but range from 0 to 5 percent. Mean annual precipitation ranges from 45 to 55 inches. Mean annual temperature ranges from 64 degrees to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64 inches. A perched water table is at 2 to 3 feet below the surface from February to May. Most of the acreage is in improved pasture of bermudagrass, bahiagrass, dallisgrass, and pine-oak woodland. A few areas are used for cropland. Native vegetation consists of loblolly pine, southern red oak, sweetgum, post oak, hickory, beaked panicum, longleaf uniola, and annuals.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Gladewater

The Gladewater series consists of very deep, somewhat poorly drained, very slowly permeable soils on floodplains formed in clayey alluvium in floodplains. Slope ranges from 0 to 1 percent. The mean annual precipitation ranges from 38 to 46 inches and mean air temperature ranges from 64 to 68 degrees F. Frost-free days range from 235 to 275 days and elevation is 200 to 400 feet above msl. Thornthwaite P-E index ranges from about 62 to 74. Depressional areas are very poorly drained. Most of the acreage is in pasture or forest. Some areas are in native pasture or range. Pasture areas are introduced grasses such as dallisgrass and fescue. Forested areas are in mixed hardwoods including water oak, willow oak, cedar elm and black willow.

Kaufman

The Kaufman series consists of very deep, moderately well-drained, very slowly permeable soils on floodplains formed in clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 2 percent. Mean annual precipitation ranges from 35 to 50 inches, and mean annual temperature ranges from 62 to 70 degrees F. Frost-free days range from 230 to 280 days and elevation ranges from 100 to 550 feet above msl. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in pasture of dallisgrass, bermudagrass, and fescues. A few areas are used for producing cotton, corn, sorghums, and soybeans. Native vegetation is hardwoods such as elm, hackberry, oak, ash, and grasses which includes species of andropogon, paspalum, panicum, and tripsacum.

Raino

The Raino series consists of very deep, moderately well-drained, very slowly permeable soils on stream terraces or remnants of terraces on erosional uplands 50 to 200 feet above present stream terraces in loamy and clayey sediments. Slopes range from 0 to 2 percent. The mean annual precipitation is 40 to 48 inches. Frost-free days range from 235 to 275 and elevation ranges from 250 to 450 feet above msl. The average annual temperature is 64 to 69 degrees F. and the Thornthwaite P-E index is 64 to 84. Most of the acreage is in pasture. Bermudagrass, pensacolagrass, bahiagrass, and dallisgrass are the dominant pasture plants. Some native grasses include longleaf uniola, beaked panicum, purpletop, and bluestems. Overstory is mainly blackjack oak, post oak, hickory, water oak, elm, and pine in the eastern portion of series province.

Sacul

The Sacul series consists of very deep, moderately well-drained, slowly permeable soils that formed in acid, loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 2 to 25 percent but range from 1 to 40 percent. The average annual air temperature ranges from about 60 to 66 degrees F and the average annual precipitation ranges from about 48 to 54 inches. Most of the acreage is in woodland, with some area in pasture. The forest vegetation is shortleaf and loblolly pine, red oak, sweetgum, and dogwood. Bermudagrass and bahiagrass are the principal pasture grasses used.

Sawyer

The Sawyer series consists of very deep, moderately well-drained, slowly permeable soils that formed in loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 1 to 8 percent but range to 25 percent. The average annual temperature ranges from about 60 to 66 degrees F. and the average annual precipitation ranges from about 48 to 54 inches. Most areas of this soil are in forests of loblolly and shortleaf pine. Cleared areas are dominantly used for pasture. The native vegetation was mixed shortleaf pine and hardwood forest.

Talco

The Talco series consists of deep, somewhat poorly drained, slowly permeable soils on stream terraces on remmants there of 50 to 200 feet above present streams in loamy alluvial sediments of Pleistocene Age. Slopes range from 0 to 2 percent. Mean annual precipitation is 42 to 48 inches. Mean annual temperature ranges from 62 to 66 degrees F. and the Thornthwaite annual P-E index ranges from 68 to 76. Ponding occurs for brief periods during the winter and spring months. Most of the acreage is in forest and pasture. Forest vegetation includes willow oak, water oak, post oak, red oak, sweetgum, black gum, elm, and loblolly pine.

Texark

The Texark series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in clayey alluvium floodplains that drain mainly from the Blackland Prairies. Slopes are 0 to 1 percent. Average annual precipitation ranges from 40 to 55 inches, average annual temperature is 62 degrees to 70 degrees F. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in forest, pasture, and wildlife habitat. Native vegetation conaiata of hardwood trees such as green ash, hackberry, water oak, willow oak, elm, and sweetgum. Understory vegetation consists of hawthorns, sedges, grasses, and annual weeds.

Woodtell

The Woodtell series consists of soils that are deep to stratified shale and loamy materials on gently sloping stream divides. They are well-drained and very slowly permeable. The slope ranges from 1 to 20 percent. Woodtell soils are strongly to moderately steep side slopes of uplands. Slope gradients are mainly 2 to 12 percent but range from 1 to 20 percent. The soils formed in materials weathered from unconsolidated, stratified loamy, clayey, and shaly materials of Eocene age mainly in the Wilcox and Cook Mountain formations. The average annual rainfall ranges from 40 to 46 inches. The mean annual temperature is about 62 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 78. Frost-free days range from 230 to 270 and elevation ranges from 300 to 650 feet above msl. These soils are used mainly for pasture. Native vegetation is mainly post oak, blackjack oak, elm and red oak in a fairly dense savannah. In open areas tall and mid grasses such as bluestems, tridens and panicums are common with longleaf uniola under the tree canopy. American beautyberry and hawthorn species are also a part of the understory. The main pasture plants are bermudagrass and bahiagrass with crimson and arrowleaf clovers. There are scattered shortleaf and loblolly pine with small plantations and a some dense pine areas on the eastern side of the series province. Some areas are planted to small grain for winter grazing.

4.1.2.2 Hydrological Elements

4.1.2.2.1 Surface Water

The proposed reservoir would be located within the Sulphur River Basin. It would cover approximately 11,018 acres with a normal pool elevation of 401 msl. This portion of the Sulphur River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0305 (North Sulphur River). This 48-mile stream segment originates at the confluence with the South Sulphur River in Lamar County and continues to a point 4.2 miles upstream of FM 68 in Fannin County. This segment is classified as "water quality limited" and designated uses are for contact recreation and high aquatic life.

Total permitted facilities along this segment are described as follows (Table 4.1-10).[10]

Table 4.1-10 Permitted Facilities

Type	*Quantity*	*Volume*
Domestic	2 outfalls	0.12 MGD
Industrial	3 outfalls	0.3 MGD
Agricultural	1 outfall	0.00 MGD
Total	6 outfalls	0.42 MGD

Due to elevated levels of fecal coliform, the lower 25 miles of this segment does not meet the contact recreation use.

4.1.2.2.2 Ground Water

Lamar and Delta County are located within the Trinity Aquifer. The proposed reservoir, George Parkhouse II, is within the downdip portion of the Trinity Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. Some water-bearing formations dip below the surface and are covered by other formations. This is the downdip. Water from the Antlers portion of the Trinity Aquifer is mainly used for irrigation in the outcrop area of North and Central Texas.

The Trinity Aquifer consists of early Cretaceous age rocks of the Trinity Group formations which occur in a band from the Red River in North Texas to the Hill Country of south-central Texas and provides water in all or part of 55 counties. Usable quality water (containing less than 3,000 mg/l dissolved solids) occurs to depths of up to about 3,500 feet.

Water quality from the Trinity Aquifer is acceptable for most municipal and industrial purposes, however excess concentrations of certain constituents in many places exceed drinking-water standards for municipal supplies. Heavy pumpage and water-level declines in the north central Texas region have contributed to deteriorating water quality in the aquifer. Water quality naturally deteriorates in the downdip direction of all the Trinity water-bearing units.

4.1.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The proposed reservoir will cause water to be impounded on the North Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river as well as affected streams and tributaries.

The development of the proposed George Parkhouse II reservoir would greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

4.1.2.4 Biological Elements

4.1.2.4.1 Vegetation

The proposed George Parkhouse II reservoir is centrally located within the Texan province[11] and is within the Blackland Prairie region.[12] The Blackland Prairie vegetation area typically has a gently rolling to nearly level topography, which is well dissected and marked by the rapid surface drainage. The soil composition for this community is very fertile consisting of dark-colored alkaline clays mixed with gray acidic sandy loams. Blackland Prairie soils support a tall-grass prairie dominated by little bluestem. Other important grasses within the Blackland Prairie refion are big bluestem, Indiangrass, switchgrass, sideoats grama, hairy grama, tall dropseed, silver bluestem, and Texas winter grass. Under heavy grazing, Texas winter grass, buffalo grass, Texas grama, and many annuals increase or invade the land. Various post oak wooded areas dot the landscape as well as areas of pecan, cedar elm, soapberry, honey locust, sugar hackberry, and Osage orange. Invasive mesquite is common in disturbed areas. Most of the Blackland Prairie has been lost to other land uses. Only a few remnants are protected as hay meadows or conservancy land.

According to the Vegetation Types of Texas, the Texas Parks and Wildlife Department (TPWD) divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into forty-six major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the proposed George Parkhouse II reservoir location include post oak wooded (49%) and crops (51%).

According to *Water and Wildlife, 1990*, The proposed George Parkhouse II reservoir site contains four cover types within its proposed boundaries. The resource categories are: grasses (37%), crops (28%), mixed bottomland hardwood forest (17%), and other (18%).[13]

4.1.2.4.2 Fish and Wildlife

The proposed George Parkhouse II reservoir would result in a decrease of stream and terrestrial habitat, and an increase of deepwater and shoreline habitat.

The proposed George Parkhouse II reservoir is located within the Prairies and Lakes Eco-region. Some of the common wildlife in this region includes the plains pocket gopher, beaver, raccoon, porcupine, Texas kangaroo rat, hispid cotton rat, ornate box turtle, green-winged teal, bobwhite quail, red-shouldered hawk, scissortail flycatcher, white-tailed deer, Brazilian freetail bat, ringtail, nine-banded armadillo, eastern hognose snake, tarantula, Texas horned lizard, golden cheeked warbler, black-capped vireo, northern mockingbird, and guadelupe bass. [14]

4.1.2.4.3 Endangered and Threatened Species

The U.S. Fish and Wildlife Service and TPWD combined lists for threatened, endangered, or rare species identify seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the proposed project location

Table 4.1-11). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 4.1-11 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Delta and Lamar Counties)

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Least tern	*Sterna antillarum***	LE	NL
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Blue Sucker	*Cycleptus elongatus*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Mollusks			
Ouachita rock-pocketbook mussel	*Arkansia wheeleri*	LE	E
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Arkansas meadow-rue	*Thalictrum arkansanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status

** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.

LE-Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range).

LT-Federally Listed Threatened (species which is likely to become endangered within the foreseeable future).

C1-Federal Candidate, Category 1; information supports proposing to list as endangered/threatened.

E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance.

DL, PDL - Federally Delisted/Proposed Delisted.

TPWD: Texas Parks and Wildlife Department Status

E-Listed as Endangered in the State of Texas.

T-Listed as Threatened in the State of Texas.

R-Rare, but with no regulatory listing status.
(Texas Department of Transportation, Annotated County Lists of Rare Species for Delta County, 1999.)
(Texas Department of Transportation, Annotated County Lists of Rare Species for Lamar County, 1998a.)

4.1.2.5 Ecologically Unique Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD-determined high importance potential ecologically unique streams within or adjacent to the footprint of the proposed George Parkhouse II reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.1.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The regulatory definition of wetland used by the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) for administering the Clean Water Act Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on three mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline, or boundary of a wetland, was not performed at any site, within ot immediately adjacent to the proposed Prairie Creek reservoir location. A general preliminary determination was preformed on the probability of wetland occurrence based upon hydra soils preliminarydeterminations and USFWS National Wetlands Inventory (NWI) maps. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current Natural Resource Conservation Service (NRCS) data shows six hydric soil associations are within the proposed George Parkhouse II reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

The USFWS's NWI maps were reviewed for the area to determine the following indications of wetland types.

Table 4.1-12 Existing Wetland Acreage Affected by Proposed Reservoir

Wetland Type	***Approximate Acreage***	***Percentage of Total Proposed Reservoir Area***
Palustrine Forested	1243	10%
Palustrine Scrub/Shrub	176	2%
Riverine	171	1%
Total	***1590***	***13%***

4.1.2.7 Wetland Mitigation Banks

Wetland Mitigation Banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation Banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Bank includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation Bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins Mitigation Bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM Mitigation Bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of the potential Big Sandy reservoir in the Sabine River floodplain.

There are no known existing or proposed Wetland Mitigation Bank projects that are located near or adversely affected by the proposed George Parkhouse II reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.1.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland hardwoods comprise almost one-third of the remaining native habitat of the state. The proposed George Parkhouse II reservoir would be located within the Sulphur River basin, which represents approximately 15 percent of the remaining bottomland hardwood areas in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the USFWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized by the USFWS according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the North East Texas 19-County Regional Water Planning area. There are no USFWS designated priority bottomland hardwoods located within or adjacent to the proposed George Parkhouse II reservoir [15] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.1.2.9 Conservation Easements

Conservation Easements, like Mitigation Banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, Conservation Easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no known Conservation Easements located within the footprint of the proposed George Parkhouse II reservoir.

4.1.2.10 Social and Economic Conditions

The proposed reservoir is located on the border of Lamar and Delta Counties. The population of these counties according to the 1990 census is 43,949 and 4,857, respectively. The Texas State Data Center has estimated the 2020 population to be approximately 47,057 and 4,564, respectively.[16] This corresponds to a seven- percent growth in Lamar County and a six- percent growth in Delta County. The median household income in 1989 for Lamar County was $21,551 and $20,208 Delta County.[17]

4.1.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they would be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the “Procedures for the Protection of Historic and Cultural Properties” (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The proposed George Parkhouse II reservoir and conveyance facility will affect portions of Lamar and Delta counties.

Historical and Archeological Resources for these two counties were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in

Table 4.1-13.[19]

Table 4.1-13 Historical and Archeological Resources for George Parkhouse II

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Delta	32	1	5	25	NA	1
Lamar	56	1	11	0	41	3

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 4.1-14) details the results of previous cultural studies that have been performed in the area since 1879. Although Delta County has been investigated more thoroughly than other counties for cultural resources due to federal mandated cultural surveys, there is the potential for additional archeological sites to be located in the area of the proposed reservoir. This is important to note because there is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Lamar County.[20]

Table 4.1-14 Evaluation of Existing Site Files, Northeast Texas Archeological Region

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Subtotal*
Delta**	42	49	15	8	114
Lamar	32	52	22	17	123
Total	**74**	**101**	**37**	**25**	**237**

* Significance refers to National Register criteria.
** Does not include all of Cooper Lake
Source: THC, 1993.

4.1.2.11.1 Cultural History

Based on reported investigations of the archeological sites, a chronological framework for the Northeast Texas Region has been determined and is presented in Table 4.1-15.

Table 4.1-15 Chronological Framework for the Northeast Texas Archeological Region

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.Table 4.1-16 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 4.1-16 Archeological Resources with Associated Periods

County	***Paleoindian***	***Archiac***	***Early Ceramic***	***Formative Caddoan Early Caddoan Middle Caddoan***	***Late Caddoan***
Delta			6	9	1
Lamar	1*		4	10	2

* Not sufficiently determined. Could be archaic.
Source: THC, 1993, and Perttula T. K., 1999.[21]

4.1.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

4.1.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the reservoir and within a one-mile buffer from the proposed reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is cropland and pasture. Table 4.1-17 depicts the percent coverage by major land uses within the proposed reservoir study area.[22]

Table 4.1-17 Land Use for the Proposed George Parkhouse II Reservoir Study Area

Land Use Category	***Percentage of Reservoir Study Area***
Cropland and Pasture	90%
Deciduous Forest Land	9%
Residential	1%

4.1.2.13 Regulated Materials

Available TNRCC data were used to determine the existence of recorded superfund clean-up sites, municipal solid waste landfill sites,... within the reservoir study area. The reservoir study area includes an area within the proposed extent of the reservoir and within a one-mile buffer from the proposed reservoir extent. The analyses indicate that there are no recorded Superfund clean up sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density at or near the proposed reservoir[23] site.

4.1.2.14 Potential Environmental Impact Summary

Table 4.1-18 Potential Environmental Impact Summary for George Parkhouse II

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown

---

[1] Freese and Nichols, Inc. Memorandum Report – Updated Water Project Opinion of Cost. 1996.

[2] Freese and Nichols, Inc. (FNI) and Turner Collie and Braden, Inc. (TC&B). 2000

[3] R.T.Saucier, U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Geological Reconnaissance of the Sulphur River and Cypress Creek Basins, Texas, November, 1967.

[4] United States Department of the Interior, Bureau of Reclamation, Texas Big Sandy Study, Supporting Material, Volume A, Engineering and Geology, July, 1990.

[5] Freese and Nichols, Inc., and Alan Plummer and Associates, Inc. Regional Water Supply Plan. Volume One – Report, and Volume Two – Appendices, Tarrant County Water Control and Improvement District Number One. 1990.

[6] Texas Water Development Board. Water for Texas. August 1997.

[7] TNRCC, 1999. Users Manual for Daily Reservoir Analysis Programs, SYMDLYBE (mainstem) & SMDYOC 99 (off-channel) Draft, December.

[8] Texas Water Development Board (TWDB), 1999. Planning Criteria of the Consensus State Water Plan, From TWDB web site, December.

[9] Natural Resource Conservation Service. 1998. Official Soil Series Descriptions [Online].Available: http://www.statlab.iastae.edu/cgi-bin/osd/osdname.cgi [May, 200].

[10] Texas Natural Resource Conservation Commission. 1996. *The State of Texas Water Quality Monitoring Program '96*. Austin, Texas. TNRCC.

[11] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[12] Gould, F. W. 1975 Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[13] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[14] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[15] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[16] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[17] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[18] Texas Historical Commission. 1998. Texas Historic Site Atlas [Online]. Available: http://atlas.thc.state.tx.us/ [2000, April].

[19] Texas Historical Commission. 1998. Texas Historic Site Atlas [Online]. Available: http://atlas.thc.state.tx.us/ [2000, April].

[20] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[21] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[22] www.tnris.state.tx.us

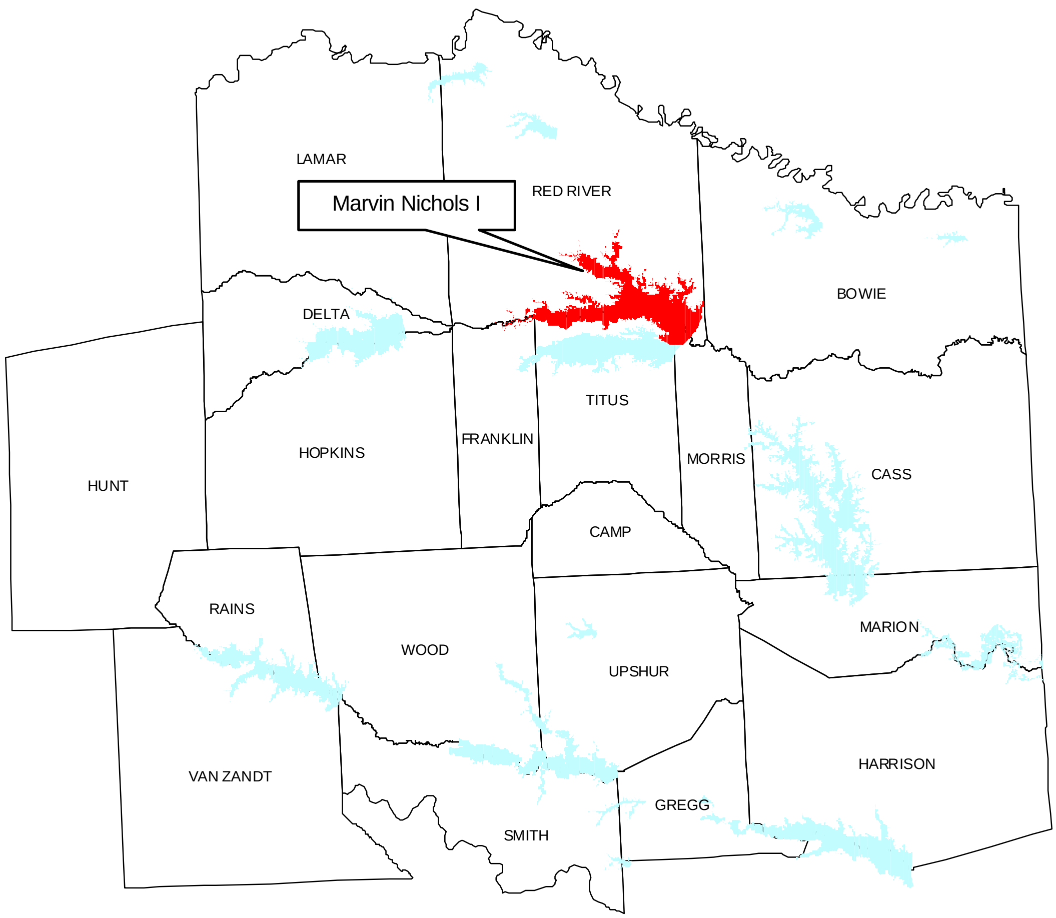
[23] www.tnris.state.tx.us

4.2 MARVIN NICHOLS I

4.2.1 Summary of Prior Studies

4.2.1.1 Location

Figure 4.2-1 Location of Marvin Nichols I within the Region D Planning Region



The Marvin Nichols I site is located about 120 miles east of Dallas and 45 miles west of Texarkana mainly in Red River County Figure 4.2-1. It is on the main stem of the Sulphur River at River Mile 114.7. The reservoir site is upstream of the confluence with White Oak Creek, a tributary that joins the proposed Sulphur River in Bowie and Morris counties. This project could be developed to meet local water supply needs as well as the needs of the Dallas/Fort Worth Metroplex,[1] by joining three existing major water supply reservoirs in the Sulphur River basin: Lake Sulphur Springs located upstream on White Oak Creek, Lake Wright Patman located downstream on the Sulphur River, and Lake Cooper located upstream of Marvin Nichols I on the South Sulphur River, see Exhibit C *(See Appendix, Exhibit C, Marvin Nichols I).*

4.2.1.2 Impoundment Size and Volume

At the conservation pool elevation of 312.0 feet mean sea level (msl), the storage capacity and surface area of Marvin Nichols I is 1,369,717 acre-feet and 62,128 acres respectively.[2] The storage capacity and surface area corresponding to the 100-year flood elevation of 312.8 feet msl is 1,420,243 acre-feet and

63,775 acres, respectively.[3] At the probable maximum flood (PMF) elevation of 319.1 feet msl, the reservoir contains 1,864,788 acre-feet and a surface area of 77,612 acres. Reservoir capacity and area relationships shown below are taken from previous reports and are based on planimeter and digitizer measurements of areas and elevations from U.S. Geological Survey (USGS) 1:24,000 contour maps.

4.2.1.3 Site Geology and Topography

The proposed Marvin Nichols I damsite is in the Sulphur River basin in the Coastal Plain physiographic province. It is characterized by low elevations and relief, with wide and extremely flat floodplains.

Two notable structural features are in the vicinity of the damsite: the East Texas Syncline, and the Mexia-Talco Fault System. The East Texas Syncline (south of the damsite) trends northeast-southwest and has affected the regional dip of the strata. The Mexia-Talco Fault System is composed of a series of en echelon grabens; individual faults in this system have steep dips and near-surface displacements of several hundred feet. This fault system is discussed below.

The sediments of interest underlying the site are of Quaternary and Tertiary ages. Bedrock is covered by deposits of alluvial terraces and recent alluvial deposits in the valley bottom.

Two alluvial terraces are widespread in the area of the proposed dam. They appear to differ mainly in age and topographic position, but are otherwise quite similar. Both consist of an upper zone of medium to hard, massive to irregularly layered clays, and silty to sandy clays, overlying a zone composed mainly of loose fine sand or silty sand with occasional clay layers. Gravels may be present at the contact of the terraces and underlying bedrock. These materials were found to be about 30 to 80 ft thick along the proposed dam axis.

The recent alluvial deposits in the river valley have been estimated at 40 to 60 ft thick. Borings in the area indicate a lithologic sequence quite similar to that of the terraces. The main differences being that the recent alluvium has a greater amount of sand in the upper, fine-grained alluvium, a possibly greater concentration of gravel near the bottom of the lower sandy portion, and uniformly lower consistencies and relative densities of all soils.

The underlying bedrock consists of undifferentiated Wilcox Group deposits from the Tertiary System. A 1967 report[4] discusses the materials using soils terminology, although others[5] describe the materials as bedrock. Test results and descriptions on boring logs indicate that the materials are typically shales and/or claystones, with possible sandstones and siltstones, although the latter may be shales/claystones with varying amounts of sand and silt fractions. Degree of fissility cannot be quantified from the available information. The materials are reported to be low to high plastic.

4.2.1.3.1 Geotechnical Conditions and Limitations

The reported low-strength materials in the recent alluvium and terrace deposits should be treated as sources for potential modes of failure with regard to main embankment settlement, differential settlement, and slope stability. Adequate investigation is required to evaluate these materials for dam design or to recommend their removal. Loading upon the underlying bedrock and potential development of positive pore pressures therein should be considered to preclude potential slope stability issues.

The sandy portions of the terrace and recent alluvium deposits may provide a significant path for seepage through the dam foundations and abutments, although the terrace material is considered as providing the greater potential seepage path.[4] Countermeasures could include an upstream impervious blanket and cutoff walls through the dam foundations.

According to Texas Department of Transportation (TxDOT) personnel and others, the possibility exists that excess hydrostatic pressures are present within the sandy materials below the upper clays in the riverbed alluvium. This is based on observations and opinions that have not been corroborated by studies. Available boring logs do not indicate this condition. The Carrizo-Wilcox aquifer is the major aquifer underlying the site; its condition and possible contribution to the situation could not be evaluated based on the information reviewed.

The possibility of such excess hydrostatic pressures is questionable considering the geologic setting and the possibility that the upper alluvium could be deposited to form a relatively impermeable blanket over a sufficiently large area for the pressures to develop. It would be prudent to assess the reported condition during a future subsurface exploration program for the dam.

The project is in seismic zone 1, a zone of minor seismic hazard. It is reported to lie between two faults of the Mexia-Talco Fault System, although the actual faults may be a few hundred to a few thousand feet from reported locations. The fault system has, however, reportedly been inactive during recent times, and is not considered to be an issue for a well-designed and constructed dam. The conditions described in previous paragraphs should be evaluated using modern seismic analyses methods to study dam performance under design earthquake loading.

4.2.1.3.2 Construction Materials

No borrow materials investigation is known to have been conducted for the project. Available boring logs do not indicate the presence of significant sources of clean sands, sands that could easily be produced on-site, or gravels, materials that would be needed for filters, drains, and concrete. The materials would be available from commercial producers along the Red River and Texarkana areas, at haul distances estimated at 25 to 40 miles. Stone suitable for rip-rap is reportedly not available in the area[5] but would be available from commercial producers in southern Oklahoma at haul distances estimated at 40 to 80 miles.

It is anticipated that dam core and shell construction materials could be produced from alluvial and terrace deposits within the reservoir.

4.2.1.4 Dam Type and Size

As envisioned, Marvin Nichols I main dam would consist of a 25,000 ft-long earth embankment constructed across the Sulphur River with an additional 29,000 ft-long earth embankment dike built along the low stream divide between the Sulphur River and the White Oak Bayou. In addition, four dikes will be required along low points along the stream divide varying in length from 2,000 ft to 8,000 ft. The final main dam crest would be 24 ft wide at an elevation of 330 ft msl. It would have a maximum height of about 71 ft at the floodplain crossing [4]. The embankment would have a height of about 26 ft for most of its length and maximum height of about 56 ft. A more recent study shows soil cement protection of the dam face, 3.5H:1V side slopes, a 22-foot wide roadway, and a slurry trench cutoff wall.

From flood routing studies, the spillway crest length of 940 ft was estimated by routing the probable maximum flood through the reservoir. The spillway system contains 19, 40-ft x 40-ft gates at a crest elevation of 285 ft msl.[3]

4.2.1.5 Hydrology and Hydraulics

The amount and distribution of natural streamflows throughout the basin tributary to the Marvin Nichols I damsite is fundamental to developing an appropriate analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering the development of new storage facilities for future water supplies and their associated new water rights. Potential yield analyses as established by reservoir operation studies under various operational assumptions have been the primary focus of recent reports with variations for changes in water records, water rights, and firm yield criteria. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, pass-through flows to satisfy existing downstream rights and environmental requirements, and reservoir area and capacity characteristics.

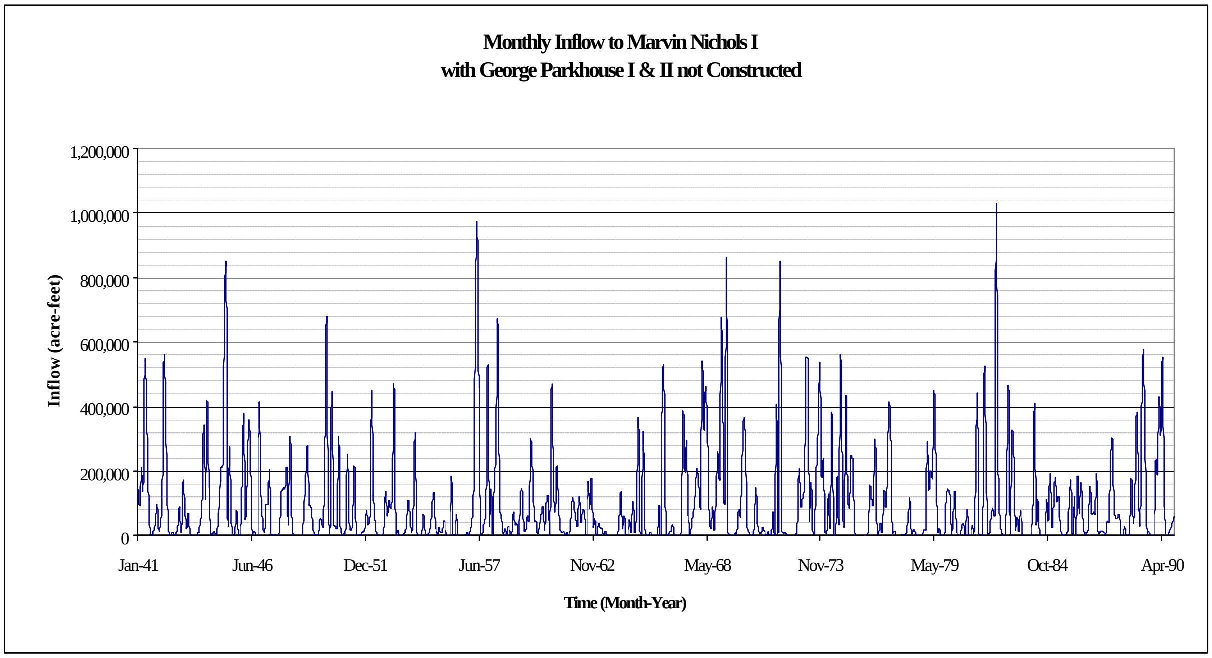
4.2.1.5.1 Reservoir Inflows

Daily reservoir inflows were developed from USGS historical flows originating below major reservoirs upstream of the proposed Marvin Nichols I site. To derive the naturalized flows from the historical flows, daily flows are converted to monthly flows, and adjustments are made to the flows to account for diversions for upstream water rights and monthly spills from upstream major reservoirs. The adjusted monthly inflows are converted back to daily values using the historical pattern of flow from nearby USGS gauges.[6]

Figure 4.2-2 shows the studies performed for from the North Texas Municipal Water District for the period from January 1941 through April 1990. This period of record may be expanded in the future to include more recent inflow data. For Marvin Nichols I, the reservoir inflow equations used assumed George Parkhouse II was not constructed, therefore inflow estimates were based only on drainage area ratios. Reservoir inflow values are similar to previously reported values from the 1990 study that are updated to include:

- A longer period of record (extended from 1986 through 1990 instead of 1941 to 1990).
- Changes to water rights since the previous studies were completed.
- The impact on yield based on the Environmental Water Needs Criteria being considered by the TWDB, the TPWD, and the TNRCC.

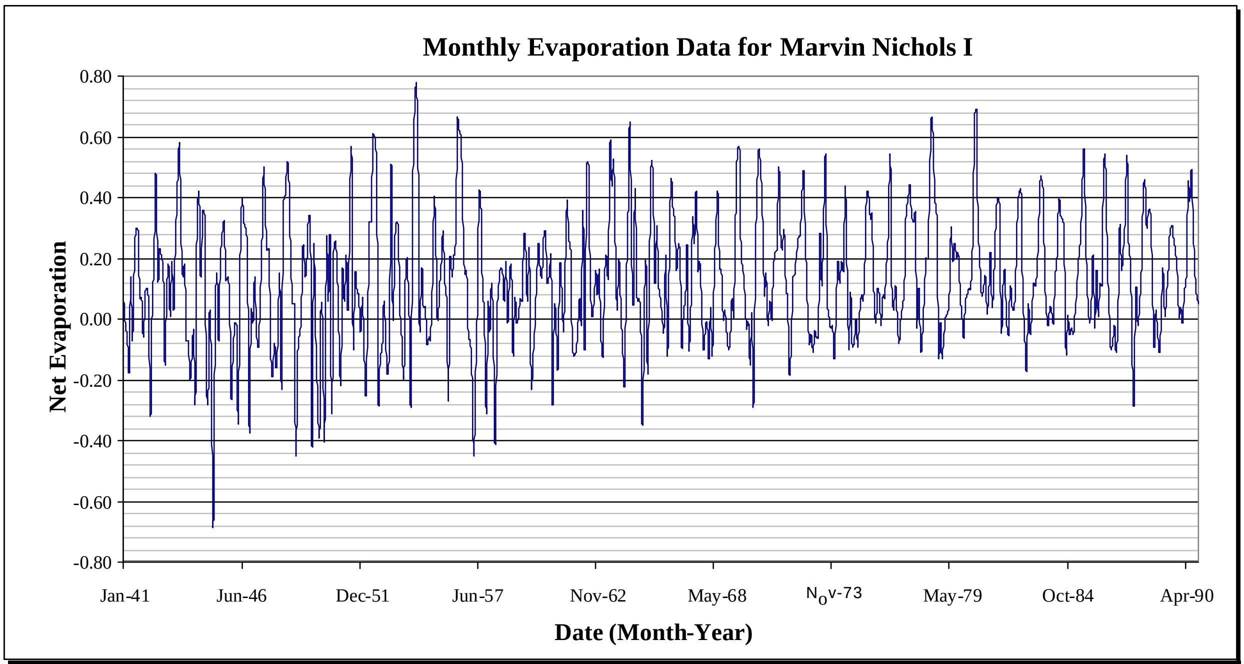
Figure 4.2-2 Daily Reservoir Inflow Curve



4.2.1.5.2 Reservoir Evaporation

Reservoir evaporation data was estimated in the 1990 Regional Water Supply Plan using the Texas Water Development Board: Report 64, Monthly Reservoir Evaporation Rates for Texas and Updates to Monthly Reservoir Evaporation Rates for Texas. The net evaporation used in the reservoir operation studies have been calculated as the difference between gross reservoir evaporation and precipitation, with positive values representing conditions when evaporation exceeds precipitation, see Figure 4.2-3. Daily evaporation values are assumed to be constant within each month.

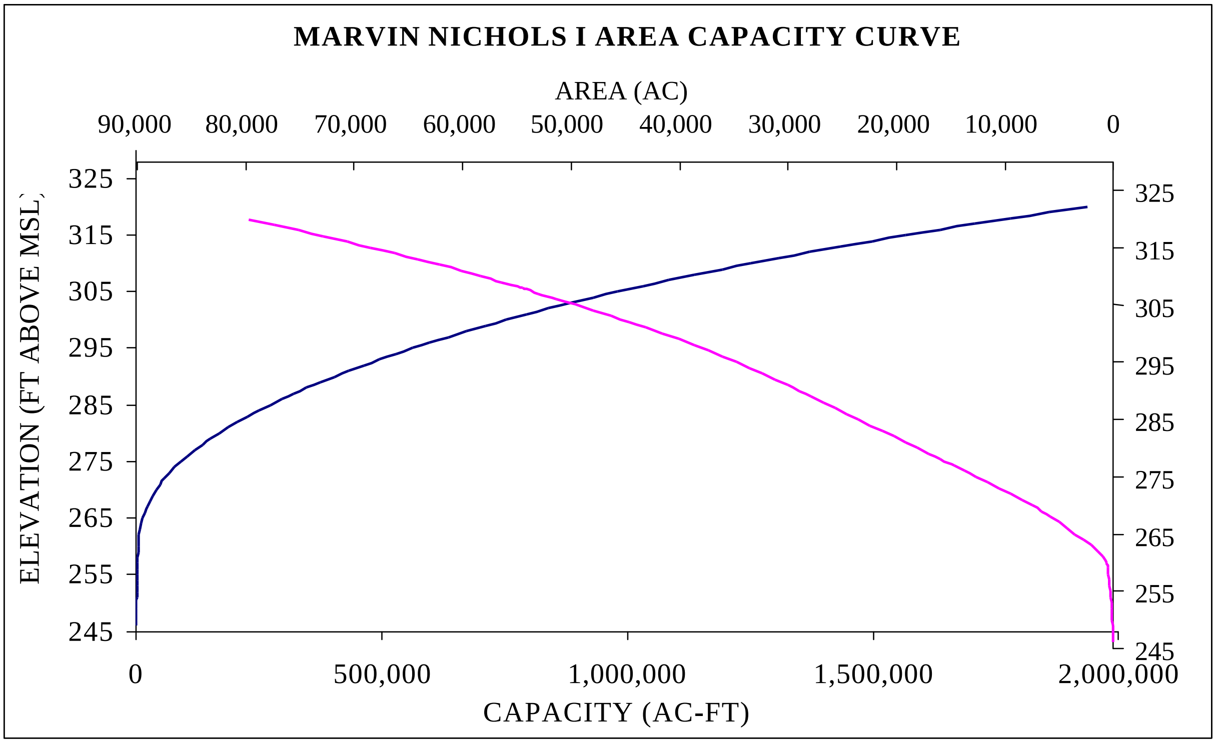
Figure 4.2-3 Monthly Evaporation Rates Curve



4.2.1.5.3 Area Capacity Data

The elevation-area-capacity relationship (also referred to as area-capacity curve) for a reservoir is based on the topographic characteristics of the land to be inundated and is generally developed during the reservoir planning phase. See Figure 4.2-4 for the Marvin Nichols I Area Capacity Curve. Reservoir area and capacity relationships shown below are taken from previous reports and are based on planimeter and digitizer measurements of area and elevation from USGS 1:24,000 contour maps. During the life of the reservoir, sediment deposition within the reservoir typically alters that relationship and reduces the reservoir reserve capacity. Sediment deposition is distributed in various zones of a reservoir at differing rates, depending on the shape of the reservoir and other factors such as the type of sediment from the tributary basin.

Figure 4.2-4 Area Capacity Curve



4.2.1.6 Water Quality

The examination of water quality is based upon existing water quality and streamflow data provided by the USGS and the TWDB. Water quality data for Marvin Nichols I was recorded at a single location in the Sulphur River near Talco, Texas from October 1979 to July 1987. The water quality analyses include an evaluation of inorganic parameters and examination of data on metals and biological contaminants. The water quality standards considered are taken from the following agencies: U.S. Environmental Protection Agency (EPA) National Primary Drinking Water Regulations, EPA Secondary Drinking Water Regulations, 1986 EPA Quality Criteria for Water, Texas Department of Health Primary and Secondary Drinking Water Regulations, and 1988 Texas Surface Water Quality Standards (TSWQS). Water quality data are also compared to the currently treated Fort Worth water quality, and the raw water quality of Lake Worth and Cedar Creek Reservoir, which are existing water supply sources for Tarrant County District customers. The comparison provides an indication of the degree of treatment required for the Marvin Nichols water source. Refer to Table 4.2-1 for water quality data.

Table 4.2-1 Water Quality Data

Parameter	*Unit*	*1988 Texas Surface Water Quality Standards*	*Historical Physical and Chemical Water Quality Data*	
			Flow Weighted Average	*Range of Data*
Arsenic	(µg/l)	360/190	3.9	0.5 – 7
Barium	(µg/l)	–	56.5	40 - 140
Cadmium	(µg/l)	32.9/1.12	0.22	0.5 – 2
Calcium	(mg/l as $CaCO_3$)	–	81	19.4 - 298
Chloride	(mg/l)(c)	60	6.9	4.2 – 67
Chromium	(µg/l)	1,708/203	6.2	5 – 50
Copper	(µg/l)	18.8/12.6	1.5	0.5 – 5
Dissolved Oxygen	(mg/l)(a)	5.0	7.76	2.2 – 12
Fecal Coliform	(# / 100 ml)(b)	200	–	–
Fluoride	(mg/l)	–	0.24	0.2 – 0.4
Iron	(mg/l)		36.5	1.5 - 190
Langelier Index(e)				Moderate
Lead	(µg/l)	79.6/3.1	1.9	0.5 – 15
Magnesium	(mg/l)	–	2.7	2.1 – 11
Manganese	(mg/l)	–	21.8	9 – 800
Mercury	(µg/l)	2.4/0.012	0.02	0.05 – 0.1
Nickel	(µg/l)	1,394/155	–	–
Nitrate	(mg/l)	–	0.93	0.08 – 4.2
PH		6 – 8.5	–	7.3 – 8.1
Selenium	(µg/l)	260/35	0.3	0.5 – 1
Silver	(µg/l)	3.92/0.49	0.2	0.5 – 1
Sodium	(mg/l)	–	11.8	6.4 – 100
Sulfate	(mg/l)(c)	150	26.3	7 – 220
Total Alkalinity	(mg/l as $CaCO_3$)	–	84.8	21 – 281
Total Dissolved Solids	(mg/l)(c)	600	148.5	110 – 608
Total Hardness	(mg/l as $CaCO_3$)	–	92.5	31 – 350
Turbidity	(NTU)	–	80.8	4.5 – 1000
Zinc	(µg/l)	115/104	8.8	1.5 – 30

Notes:
(a) No measurements should fall below this value.
(b) Thirty-day geometric mean not to exceed this value.
(c) Annual average not to exceed this value.
(d) Standards for arsenic and subsequent parameters are expressed as acute limit/chronic limit.
(e) Indicates the tendency of the raw water to become corrosive during cold weather.
mg/l = ppm (parts per million)
µg/l = ppb (parts per billion)
(f) Data in this report is based on analyses done at the time the reservoir was initially evaluated and the water quality evaluations were based on a comparison with standards that may have since changed.

Water quality data and standards were developed from the 1990 "Regional Water Supply Plan". The report summarizes that Marvin Nichols I has existing or projected water quality, which can meet probable long-range receiving water and water supply criteria. During low flow periods, the standards for some physical and inorganic parameters are exceeded, but the flow-weighted averages indicate the water quality measurements is well below the standards limits. As a result, the water quality is good and suitable, with appropriate treatment for potable water supplies.

4.2.1.7 Project Yield for Water Supply

Firm yield as described in the SB1 Regional Water Plan by the State of Texas is "the maximum amount of water supply, based upon simulation, that a reservoir could have produced each year if it had been in place during the drought of record is firm yield. Firm yield analyses reported in the 1997 Water for Texas and any other equivalent existing analyses are acceptable. All water availability based on firm yield must satisfy full utilization of senior water rights. Where special conditions exist, such as the Rio Grande Project, water available based on operating procedures during the drought of record conditions will be used in place of reservoir firm yield analysis. In performing a simulation for firm yield determination for a new site, the following criteria must be met."[1]

The basic procedures required in analyzing water availability in the river basin involve simulating on a monthly basis the ability of individual water rights to satisfy their authorized diversions or storage quantities under historical, but naturalized characteristics. By taking into account the wide range of historical naturally occurring streamflow conditions, the results provide a meaningful indication of the water available for the future. The TWDB has criteria for determining firm yield analyses.

4.2.1.7.1 Definition of Firm Yield

The Texas Water Development Board guidelines 31 TAC 357.7(a)(3) requires "an evaluation of adequacy of current water supplies available to the regional water planning area for use during drought of record. This evaluation shall consider surface water and groundwater data from the State Water Plan, existing water rights, contracts and option agreements, other planning and water supply studies, and analysis of water supplies currently available to the regional water planning area. Analysis of surface water available during drought of record from reservoirs shall be based on firm yield analysis of reservoirs." The water availability based on firm yield must satisfy full utilization of senior water rights.

4.2.1.7.2 Initial Reservoir Operation Study:

The yield available from the Marvin Nichols I reservoir was calculated by computer operation studies using the following hydrologic data and operating assumptions:[2]

- area and capacity characteristics;
- runoff;
- evaporation data;
- Cooper Reservoir and Lake Sulphur Springs are operated at their full, permitted diversions. Spills from these reservoirs are available for use downstream;
- Releases are made from the reservoirs immediately upstream from Lake Wright Patman to keep the yield from that reservoir at its current level of 160,800 acre-feet per year, and
- Other existing water rights are assumed to make full use of available flows to the extent of their permits.

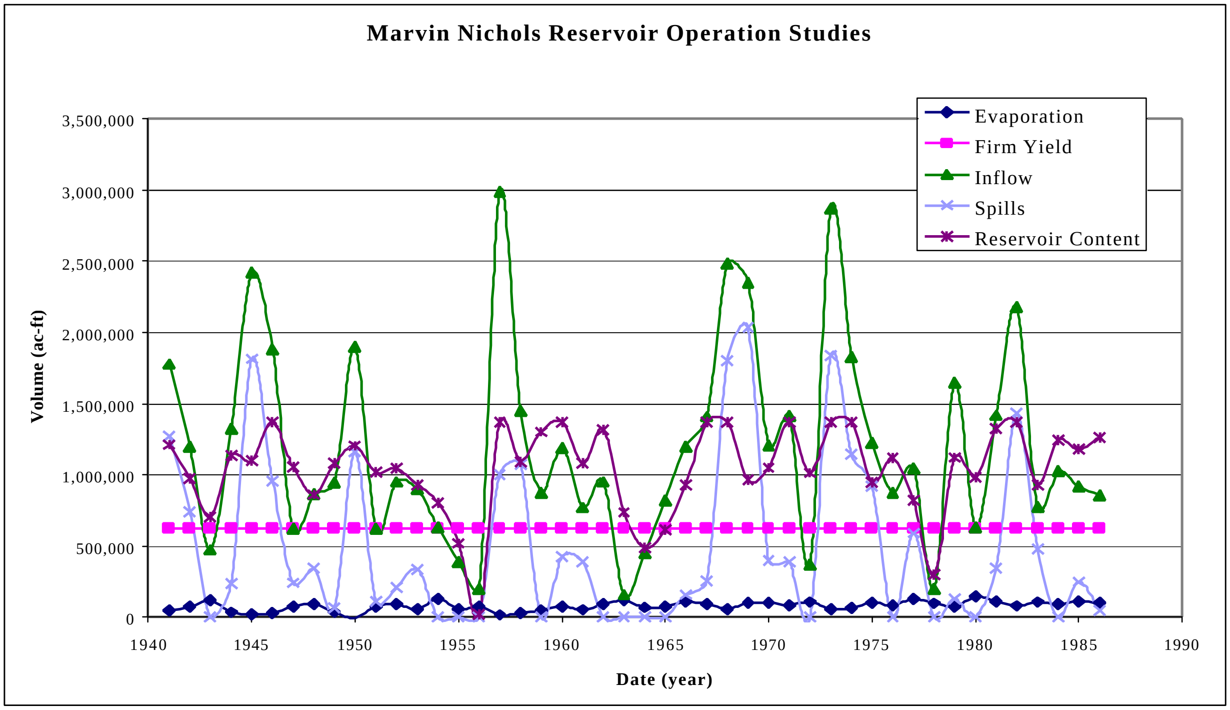
Reservoir inflows are from runoff originating below the proposed George Parkhouse Reservior.[2]

The annual firm yield from Marvin Nichols I under the operating assumptions above is estimated at 624,000 acre-feet/year (557.4 million gallons per day).

Figure 4.2-5 shows the results of the reservoir operation studies reproduced in graphical format. The critical dry period is from June 1953 to January 1957 with a minimum content of 237 ac-ft. Pass-through flows to satisfy environmental requirements were not included in the initial reservoir operation analysis.

This Space Intentionally Left Blank

Figure 4.2-5 Initial Reservoir Operation Study



4.2.1.7.3 Modified Reservoir Operation Study

A more recent study presents the following:

The yields for the proposed project under various assumptions are determined by daily reservoir operation studies with pass-throughs of inflow as in the "Environmental Water Needs Criteria." The pass-through requirements as used in the reservoir operation studies are shown in the following Table 4.2-2.

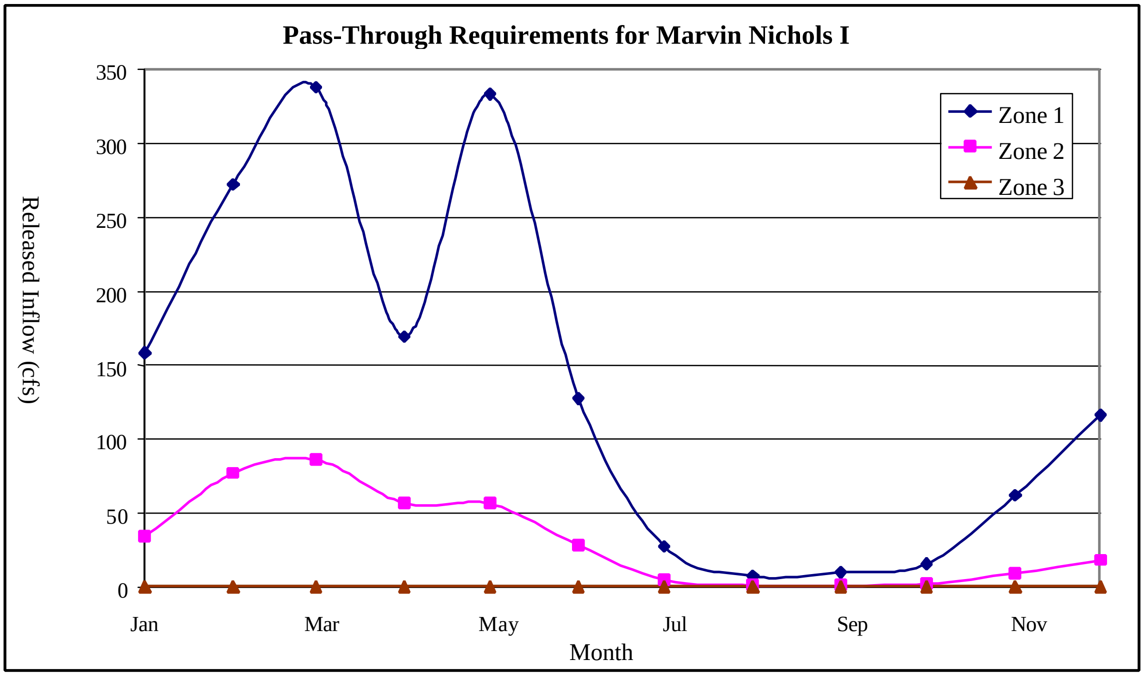
Table 4.2-2 Environmental Flow Requirements

Zone	*Goal*	*Content (%)*	*Content (af)*
1	Median	>80%	>1,095,774
2	25%	50-80%	684,859 – 1,095,774
3	7Q2	<50%	<684,859

The zone designation refers to the content percentage of the reservoir with relation to its conservation pool. The 7Q2 designation refers to the low flow value. The flushing flow (1.5-year event) is 35,968 cfs.

The amount of flow released for pass-through requirements varies by month and reservoir content level as shown in Figure 4.2-6.

Figure 4.2-6 Pass-through Requirements



The modified reservoir operating assumptions studied are as follows:

- Capturing all Inflow;
- Releases for Downstream Rights to Protect Wright Patman Diversions;
- Releases for Downstream Rights to Protect Wright Patman Diversions and Environmental Flow Criteria;
- Releases for Downstream Rights to Protect Wright Patman Reservoir Elevation, and
- Releases for Downstream Rights to Protect Wright Patman Reservoir Elevation and Environmental Flow Criteria.

Table 4.2-3 presents the average annual yields for the five assumed situations and demonstrates releases made to satisfy increasing downstream water right demands decrease the average annual yield. The estimated decreases in the average annual yield due to the downstream protection right are based upon a 641,200 acre-ft per year (572.4 mgd) yield, noted in the updated Freese and Nichols, Inc. 1996 report. This is an increase from the annual yield of 624,000 acre-ft per year (557.4 mgd) used before 1996 and discussed in the Initial Reservoir Operation Study, above.

The updated 1996 study shows a reduction in yield from the previous 1990 study due to the inclusion of the environmental flow requirements.

Table 4.2-3 Annual Firm Yield from Marvin Nichols I under Stated Operating Assumptions

Operation Study	*Yield*
Capturing all Inflow	572.4 mgd (641,200 af/y)
Releases for Downstream Rights to Protect Wright Patman Diversions	564.6 mgd (632,400 af/y)
Releases for Downstream Rights to Protect Wright Patman Diversions and Environmental Flow Criteria	552.3 mgd (618,700 af/y)
Releases for Downstream Rights to Protect Wright Patman Reservoir Elevation	509.7 mgd (570,900 af/y)
Releases for Downstream Rights to Protect Wright Patman Reservoir Elevation and Environmental Flow Criteria	501.1 mgd (561,300 af/y)

4.2.1.7.4 Updated Yield Studies

Additional yield studies were performed for purposes of this Reservoir Site Assessment. The recently completed TNRCC Water Availability Model (WAM) of the Sulphur River Basin and the Daily Reservoir Analysis Model, SIMDLYBE[7] were used to re-analyze the firm yield of the previously described reservoir configuration. The WAM model utilized the Water Rights Analysis Package (WRAP) computer program developed by the Texas Water Resources Institute of Texas A & M University. The WAM/WRAP model was used to develop monthly inflows to the reservoir and the SIMDLYBE model was then used to calculate the firm yield based on daily inflows distributed from the WAM monthly inflows. Specific steps followed in the calculation of the updated firm yield are listed below.

1. Add a control point to the dataset of the Sulphur River Basin WAM model at the location of the proposed dam. Execute the WRAP program to obtain monthly naturalized and regulated inflows for the damsite location.

2. Distribute both the naturalized and regulated monthly inflows into daily inflows using daily flows recorded at U.S. Geological Streamflow gauges which are most nearly representative of the flow at the damsite. In the case of Marvin Nichols I the streamgauge and time periods used are presented in Table 4.2-4.

3. Conduct a statistical analysis of the naturalized daily flows to determine the environmental pass-through requirements in accordance with the Consensus Environmental Guidelines Planning Criteria of the State Water Plan.[8] The results of this statistical analysis are presented in Table 4.1-4. The seven-day/two year flows (7Q2) presented in this table are based on the records of Gauge No. 7343200.

4. Create a SIMDLYBE model of the proposed reservoir site using the regulated daily flows and the environmental pass-through (releases). Execute this model for conditions with and without the environmental pass-through assumptions to calculate the firm yield of the proposed reservoir. Table 4.2-5 presents the results of the updated firm yield analysis and a comparison of the most recent previous analysis with environmental pass-through.

Table 4.2-4 U.S. Geological Streamflow Gauges

Gauge Number	*Stream Guage*	*Time Periods*
7344000	Sulphur River near Darden	Jan. 1940 – Dec. 1956
7343200	Sulphur River near Talco	Jan. 1957 – Dec. 1996

Table 4.2-5 Pass-through (Release) Requirements for Marvin Nichols I (cubic feet/second)

Zone	*Goal*	*JAN*	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
1	Median	158.9	272.3	339.0	196.8	333.4	127.6	27.9	7.6	10.0	15.9	62.3	116.5
2	25%	34.5	77.1	86.3	56.6	56.5	28.2	5.0	1.2	1.3	2.4	9.4	18.4
3	7Q2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1

Table 4.2-6 Updated Firm Yield for Marvin Nichols I

Updated FIRM Yield				*Previous Analysis (FNI, 1996)*			
W/O Environmental Releases		***WITH Environmental Releases***		*With Environmental Releases (Protecting Wright Patman Diversion)*		*With Environmental Releases (Protecting Wright Patman Storage)*	
Acre Feet/Year	***MGD****	***Acre Feet/Year***	***MGD****	*Acre Feet/Year*	*MGD**	*Acre Feet/Year*	*MGD**
557,239	**497.6**	**550,842**	**491.9**	618,477	552.3	561,142	501.1

* Million Gallons per Day

** *Updated firm yield with Environmental Releases has comparable assumptions to the previous* analysis with Environmental Releases and Protecting Wright Patman Storage.

The updated yield study shows a slight decrease in yield from the previous study. This can be attributed to the use of the Sulphur Basin WAM model which was not available in 1996. Other factors not included in the updated study may reduce the firm yield further. These are the exclusion of return flows from the design runoff in accordance with the recent TNRCC guidelines and accounting for watershed runoff from the reservoir area in the evaporation computations.

4.2.1.8 Other Potential Benefits

Other potential benefits may include hydropower generation, flood control, irrigation and recreation. No studies have been conducted to evaluate additional benefits.

4.2.1.9 Land Acquisition and Easement Requirements

The acquisition of land and easement requirements includes land in the conservation pool to elevation 312.0 and flood easements for land above the conservation pool subject to the probable maximum flood elevation 319.1. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 62,125 acres plus the additional surface area attained at another 5 ft above the conservation pool elevation, which together is approximately 72,825 acres.

4.2.1.9.1 Potential Land Use Conflicts

Field reconnaissance studies have been conducted to locate potential land use development conflicts and the proposed resolutions together with the estimated cost of addressing the issue in terms of roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. The estimated cost basis is from 1989 prices. The reservoir system capital costs includes these items as a cost element. Refer to Table 4.2-7 for land use conflicts.

Table 4.2-7 Reservoir Conflicts Table

No.	Conflict	Proposed Resolution	Cost
1	County Road No. 1	Reroute road.	$434,300
2	County Road No. 3	Build road approaches and new bridge across Shawnee Creek.	$251,500
3	County Road No. 8	Reroute road around edge of reservoir to County Road No. 6.	$460,900
4	County Road No. 9	Reroute road around edge of reservoir.	$415,700
5	County Road No. 10	Build a new bridge across Sulphur River and raise roadway.	$5,626,700
6	County Road No. 10	Reroute road and build new bridge across Whiteoak Creek.	$239,000
7	F.M. 44	Reroute road, build 2 new bridges across Dillard Creek.	$2,050,400
8	F.M. 71	Reroute roadway.	$763,800
9	F.M. 412	Reroute road, build 3 new bridges across Kickapoo Creek and raise roadway.	$2,860,200
10	F.M. 1487	Reroute road, build 3 new bridges across Cuthand Creek and Sand Branch, and raise roadway.	$5,880,400
11	U.S. HWY 271	Build road approaches and 3 new bridges across Sulphur River and Sanders Slough.	$3,597,900
12	River Crest Lake	Place soil cement for slope protection and build security fence.	$124,300
13	16” Lone Star Gas	Replace pipeline and add 2 gate valves.	$1,277,500
14	20” Mobil Oil	Replace pipeline and add 8 gate valves.	$3,872,700
15	138 KV Powerline	Replace powerline over reservoir.	$850,500
16	Unnamed Cemetery	Relocate cemetery outside reservoir.	$183,400
17	Evergreen Cemetery	Relocate cemetery outside reservoir.	$273,000
18	Cedar Creek Cemetery	Relocate cemetery outside reservoir.	$1,076,300
19	Trix-Liz Oil Field	Raise producing wells, plug nonproducing wells and relocate storage tanks.	$2,955,800
			$33,194,300

4.2.1.9.2 Local, State, and Federal Permitting Requirements

Major reservoir development requires substantial investment to acquire the key permits. The following four permits comprise the greatest challenges: 1) Water rights permits from the TNRCC, 2) Section 404 permit from the U.S. Army Corps of Engineers, including all NEPA compliance, 3) Antiquities Permit from the Texas Antiquities Committee, and 4) Sand and Gravel Permit from the Texas Parks and Wildlife Department. A summary of the requirements to obtain these permits is presented in Table 4.2-8.

Table 4.2-8 Major Permitting Requirements

Permit	*Issuing Agency*	*Summary of Requirements*
Water Rights	TNRCC	Engineering report; environmental effects report on water quality and fish and wildlife; water conservation plan; public hearing; may include mitigation requirements.
Section 404*	U.S. Army Corps of Engineers	Description of proposed fill activities; preparation of environmental impact statement; may require special studies by applicant, including archeological survey, water quality studies, ecological studies and NEPA compliance; may include mitigation requirements.
Antiquities Permit	Texas Antiquities Committee	Archeological survey, testing and evaluation, and mitigation of important sites.
Sand and Gravel Permit	Texas Parks and Wildlife Department	$0.20 per cubic yard of sand, gravel or marl excavated from river channel.

* Includes Section 401 Certification of Water Quality from TNRCC.

No hydroelectric facilities are proposed at this time for Marvin Nichols I, therefore a license from the Federal Energy Regulatory Commission (FERC) is not required. A strategy for future hydropower development should be considered after the project is fully permitted. Appropriate outlet works studies can be provided if appropriate. In this way the FERC does not become the lead federal agency. This will greatly simplify the permitting cycle. Given the high energy values that exist today a hydro-retrofit may prove to be of economic value.

4.2.1.10 Updated Project Costs

Opinions of probable project cost for the Marvin Nichols I Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1989.[2] The cost estimates are updated to the second quarter of 1999 (June) using the *Engineering News Record* (ENR) Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of

opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines set forth in "Appendix B" unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15 percent of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5 percent of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10 percent of land cost.
- Engineering fees, which were taken at 35 percent of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20 percent contingency of the overall project cost. This contingency cost is covered in the 35 percent Engineering and Related Item Fee.
- Interest during construction was accrued assuming percent years of construction using only the construction cost at a 6 percent interest rate and 4 percent investment.

These changes resulted in a higher capital cost estimate than the initial analysis, which estimated the project cost at $446,518,000. Please refer to Table 4.2-9 for the Updated Project Cost and Table 4.2-10 for the Construction Cost.

4.2.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in Table 4.2-9. The assumed average developed cost per ac. of land for the reservoir was $550/ac. and the easement cost was $412.50/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 62,125 acres plus the additional surface area attained at another 5 ft above the conservation pool elevation, which together is approximately 72,825 ac.

4.2.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in Table 4.2-9.

4.2.1.10.3 Construction Costs

As shown in Table 4.2-10, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

This Space Intentionally Left Blank

Table 4.2-9 Updated Project Costs

Description	*Quantity*	*Unit*	*Unit Price ($)*	*Cost ($)*	*Total Cost ($)*
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$112,617,000
Relocations (conflict resolution)		L.S.			$33,194,300
Construction Capital Costs (CCC) Subtotal:					**$145,811,300**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$51,034,000
Land Cost					$56,797,490
Land Purchase	62,125	Ac.	$550.00	$34,168,750	
Easements	10,700	Ac.	$412.50	$4,413,750	
Lignite	3,540	Ac.	$425.00	$1,504,500	
Acquisition (15% of land purchase & lignite)		L.S.		$5,350,988	
Contingencies (25% of land, easements, lignite, acquisition)		L.S.		$11,359,497	
Studies, Mitigation, Permitting					$66,678,490
Environmental Studies		L.S.		$500,000	
Archeological Studies (pmf pool)	77600	Ac.	$10.00	$776,000	
Geotechnical Studies		L.S.		$1,938,000	
Mitigation Costs (equal to land cost)		L.S.		$56,797,490	
Permitting		L.S.		$6,667,000	
Interest During Construction (4 yrs. at 6% with 4% return)					$18,206,000
Other Project Costs Subtotal:					**$192,715,980**
		Dec. 1998 Subtotal:			$338,527,280
20-City Average Escalation Factor	31.9%				$107,990,210
OPINION OF PROBABLE PROJECT COST					**$446,518,000**

1. Original cost estimates were taken from COE, 1989.
2. The 35 percent engineering and other fee includes the engineering design costs listed in the original estimate.
3. Mitigation costs were included.

Table 4.2-10 Construction Costs

Item #	Description	Quantity	Unit	Unit Price ($)	Cost ($)
1	Excavation				
	Approach Channel	320,000	C.Y.	$1.31	$ 419,200
	Discharge Channel	310,000	C.Y.	$1.31	$ 406,100
	Spillway	2,425,600	C.Y.	$1.20	$ 2,910,720
2	Fill				
	Impervious	1,511,300	C.Y.	$1.75	$ 2,644,775
	Random	6,508,300	C.Y.	$1.75	$ 11,389,525
3	Filter, 1 & 2 (Foundation Drainage)	795,000	C.Y.	$10.00	$ 7,950,000
4	Bridge	940	L.F.	$720.00	$ 676,800
5	Roadway	126,900	S.Y.	$4.60	$ 583,740
6	Cutoff Slurry Trench	2,061,000	S.F.	$3.50	$ 7,213,500
7	Soil Cement	482,900	C.Y.	$16.00	$ 7,726,400
8	Elevator	1	ea.	$100,000.00	$ 100,000
9	Barrier Warning System	2,256	L.F.	$12.00	$ 27,072
10	Gates				
	Gate & Anchor (Install & Paint)	22,800	S.F.	$120.00	$ 2,736,000
	Stop gate & Lift Beam	480	L.F.	$1,450.00	$ 696,000
	Hoist	19	ea.	$118,000.00	$ 2,242,000
11	Electrical		L.S.		$ 340,000
12	Power Drop		L.S.		$ 144,000
13	Low Flow System		L.S.		$ 1,000,000
14	Monorail System	940	L.F.	$640.00	$ 601,600
15	Embankment Internal Drainage	51,900	L.F.	$38.00	$ 1,972,200
16	Guardrail	1,880	L.F.	$18.00	$ 33,840
17	Grassing	40	Ac.	$3,700.00	$ 148,000
18	Concrete (Mass)	223,900	C.Y.	$125.00	$ 27,987,500
19	Concrete (Walls)	3,600	C.Y.	$200.00	$ 720,000
20	Dam Instrumentation		L.S.		$ 1,000,000
21	Land Clearing	13,750	Ac.	$535.00	$ 7,356,250
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$ 89,025,222**
	Clearing & Grubbing, care of water (5% of Subtotal)				$4,451,261
	Mobilization (5% of BCS)				$4,451,261
			Subtotal:		$97,927,800
	OH & P (15% of Subtotal)				$14,689,170
	Construction Capital Cost Subtotal (CCC)				**$ 112,617,000**

Notes:
1. Dam instrumentation cost was included with the construction costs.
2. Contractor's Overhead and profit at 15 percent of subtotal of construction costs was included.

4.2.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally, this key planning parameter is developed by obtaining the annual firm yield, which for this site is 550,842 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $446,518,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6 percent per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5 percent of the total construction cost. For the Marvin Nichols I Reservoir, the Operations and Maintenance (O&M) is $2,187,170 and the annualized debt service is $31,614,800. The firm yield is then divided into the total annualized cost of $33,801,970 to yield a unit cost of $61.37 per acre-foot ($0.19/1,000 gal) of firm yield. These annualized costs are summarized in 404 contained in the executive summary.

4.2.2 Environmental Overview –Affected Environment and Environmental Consequences

4.2.2.1 Geological Elements

4.2.2.1.1 Physiography

The proposed reservoir is located within the Blackland Prairies, which covers approximately 12.6 million acres of land. It averages 30-45 inches of precipitation annually with 230 to 280 frost-free days. The topography is nearly level to rolling with an elevation of 250 to 700 feet above mean sea level (msl). The Blackland Prairie area intermingles with the Post Oak Savannah in the southwest and has a division known as the San Antonio and Fayette Prairies. This rolling and well-dissected prairie represents the southern extension of the true prairie that occurs from Texas to Canada.

The upland Blacklands are dark, calcareous shrink-swell clayey soils, changing gradually with depth to light marls or chalks. Bottomland soils are generally reddish brown to dark gray, slightly acid to calcareous, loamy to clayey and alluvial. The soils are inherently productive and fertile, but many have lost productivity through erosion and continuous agricultural related activities.

The Blackland Prairie is characterized by little relief and dark, thick, plastic clay soils. All outcropping strata are generally classified as sedimentary. The exposed bedrock is composed of nearshore and shoreline marine sediment deposited at the edge of the Gulf Coast Embayment by a shallow Cretaceous sea existing approximately 100 million years ago. Sediment deposited in this sea consists of sand, silt, clay and formed layers that incline eastward toward the embayment with an average slope of 45 feet per mile.

4.2.2.1.2 Geology

Soil surface outcroppings in the North Texas Region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. North Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in North Texas. For the past 60 million years, the North Texas Region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the North Texas Region are varied and abundant. Lamar and Red River Counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[9]

The area of the proposed Marvin Nichols I reservoir was formed during the upper cretaceous period. The area is composed primarily of Navarro Group undivided, Marlbrook Marl, and Ozan Formation. Small portions of Fluviatile terrace deposits and Alluvium are also found which were formed in the Pleistocene and recent periods, respectively.

The upper part of the Navarro Group is mostly clay, silty, and in parts sandy, which increases downward. This portion is calcareous, glauconitic, with calcareous concretions common with some cone-in-cone. It is medium gray to bluish gray. The weathers are light yellowish gray and medium greenish gray. Marine megafossils are scarce. The lower part is mostly sand, silty, clayey, weakly coherent, light to medium gray. The weathers are light yellowish gray. Marine megafossils are abundant locally. It is indistinctly to thinly bedded and has a thickness of 500-775 feet.

Marlbrook Marl is slightly glauconitic in the upper part and highly plastic when wet. It is strikingly uniform throughout and is medium bluish gray to yellowish gray. The weathers are light gray to white and forms smooth, rolling topography. Marine megafossils are scarce. It has a thickness of 150 to 450 feet and thins eastward.

Ozan Formation is clay, calcareous, with some fine sand. It is bluish gray and the weathers are light gray. Marine megafossils are present and it has a thickness of 425 feet.

Fluviatile terrace deposits are mostly sand, silt, and some clay. It is moderately well bedded, mostly red to tan in color. It has surface scrools with immature soils and a weakly developed or locally not recognizable B-horizon. Fresh-water and terrestrial molluscan faunas are sparse. The maximum thickness if 30 feet.

Alluvium are floodplain deposits. It is found within the Red River drainage system and includes low terrace deposits not readily distinguishable on high altitude aerial photographs. The top surface is 5 to 11 feet above the floodplain.

4.2.2.1.3 Soils

The area of the proposed Marvin Nichols I reservoir contains six major soils associations.[9] These associations include: Annona-Ashford-Sawyer; Annona-Freestone-Woodtell; Derley-Raino-Talco; Kaufman-Gladewater-Texark; Sayer-Eylau-Sacul; and Woodtell-Freestone-Bernaldo. Approximately one percent of the area is Annona-Ashford-Sawyer; 21 percent Annona-Freestone-Woodtell; three percent Derley-Raino-Talco; 71 percent Kaufman-Gladewater-Texark; one percent Sayer-Eylau-Sacul; and two percent Woodtell-Freestone-Bernaldo. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Annona

The Annona series consists of very deep, moderately well drained, very slowly permeable soils formed in clayey alluvial terrace sediments. These soils are on nearly level to moderately sloping Pleistocene terraces ranging from 0 to 8 percent. Mean annual temperature ranges from 64 to 68 degrees F., mean annual precipitation ranges from 40 to 48 inches, and the summer rainfall is about 25 to 30 inches. Frost-free days range from 230 to 280. The elevation ranges from 200 to 500 feet above msl. Thornthwaite annual P-E index ranges from 64 to 78. A saturated zone is perched above the Bt horizon for short periods following heavy rains. Almost all of this soil is in pasture and woodland. Forests are mixed hardwood and pine. Major hardwood species are red oak, post oak, sweetgum, and hickory. Needleleaf trees are predominantly shortleaf and loblolly pine. Pastures include improved bermudagrass, common bermudagrass, bahiagrass, with arrowleaf clover, crimson clover, and vetch overseeded. Some areas are used for growing corn, soybeans, grain sorghum, wheat, or hay crops.

Ashford

The Ashford series consists of very deep, poorly drained, very slowly permeable soils that formed in clayey alluvium on terraces of Pleistocene age. Slopes range from 0 to 1 percent. Mean annual precipitation ranges from 42 to 55 inches. The mean annual temperature ranges from 63 to 67 degrees F. Elevation ranges from 225 to 275 feet above msl. Frost-free days range from 235 to 270. Thornthwaite P-E indices exceed 64. Ashford soils are ponded for long periods during the rainy season. The majority of this soil is woodland. Native vegetation includes red oak, water oak, willow oak, post oak, hickory, and green ash. Understory vegetation is mainly longleaf uniola, broomsedge bluestem, rushes, sedges and hawthorn. Some areas are cleared and farmed to soybeans and rice. A few areas are used for pasture.

Bernaldo

The Bernaldo series consists of very deep, well drained, moderately permeable soils that formed in loamy alluvial deposits. The soils are on nearly level to moderately sloping stream terraces. Slopes are dominantly less than 5 percent but range from 0 to 8 percent. Bernaldo soils are on nearly level to moderately sloping areas about 10 to 130 feet above present streams. The average annual precipitation ranges from 40 to 48 inches and the mean annual temperature ranges from 64 to 68 degrees F. Frost-free days range from 240 to 260 and elevation ranges from 200 to 550 feet above msl. Thornthwaite annual P-E indices range from 64 to 84. Most acreage is in woodland with dominant pine species of loblolly and shortleaf and many oak species and other southern hardwoods. Some areas are in pasture. Pastures are mainly in improved or common bermudagrass, bahiagrass, overseeded with legumes of crison and arrowleaf clovers, vetch or singletary peas. Small areas are farmed to corn, small grains for grazing, sorghum for grazing and hay, and truck crops.

Derly

The Derly series consists of very deep, poorly drained, very slowly permeable soils mainly on Pleistocene Age Terraces formed in loamy and clayey sediments about 30 to 80 feet above present floodplains. Slopes range from 0 to 1 percent. The average annual temperature ranges from 63 to about 68 degrees F.; the average annual rainfall ranges from 36 to 46 inches. Frost-free days ranges from 230 to 275, and the elevation ranges from 150 to 400 feet above msl. Thornthwaite P-E index ranges from 60 to 68. Water is ponded on the surface for brief to long periods during the winter and spring seasons of most years. Most of the acreage is in pasture and woodland. Native vegetation is an overstory of elm, post oak, willow oak, and water oak. Grasses include such species as beaked panicum, longleaf uniola, and sedges. Bermudagrass, dallisgrass, and fescuegrass are the dominant pasture plants.

Eylau

The Eylau series consists of deep, moderately well-drained, moderately slowly permeable soils that formed in thick loamy Coastal Plain sediments on uplands. Slopes are dominantly 1 to 2 percent but range from 0 to 5 percent. Mean annual precipitation ranges from 45 to 55 inches. Mean annual temperature ranges from 64 degrees to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64 inches. A perched water table is at 2 to 3 feet below the surface from February to May. Most of the acreage is in improved pasture of bermudagrass, bahiagrass, dallisgrass, and pine-oak woodland. A few areas are used for cropland. Native vegetation consists of loblolly pine, southern red oak, sweetgum, post oak, hickory, beaked panicum, longleaf uniola, and annuals.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Gladewater

The Gladewater series consists of very deep, somewhat poorly drained, very slowly permeable soils on floodplains formed in clayey alluvium in floodplains. Slope ranges from 0 to 1 percent. The mean annual precipitation ranges from 38 to 46 inches and mean air temperature ranges from 64 to 68 degrees F. Frost-free days range from 235 to 275 days and elevation is 200 to 400 feet above msl. Thornthwaite P-E index ranges from about 62 to 74. Depressional areas are very poorly drained. Most of the acreage is in pasture or forest. Some areas are in native pasture or range. Pasture areas are introduced grasses such as dallisgrass and fescue. Forested areas are in mixed hardwoods including water oak, willow oak, cedar elm and black willow.

Kaufman

The Kaufman series consists of very deep, moderately well-drained, very slowly permeable soils on floodplains formed in clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 2 percent. Mean annual precipitation ranges from 35 to 50 inches, and mean annual temperature ranges from 62 to 70 degrees F. Frost-free days range from 230 to 280 days and elevation ranges from 100 to 550 feet above msl. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in pasture of dallisgrass, bermudagrass, and fescues. A few areas are used for producing cotton, corn, sorghums, and soybeans. Native vegetation is hardwoods such as elm, hackberry, oak, ash, and grasses which includes species of andropogon, paspalum, panicum, and tripsacum.

Raino

The Raino series consists of very deep, moderately well-drained, very slowly permeable soils on stream terraces or remmants of terraces on erosional uplands 50 to 200 feet above present stream terraces in loamy and clayey sediments. Slopes range from 0 to 2 percent. The mean annual precipitation is 40 to 48 inches. Frost-free days range from 235 to 275 and elevation ranges from 250 to 450 feet above msl. The average annual temperature is 64 to 69 degrees F. and the Thornthwaite P-E index is 64 to 84. Most of the acreage is in pasture. Bermudagrass, pensacolagrass, bahiagrass, and dallisgrass are the dominant pasture plants. Some native grasses include longleaf uniola, beaked panicum, purpletop, and bluestems. Overstory is mainly blackjack oak, post oak, hickory, water oak, elm, and pine in the eastern portion of series province.

Sacul

The Sacul series consists of very deep, moderately well-drained, slowly permeable soils that formed in acid, loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 2 to 25 percent but range from 1 to 40 percent. The average annual air temperature ranges from about 60 to 66 degrees F and the average annual precipitation ranges from about 48 to 54 inches. Most of the acreage is in woodland, with some area in pasture. The forest vegetation is shortleaf and loblolly pine, red oak, sweetgum, and dogwood. Bermudagrass and bahiagrass are the principal pasture grasses used.

Sawyer

The Sawyer series consists of very deep, moderately well-drained, slowly permeable soils that formed in loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 1 to 8 percent but range to 25 percent. The average annual temperature ranges from about 60 to 66 degrees F. and the average annual precipitation ranges from about 48 to 54 inches. Most areas of this soil are in forests of loblolly and shortleaf pine. Cleared areas are dominantly used for pasture. The native vegetation was mixed shortleaf pine and hardwood forest.

Talco

The Talco series consists of deep, somewhat poorly drained, slowly permeable soils on stream terraces on remmants there of 50 to 200 feet above present streams in loamy alluvial sediments of Pleistocene Age. Slopes range from 0 to 2 percent. Mean annual precipitation is 42 to 48 inches. Mean annual temperature ranges from 62 to 66 degrees F. and the Thornthwaite annual P-E index ranges from 68 to 76. Ponding occurs for brief periods during the winter and spring months. Most of the acreage is in forest and pasture. Forest vegetation includes willow oak, water oak, post oak, red oak, sweetgum, black gum, elm, and loblolly pine.

Texark

The Texark series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in clayey alluvium floodplains that drain mainly from the Blackland Prairies. Slopes are 0 to 1 percent. Average annual precipitation ranges from 40 to 55 inches, average annual temperature is 62 degrees to 70 degrees F. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in forest, pasture, and wildlife habitat. Native vegetation conaiata of hardwood trees such as green ash, hackberry, water oak, willow oak, elm, and sweetgum. Understory vegetation consists of hawthorns, sedges, grasses, and annual weeds.

Woodtell

The Woodtell series consists of soils that are deep to stratified shale and loamy materials on gently sloping stream divides. They are well-drained and very slowly permeable. The slope ranges from 1 to 20 percent. Woodtell soils are strongly to moderately steep side slopes of uplands. Slope gradients are mainly 2 to 12 percent but range from 1 to 20 percent. The soils formed in materials weathered from unconsolidated, stratified loamy, clayey, and shaly materials of Eocene age mainly in the Wilcox and Cook Mountian formations. The average annual rainfall ranges from 40 to 46 inches. The mean annual temperature is about 62 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 78. Frost-free days range from 230 to 270 and elevation ranges from 300 to 650 feet above msl. These soils are used mainly for pasture. Native vegetation is mainly post oak, blackjack oak, elm and red oak in a fairly dense savannah. In open areas tall and mid grasses such as bluestems, tridens and panicums are common with longleaf uniola under the tree canopy. American beautyberry and hawthorn species are also a part of the understory. The main pasture plants are bermudagrass and bahiagrass with crimson and arrowleaf clovers. There are scattered shortleaf and loblolly pine with small plantations and a some dense pine areas on the eastern side of the series province. Some areas are planted to small grain for winter grazing.

4.2.2.2 Hydrological Elements

4.2.2.2.1 Surface Water

The proposed reservoir would be located within the the Sulphur River Basin on Sulphur River, between Cooper Lake and Wright Patman Lake. This portion of the Sulphur River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0303 (Sulphur/South Sulphur River). The 181-mile stream segment flows in a downstream direction from Cooper Lake Dam in Delta/Hopkins County to a point 0.9 miles downstream of Bassett Creek in Bowie/Cass County. This segment is classified as "water quality limited" and designated uses are for contact recreation and high aquatic life.

Total permitted facilities along this segment are described as in the following table:[10]

Table 4.2-11 Permitted Facilities relating to the Proposed Marvin Nichols I Reservoir

Type	*Quantity*	*Volume*
Domestic	17 outfalls	9.05 MGD*
Industrial	6 outfalls	200.06 MGD
Agricultural	13 outfalls	0.00 MGD
Total	**36 outfalls**	**209.11 MGD**

* MGD = Million Gallons per Day

The lower and upper portions of this segment periodically show depressed levels of oxygen and elevated levels of nutrients. Sluggish flow, coupled with nutrient and suspended sediment loading from point and nonpoint sources, likely contributes to the problems noted for the decreased level of dissolved oxygen and the increased level of nutrients in the river.

4.2.2.2.2 Ground Water

The proposed reservoir is located mainly within the Nacatoch Aquifer. The Nacatoch Aquifer occurs in a narrow band in northeast Texas and extends eastward into Arkansas and Louisiana. Pumpage from the aquifer totaled 3,484 acre-feet in 1994, 74 percent of which was used for municipal purposes.

The Nacatoch formation, composed of one to three sequences of sands separated by impermeable layers of mudstone or clay, was deposited in the East Texas basin during the Cretaceous Period. The aquifer also includes a hydrologically connected mantle of alluvium up to 80 feet thick where it covers the Nacatoch along major drainage ways. The south and east basinward dip of the formation is interrupted by the Mexia-Talco fault zone, which alters the normal flow direction and adversely affected the chemical quality of the groundwater. Groundwater in this aquifer is usually under artesian conditions except in shallow wells on the outcrop where water-table conditions exist.

The water quality of groundwater in the aquifer is generally alkaline, high in sodium bicarbonate, and soft. Dissolved-solids concentrations increase in the downdip portion of the aquifer and are significantly higher downdip of faults. In areas where the Nacatoch occurs as multiple sand layers, the upper layer contains the best-quality water. The water quality is generally acceptable for most uses, however, the high degree of mineralization precludes its use for irrigation in some areas.

Annual availability, equivalent to annual effective recharge, for the Nacatoch Aquifer is estimated to be 3,030 ac-ft. Recharge to the aquifer occurs mainly from precipitation on the outcrop. Aquifer water levels have been significantly lowered in some areas as a result of pumpage exceeding the effective recharge.

4.2.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The proposed reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river, as well as affected streams and tributaries.

The development of the proposed Marvin Nichols I reservoir would greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

4.2.2.4 Biological Elements

4.2.2.4.1 Vegetation

The proposed Marvin Nichols I reservoir is centrally located within the Austroriparian province[11] and is within the Post Oak Savannah.[12] The Post Oak Savannah vegetation area typically has a gently rolling to hilly topography, with moderately dissected wooded plain. The soil composition for this community consists of gray, slightly acidic sandy loams, and reddish brown to dark gray, slightly acidic to calcareous, loamy to clayey alluvial. The Post Oak Savannah soils support short oak trees and tallgrasses. Trees in the region consist of post oak and blackjack oak, elms, junipers, hackberries, and hickories. Yaupon, American beautyberry, coralberry, greenbriar, and grapes are shrubs and vines that are characteristic to the area. Grasses in the area includes little bluestem, indiangrass, switchgrass, silver bluestem, Texas wintergrass, purpletop, narrowleaf wildoats, beaked panicum, brownseed paspalum, threeawn, broomsedge bluestem, splitbeard bluestem, rosette grasses, and lovegrasses. Forbs in the region consist of wild indigo, indigobrush, sennas, tickclover, lespedeza, prairie-clovers, western ragweed, crotons, and sneezeweeds. There has been some vegetation introduced into the area, including bermudagrass, bahiagrass, weeping lovegrass, and clover.

According to the Vegetation Types of Texas, The Texas Parks and Wildlife Department (TPWD) divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into forty-six major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the proposed Marvin Nichols I reservoir location include water oak, elm, hackberry (60%); post oak, forest, grass (20%), other (17%), and post oak, wooded forest (3%).

According to *Water and Wildlife, 1990*, The proposed Marvin Nichols I reservoir site contains four cover types within its proposed boundaries. The resource categories are: mixed bottomland hardwood forest (45%), mixed post oak forest (23%), grasses (19%), and other (13%).[13]

4.2.2.4.2 Fish and Wildlife

The proposed Marvin Nichols I reservoir would result in a decrease of stream and terrestrial habitat, and an increase of deepwater and shoreline habitat.

The proposed Marvin Nichols I reservoir is located within the Prairies and Lakes Eco-region. Some of the common wildlife in this region includes the plains pocket gopher, beaver, raccoon, porcupine, Texas kangaroo rat, hispid cotton rat, ornate box turtle, green-winged teal, bobwhite quail, red-shouldered hawk, scissortail flycatcher, white-tailed deer, Brazilian freetail bat, ringtail, nine-banded armadillo, eastern hognose snake, tarantula, Texas horned lizard, golden cheeked warbler, black-capped vireo, northern mockingbird, and guadelupe bass. [14]

4.2.2.4.3 Endangered and Threatened Species

The U.S. Fish and Wildlife Service (USFWS) and TPWD combined lists for threatened, endangered, or rare species identify seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the proposed project location (Table 4.2-12). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 4.2-12 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Franklin, Morris, Red River, and Titus Counties)

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Eskimo Curlew	*Numenius borealis*	LE	E
Henslow's Sparrow	*Ammodramus henslowii*		R
Least tern	*Sterna antillarum***	LE	NL
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Blue Sucker	*Cycleptus elongatus*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Shovelnose Sturgeon	*Scaphirhychus platorynchus*		T
Western Sand Darter	*Etheostoma clarum*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Mollusks			
Ouachita rock-pocketbook mussel	*Arkansia wheeleri*	LE	E
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Arkansas meadow-rue	*Thalictrum arkansanum*		R
Rough-stem aster	*Aster puniceus* spp. *Eliotti* var. *scabricaulis*		R

Sources: USFWS 1998, TPWD 1999.
USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE-Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range).
LT-Federally Listed Threatened (species which is likely to become endangered within the foreseeable future).
C1-Federal Candidate, Category 1; information supports proposing to list as endangered/threatened.
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance.
DL, PDL - Federally Delisted/Proposed Delisted.

TPWD: Texas Parks and Wildlife Department Status
E-Listed as Endangered in the State of Texas.
T-Listed as Threatened in the State of Texas.
R-Rare, but with no regulatory listing status.
(Texas Department of Transportation, Annotated County Lists of Rare Species for Franklin, Morris and Titus Counties, 1999.)
(Texas Department of Transportation, Annotated County Lists of Rare Species for Red River County, 1998a.)

4.2.2.5 Ecologically Unique Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the Regional Water Plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.

Threatened or Endangered Species/Unique Communities: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD-determined high importance potential ecologically unique streams within or adjacent to the footprint of the proposed Marvin Nichols I reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.2.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The regulatory definition of wetland used by the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) for administering the Clean Water Act Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on three mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline, or boundry of a wetland, was not performed at any site, within ot immediately adjacent to the proposed Marvin Nichols I reservoir location. A general preliminary determination was preformed on the probability of wetland occurrence based upon hydric soils preliminarydeterminations and USFWS National Wetlands Inventory (NWI) maps. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current Natural Resource Conservation Service (NRCS) data shows six hydric soil associations are within the proposed Marvin Nichols I reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

The USFWS's NWI maps were reviewed for the area to determine the following indications of wetland types.

Table 4.2-13 Existing Wetland Acreage Affected by Proposed Reservoir

Wetland Type	***Approximate Acreage***	***Percentage of Total Proposed Reservoir Area***
Lacustrine Open Water	70	≤ 1%
Palustrine Aquatic Bed	3	≤ 1%
Palustrine Emergent	761	1%
Palustrine Forested	27,690	45%
Palustrine Open Water	8	≤ 1%
Palustrine Scrub/Shrub	664	1%
Riverine	1,411	2%
Total	***30,607***	***49%***

4.2.2.7 Wetland Mitigation Banks

Wetland Mitigation Banking is a method by which compensatory mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation Banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Bank includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation Bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins Mitigation Bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM Mitigation Bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of the potential Big Sandy reservoir in the Sabine River floodplain.

There are no known existing or proposed Wetland Mitigation Bank projects that are located near or adversely affected by the proposed Marvin Nichols I reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.2.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland hardwoods comprise almost one-third of the remaining native habitat of the state. The proposed Marvin Nichols I reservoir would be located within the Sulphur River basin, which represents approximately 15 percent of the remaining bottomland hardwood areas in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the USFWS. Within Texas, 62 bottomland hardwood sites were prioritized by the USFWS according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the North East Texas19-County Regional Water Planning area. The proposed Marvin Nichols I reservoir is within and adjacent to the Sulphur River Bottom West site and is listed as a Priority 1 site and a Priority 5 site [15] by the USFWS *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.2.2.9 Conservation Easements

Conservation Easements, like Mitigation Banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, Conservation Easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no known Conservation Easements within the footprint of the proposed Marvin Nichols I reservoir. However, the White Oak Creek Wildlife Management Area (WMA) is located downstream of the reservoir site.

4.2.2.10 Social and Economic Conditions

The proposed Marvin Nichols I reservoir is located in Franklin, Morris, Red River, and Titus Counties. The majority of the reservoir is in Red River County, which has a population of 14,317 according to the 1990 Census. The Texas State Data Center has estimated the 2020 population to be approximately

15,077.[16] This corresponds to a five-percent growth in Red River County. The median household income for Red River County in 1989 was $16,217.[15]

4.2.2.11 Historical or Archeological Resources

If identifiable cultural resources are discovered during project operation or construction, they would be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The proposed Marvin Nichols I reservoir will affect portions of Franklin, Morris, Red River, and Titus Counties.

Historical and Archeological Resources for these four countries were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in

Table 4.1-134.[19]

Table 4.2-14 Historical and Archeological Resources for Marvin Nichols I

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Franklin	27	1	8	17	1	0
Morris	26	1	24	0	1	0
Red River	115	1	108	0	6	0
Titus	39	1	37	0	1	0

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 4.2-15) details the results of previous cultural studies that have been performed in the area since 1879. Although Titus County has been investigated more thoroughly than the other counties for cultural resources due to the construction of existing reservoirs and conveyance facilities, there is the potential for additional archeological sites to be located in the area of the proposed reservoir. There is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Franklin, Morris, and Red River Counties.[17]

Table 4.2-15 Evaluation of Existing Site Files, Northeast Texas Archeological Region

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Subotal*
Franklin	15	42	25	5	87
Morris	5	6	6	9	26
Red River	32	104	30	18	184
Titus	149	239	52	17	457
Total	**201**	**391**	**113**	**49**	**754**

* Significance refers to National Register criteria.
Source : THC, 1993.

4.2.2.11.1 Cultural History

Based on reported investigations of the archeological sites, a chronological framework for the Northeast Texas region has been determined and is presented in Table 4.2-16.

This Page Intentionally Left Blank

Table 4.2-16 Chronological Framework for the Northeast Texas Archeological Region

Period	***Dates***
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition. Table 4.2-17 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 4.2-17 Archeological Resources with Associated Periods

County	***Paleoindian***	***Archiac***	***Early Ceramic***	***Formative Caddoan Early Caddoan Middle Caddoan***	***Late Caddoan***
Franklin			1	5	14
Morris				1	15
Red River			5	12	14
Titus		1	4	14	27

Source: THC, 1993, and Perttula T. K., 1999.[18]

4.2.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the region's archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

4.2.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the reservoir and within a one-mile buffer from the proposed reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is cropland and pasture. Table 4.2-18 depicts the percent coverage by major land uses within the proposed reservoir study area.[19]

Table 4.2-18 Land Use for the Proposed Marvin Nichols I Reservoir Study Area

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	46%
Deciduous Forest Land	40%
Mixed Forest Land	12%
Evergreen Forest Land	1%
Reservoirs	1%

4.2.2.13 Regulated Materials

Available TNRCC data were used to determine the existence of recorded superfund clean up sites, municipal solid waste landfill sites… within the reservoir study area. The reservoir study area includes an area within the proposed extent of the reservoir and within a one-mile buffer from the proposed reservoir extent. The analyses indicate that there are no recorded Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density at or near the proposed site.[20]

Table 4.2-19 Potential Environmental Impact Summary for Marvin Nichols I

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
Substantial Wetland Areas	Moderate
USFWS Priority Bottomland Hardwood Area	Moderate
White Oak Creek WMA	Moderate

---

[1] State of Texas. Texas Water Development Board. August 1997. Water for Texas.

[2] Freese and Nichols Inc., and Alan Plummer and Associates, Inc. 1990. Regional Water Supply Plan. Volume One – Report, and Volume Two – Appendices, Tarrant County Water Control and Improvement District Number One.

[3] Meeting between Freese and Nichols, Inc. (FNI) and Turner, Collie and Braden, Inc. (TC&B). 2000.

[4] R.T.Saucier. U.S. Army Engineer Waterways Experiment Station. Corps of Engineers. November 1967. Geological Reconnaissance of the Sulphur River and Cypress Creek Basins, Texas.

[5] United States Department of the Interior. Bureau of Reclamation. July 1990. Texas Big Sandy Study, Supporting Material, Volume A, Engineering and Geology.

[6] FNI, 1996. Freese and Nichols, Inc. 1996. North Texas Municipal Water District.

[7] TNRCC, 1999. Users Manual for Daily Reservoir Analysis Programs, SYMDLYBE (mainstem) & SMDYOC 99 (off-channel) Draft, December.

[8] Texas Water Development Board (TWDB), 1999. Planning Criteria of the Consensus State Water Plan, From TWDB web site, December.

[9] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[10] Texas Natural Resource Conservation Commission (TNRCC). 1996. *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96.*

[11] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science,* 2:93-117.

[12] F.W. Gould, Vegetational Areas of Texas, 1962,1969

[13] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[14] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[15] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[16] Texas Historical Commission. 1998. Texas Historic Site Atlas [Online]. Available: http://atlas.thc.state.tx.us/ [2000, April].

[17] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[18] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[19] www.tnris.state.tx.us

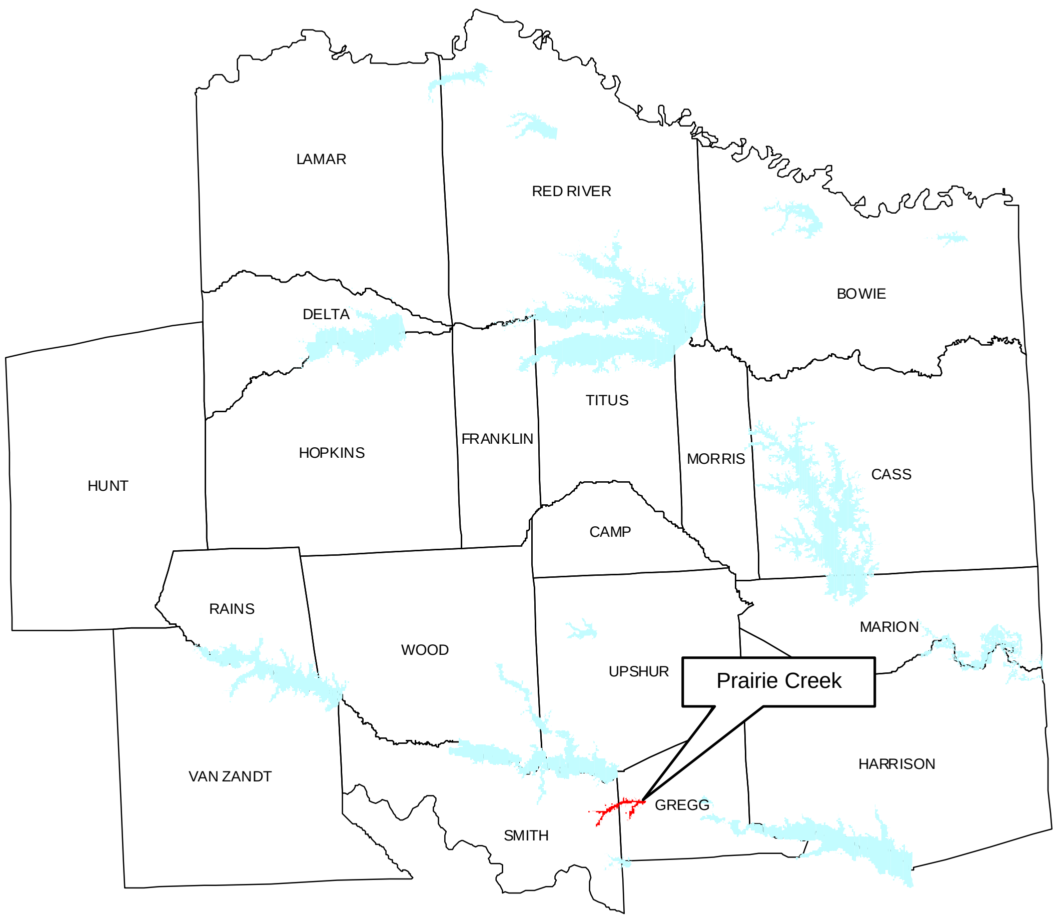
[20] www.tnris.state.tx.us----GIS

4.3 PRAIRIE CREEK

4.3.1 Summary of Prior Studies

4.3.1.1 Location

Figure 4.3-1 Location of Prairie Creek within the Region D Planning Region



Prairie Creek, as proposed in the City of Longview Preliminary Engineering Report for Prairie Creek,[1] has a damsite located 11 miles west of Longview in Gregg and Smith counties in northeast Texas just upstream of the FM 2207 crossing of Prairie Creek (figure 4.3-1). The damsite was selected in order to maximize yield without requiring relocation of FM 2207. Prairie Creek flows generally in an easterly direction and is a tributary to the Sabine River. Development of Prairie Creek reservoir should provide service to the Longview water supply service area, which includes the cities of Longview, Kilgore, White Oak, and Hallsville and other rural areas *(See Appendix, Exhibit D, Prairie Creek).*

4.3.1.2 Impoundment Size and Volume

At the top of conservation storage elevation of 318.0 feet msl, the storage capacity and surface area of Prairie Creek is 45,164 acre-feet and 2,280 acres respectively.[1] At the probable maximum flood (PMF) elevation of 339.5 feet msl, the reservoir surface area is 4,282 acres.[1] At the gated ogee elevation of 300.0 ft msl, the storage capacity is 14,545 acre-feet with a surface area of 1,145 acres. Reservoir area and capacity relationships shown below are based on planimeter and digitizer measurements of surface areas and corresponding elevations from U.S. Geological Survey 1:24,000 contour maps.

4.3.1.3 Site Geology and Topography

Site topography varies from hilly in the upland areas to nearly level in the floodplains.

The proposed damsite lies within the East Texas Embayment, a Mesozoic-aged depression typically defined by the basin rim faulting of the Mexia-Talco fault zone to the west and north, the Sabine Uplift to the east, and the Angelina-Caldwell flexure to the south. The materials in the embayment consist of sediments of the Cretaceous and Tertiary systems that have been modified by underlying salt dome movements.[2]

Structurally, the damsite lies immediately southeast of the Hawkins salt dome that is a dominant feature of the Hawkins oil and gas field. The Hawkins salt dome has resulted in deep subsurface faulting directly over the dome, but this has reportedly not significantly distorted Tertiary formations to a depth of about 2,000 ft below ground surface. Contours of the base of the Austin Formation, commonly used to trace the structural effects of salt intrusions, reportedly indicates that the damsite lies southeast of the actual salt dome, in an area free of faults and with nearly flat bedding.

Quaternary alluvium and alluvial terrace deposits, and Tertiary sediments of the Sparta, Weches, and Queen City Formations underlie the damsite and outcrop within the reservoir area.

The alluvial terrace material consists of upper level river sediments located above the present flood plain. The materials were originally deposited primarily as silt and granular materials, and have weathered to clay-matrix soils. At one location investigated, these materials were composed of about 15 ft of stiff to very stiff, lean and silty clays.

The recent alluvium in the river valley has been found to be between about 12 to 20 ft deep, and was also encountered under terrace deposits, between a depth of about 19 and 33 ft. The recent alluvium encountered consisted of medium dense sands under the terrace materials, and stiff to very stiff sandy lean clay in the flood plain, grading with depth to a medium dense, silty sand or clayey sand.

The Sparta, Weches, and Queen City Formation materials have been described using soils terminology although others describe the materials using rock terminology[3]. Possible rock structure and degree of weathering of the materials encountered were not identified on available boring logs, but based on sampling records, it is possible that these materials classify as rock.

The Sparta Formation is described as composed predominantly of hard silt with sand containing thin sandstone and siltstone ledges. Hard, low plastic clay is also reported.

The Weches Formation is described as composed of stiff, sandy, low plastic, clay, and very dense, silty sand. One boring encountered two feet of very dense, well-graded sand, locally known as iron-ore gravel, at the contact of the Weches Formation and the overlying recent alluvium.

The Queen City Formation is described as composed of hard, high and low plastic, clays, and very dense, silty sand.

Groundwater in boreholes was recorded after drilling. Groundwater was reported at a depth of about 2 ft in the flood plain, and at a depth of about 11 to 13 ft outside of the flood plain.

4.3.1.3.1 Geotechnical Conditions and Limitations

Both the terrace deposits and recent alluvium are reported to have adequate strength to permit construction of the proposed 66-ft high embankment dam[2]. It is possible that considerable foundation excavation may be needed to reach a base upon which to begin construction, depending upon the groundwater conditions at the time of construction. Loading upon the underlying, shallow bedrock, particularly the bedrock composed of fine-grained sediments, and the potential development of positive pore pressures therein should be considered to preclude potential slope stability issues.

It is envisioned the project may require the installation of a seepage barrier, most likely a cut-off wall through the alluvial foundation and abutment materials. The presence of the randomly occurring and pervious iron-ore gravels in the upper portion of the Weches Formation provides a potential path for foundation seepage unless intercepted by a cut-off wall.

Common excavation techniques appear to have been considered adequate for the majority of the site materials; thin rock ledges may require ripping to facilitate their removal. Minor seepage from sandy layers or strata is possible.

The proposed damsite is in seismic zone 1, a zone of minor seismic hazard, near the boundary with seismic zone 0. A preliminary evaluation of the seismic stability of the proposed dam considered a seismic event corresponding to seismic zone 2.

4.3.1.3.2 Construction Materials

Sufficient quantities of relatively impervious materials are expected to be available for embankment construction. These materials will come from foundation and abutment excavations and other borrow areas within the proposed reservoir. The study considered that sands that could be produced on-site for filters and concrete should be available on-site, although the available boring logs did not indicate their presence[2].

The development of reliable gravel reserves is expected to prove difficult, due to the limited amount and erratic pattern of gravel deposition along the reach of the Sabine River considered for the dam. Drain and concrete gravel may require importation from off-site sources. Stone suitable for riprap is reportedly not available in the area; a soil-cement facing may be considered as an alternative material for construction of upstream slope protection.

4.3.1.4 Dam Type and Size

As envisioned the Prairie Creek reservoir embankment will be constructed of compacted earthfill approximately 3000 feet in length with 3.5H:1V side slopes. The maximum height of dam is 87 feet, which corresponds to elevation 345.0 feet msl. With construction of a 6-inch thick compacted gravel surface for the roadway, the dam will provide 5.5 feet of freeboard from the probable maximum flood elevation. The upstream side slope of the embankment will have a soil cement facing protecting it face from wave runup. In addition, soil cement will be used on the downstream slope from the base to elevation 300.0 to protect against Sabine River floods. A slurry trench cutoff extending from 30 feet below the natural grade into the dam body at elevation 320.0 feet msl will reduce seepage through the embankment and foundation with a built-in relief system to reduce the likelihood of piping.

The proposed service spillway will be a gated, ogee-shaped spillway with a crest elevation of 300 ft msl. Two, 20-foot wide by 20-foot high tainter gates will divide the spillway for flood control efficiency. During the probable maximum flood, the proposed service spillway will convey the peak discharge of 29,700 cfs at a maximum water surface elevation of 339.5 feet msl. The stilling basin will dissipate increasing energy from the lengthy spillway chute using baffle blocks and an end sill. The outlet works will consist of a multi-level opening, a 66-inch diameter conduit through the dam embankment, and a stilling basin.

In order to increase the annual firm yield beyond what can be expected from natural runoff from the basin, a scalping operation as discussed later is proposed which utilizes diverted flows from the Sabine River. The facilities required for the scalping operation include 38,800 feet of 66-inch diameter raw water pipeline between an existing pump station and Prairie Creek Reservoir. Modifications to the pump station for the incorporation of the proposed pipeline would be also required.

4.3.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to Prairie Creek damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

Beyond the storage available for watershed runoff from naturalized flows for yield, a scalping operation to divert flows from the Sabine River will increase the conservation yield for the project. Hydrologic and hydraulic requirements for reservoir operations studies from naturalized runoff and diversion operations are summarized.

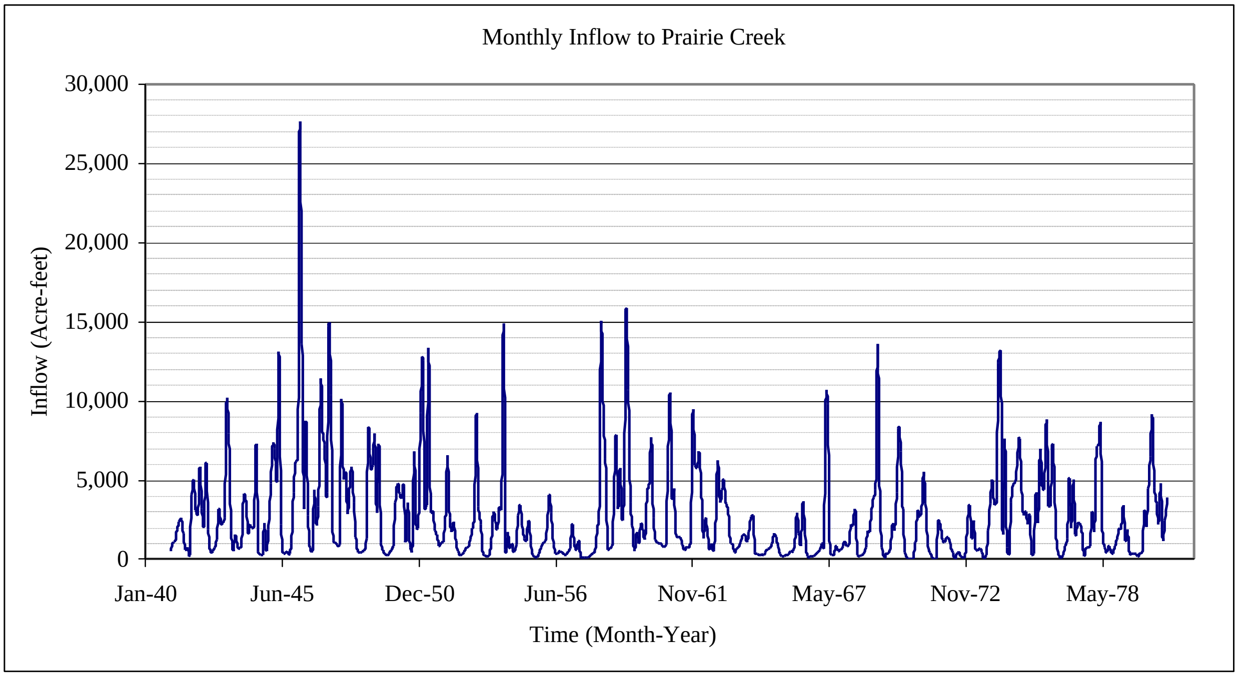
The amount and distribution of naturalized streamflows throughout the basin tributary to the Prairie Creek damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. From the 1984 study by Kindle, Stone, & Associates, reservoir yield was developed using the Texas Department of Water Resources RESOP II and the available water data from 1940-1980. In addition, the hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, pass-through flows to satisfy environmental requirements, and reservoir area and capacity characteristics.

4.3.1.5.1 Reservoir Inflows

Daily reservoir inflows are developed from U.S. Geological Survey historical flows originating below major reservoirs upstream of the proposed Prairie Creek site. The tributary drainage area is 57.2 square miles.[1] To derive the naturalized flows from the historical flows, daily flows are converted to monthly flows, and adjustments are made to these to account for diversions for upstream water rights and monthly spills from upstream major reservoirs.[1]

Figure 4.3-2 depicts the reservoir inflow from the 1984 Preliminary Engineering Report for Prairie Creek Reservoir prepared by Kindle, Stone & Associates for the period from January 1940 through December 1980. Updates could include expansion of the period of record to capture more recent inflow data, changes to water rights since the previous study was completed, and changes to the environmental flow requirements. Inflow equations are based on drainage area ratios, which vary depending on the location and size of the proposed reservoir and the corresponding location and size of the nearby U.S. Geological Survey gauging station.

Figure 4.3-2 Daily Reservoir Inflow Curve



4.3.1.5.2 Firm Yield

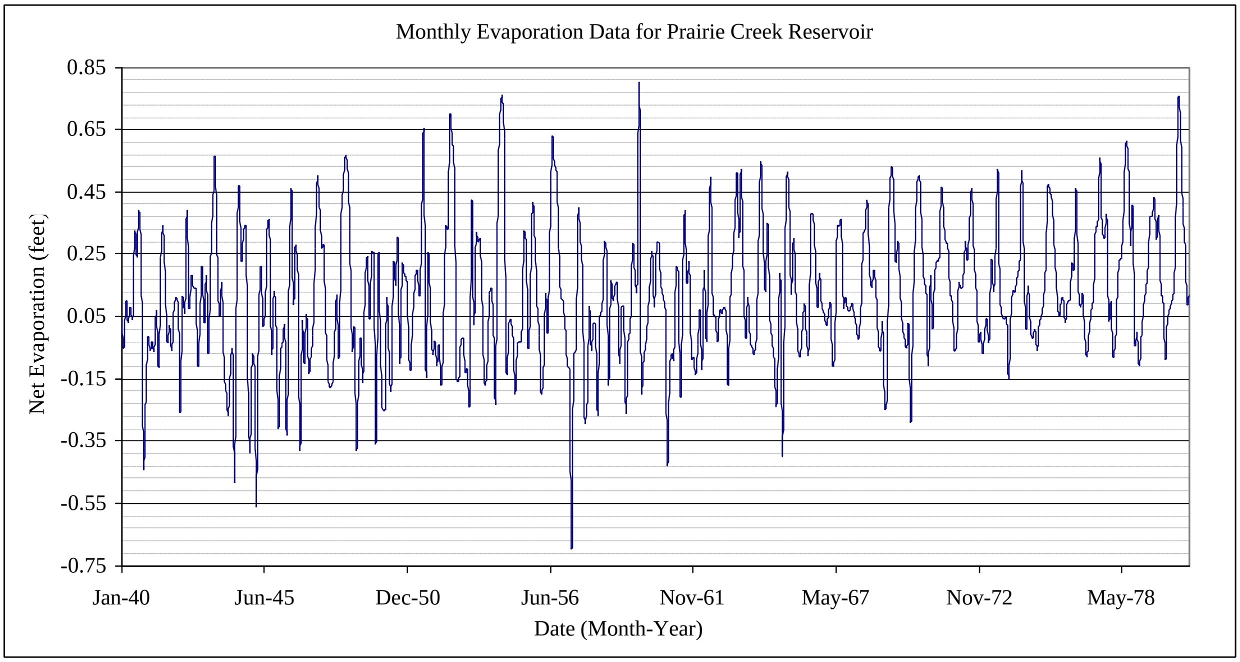
The Texas Water Development Board 31 TAC 357.7(a)(3) requires "an evaluation of adequacy of current water supplies available to the regional water planning area for use during drought of record. This evaluation shall consider surface water and groundwater data from the State Water Plan, existing water rights, contracts and option agreements, other planning and water supply studies, and analysis of water supplies currently available to the regional water planning area. Analysis of surface water available during drought of record from reservoirs shall be based on firm yield analysis of reservoirs".[4]

Firm yield studies are summarized for Prairie Creek in the section below entitled, "Project Yield for Water Supply."

4.3.1.5.3 Reservoir Evaporation

Reservoir evaporation data was estimated by Kindle, Stone & Associates in the 1984 Preliminary Engineering Report for Prairie Creek Reservoir using guidelines published by the Texas Water Development Board. The net evaporation used in the reservoir operation studies have been calculated as the difference between gross reservoir evaporation and precipitation, with positive values representing conditions when evaporation exceeds precipitation. Daily evaporation values are assumed to be constant within each month. From the report, the net reservoir evaporation rate for the study period averaged 1.35 feet per year.[1]

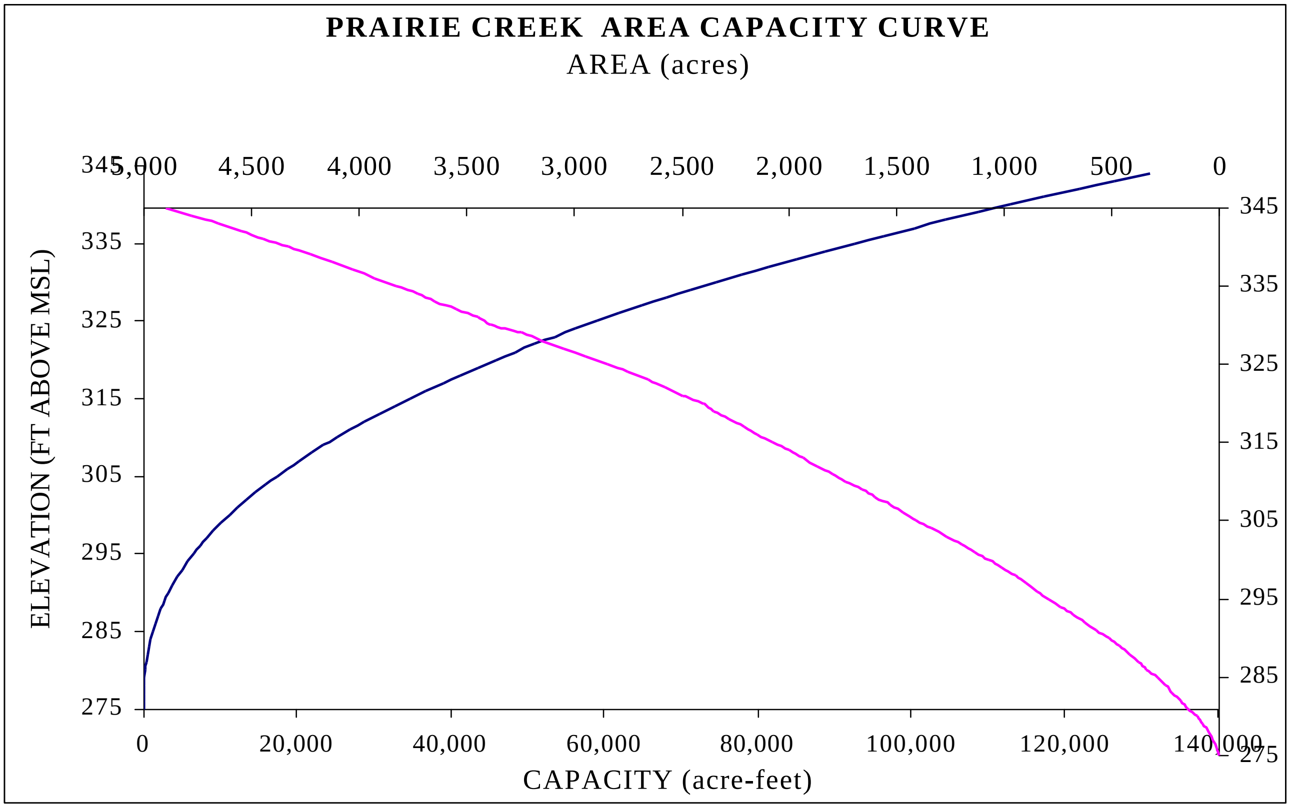
Figure 4.3-3 Monthly Evaporation Rates Curve



4.3.1.5.4 Area Capacity Data

The elevation-area-capacity relationship (also referred to as an area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. The relationship is based on the topographic characteristics of the land to be inundated by the reservoir. Reservoir area and capacity relationships shown below and are based on planimeter and digitizer measurements of area and elevation from U.S. Geological Survey 1:24,000 contour maps. During the life of the reservoir, sediment deposition within the reservoir typically alters that relationship and reduces the capacity of the reservoir. Sediment deposition is distributed in various zones of a reservoir at differing rates, depending on the shape of the reservoir and other factors such as the type of sediment from the tributary basin. A sedimentation production rate of 1.37 acre-feet per square mile per year was used in this study since it is based on field measurements of actual sedimentation at Lake Cherokee. Previously published values indicate a much lower sedimentation rate, but the conservative value is chosen partly because of the diversion flows from the Sabine River.

Figure 4.3-4 Area Capacity Curve



4.3.1.6 Water Quality

The examination of water quality is based upon existing water quality and streamflow data provided by the U.S. Geological Survey. Water quality data for Prairie Creek was recorded at a single location in the Prairie Creek near the Gladewater gauge from 1968 to 1976.[1] The water quality analyses include an evaluation of inorganic parameters and biological contaminants, if available. Table 4.3-1 provides a list of historical water quality data taken from the Kindle, Stone & Associates 1984 study.

Table 4.3-1 Water Quality Data

Parameter	*Number of Samples*	*Average Value*
Specific Conductance	82	139.7 UMHOS
PH	81	6.6 standard units
Hardness	81	109.9 mg/l as $CaCO_3$
Hardness, Noncarbonate		94.7 mg/l as $CaCO_3$
Calcium, dissolved	76	83.0 mg/l as Ca
Magnesium, dissolved	76	2.8 mg/l as Mg
Sodium, dissolved	37	13.1 mg/l as Na
Sodium Adsorption Ratio	74	1.1
Alkalinity Field	81	15 mg/l as $CaCO_3$
Carbonate	81	0 mg/l as $CaCO_3$
Sulfate, dissolved	76	10.3 mg/l as SO_4
Chloride, dissolved	82	24.0 as mg/l as Cl
Flouride, dissolved	65	0.11 mg/l as F
Silica, dissolved	75	19.8 mg/l as SiO_2
Potassium, dissolve	23	2.3 mg/l as K
Dissolved Solids, sum of constituents	74	89 mg/l
Nitrogen, nitrate	37	0.269 mg/l as N
Nitrogen, nitrate dissolve	2	0 mg/l as N

Note: Data in this report is based on analyses done at the time the reservoir was initially evaluated and the water quality evaluations were based on a comparison with standards that may have since changed.

The study interprets the results from the USGS conducted analysis from the watershed runoff to be of high quality, soft, and suitable for both domestic and industrial purposes.

4.3.1.7 Project Yield for Water Supply

Firm yield as described in the SB1 Regional Water Plan by the State of Texas is "the maximum amount of water supply, based upon simulation, that a reservoir could have produced each year if it had been in place during the drought of record. Firm yield analyses reported in the 1997 Water for Texas and any other equivalent existing analyses are acceptable. All water availability based on firm yield must satisfy full utilization of senior water rights. Where special conditions exist, such as the Rio Grande Project, water available based on operating procedures during the drought of record conditions will be used in place of reservoir firm yield analysis".[4]

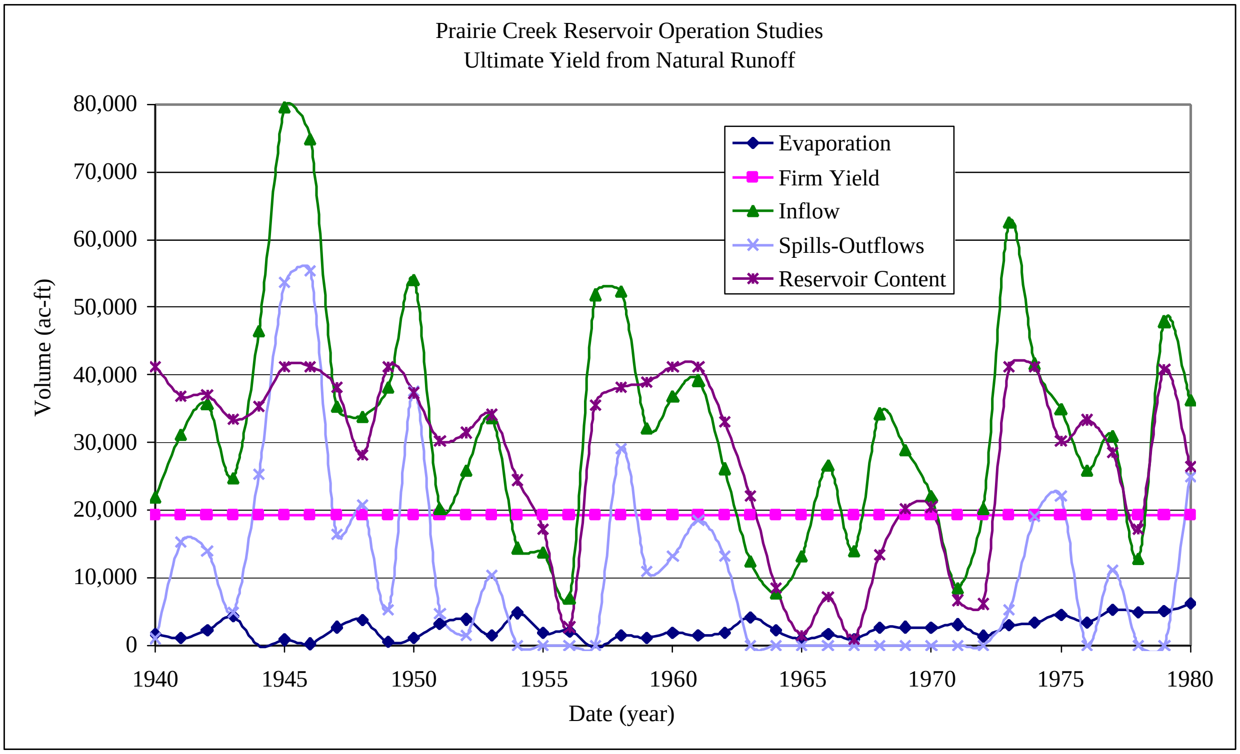
The basic procedures required in analyzing water availability in the river basin involve simulating on a monthly basis the ability of individual water rights to satisfy their authorized diversions or storage quantities under historical, but naturalized characteristics. By taking into account the wide range of historical naturally occurring streamflow conditions, the results provide a meaningful indication of the water available for the future. The Texas Water Development Board has criteria for determining firm yield analyses as outlined in Exhibit B of the SB1 Regional Water Plan.

The yield available from the Prairie Creek reservoir was calculated by computer operation studies. The analysis used area and capacity characteristics with 50 years of sediment deposition, reservoir inflow data, evaporation data, and the monthly reservoir demands such that during the critical drought period the reservoir is allowed to drawdown to the reservoir bed elevation.[1]

The annual firm yield from Prairie Creek Reservoir from natural runoff alone as calculated by Kindle, Stone & Assoc.[1] is 19,700 ac-ft/yr. (17.2 mgd) with the critical drought period determined to extend from June 1962 to September 1972.

Table 4.3-6 shows the summary of the reservoir operation studies with ultimate yield representing the firm yield with 50 years of sediment deposition reproduced in graphical format.

Figure 4.3-5 Reservoir Operation Summary



A normal pool elevation of 318.0 feet msl was established as this is the maximum water surface elevation which will not require modification of Interstate Highway 20.[1]

Reservoir yield can be significantly increased by supplementing the natural basin runoff with annual high flow diversions from the Sabine River during the months of December through May.[1] The scalping operation, as intended, will require a low water dam on the river to provide a pool for pumping, a pump station structure, raw water pumps, and a raw water pipeline to the reservoir. The hydrologic requirements include a regression analysis to determine frequency, magnitude, and duration for both low flows and high flows to determine when diversions can be made and at what capacity.[1]

Based on the analysis by Kindle, Stone & Assoc.[1] of low and high flow conditions for the proposed scalping operation, a new reservoir operation scenario is modeled. The results indicate an increase in firm yield to 38,400 acre-feet/year (34.3 mgd), a 99% increase from the firm yield produced from natural runoff alone.[1] More recent studies[5] have calculated a firm yield of 29,685 acre-feet/year (26.5 mgd) for the scalping operation. None of the above described yield studies included consideration of Environmental Pass-Through requirements in accordance with Consensus Environmental Guidelines Planning Criteria of the State Water Plan.

Additional Supplementation of the yield of Prairie Creek Reservoir via a pipeline from Toledo Bend Reservoir has also been proposed by the Sabine River Authority. A 90” pipeline would increase the total firm yield to approximately 115,000 acre-feet/year (102.6 MGD).[5]

4.3.1.7.1 Updated Yield Studies

Additional yield studies were performed for purposes of this Reservoir Site Assessment. No TNRCC Water Availability Model (WAM) of the Sabine River Basin is currently available. The TWDB Daily Reservoir Analysis Model, SIMDLYBE used to re-analyze the firm yield of the previously described reservoir configuration. Specific steps followed in the calculation of the updated firm yield are listed below.

1. Daily inflows were derived using daily flows recorded at U.S. Geological Streamflow gauges which are most nearly representative of the flow at the damsite. In the case of the Prairie Creek site the streamgauges and time periods used were:

2. Conduct a statistical analysis of the daily flows to determine the environmental pass-through requirements in accordance with the Consensus Environmental Guidelines Planning Criteria of the State Water Plan. The results of this statistical analysis are presented in Table 4.3-2. The seven-day/two year flows (7Q2) presented in this table are based on the records of Gauge No. 08020200.

3. Create a SIMDLYBE model of the proposed reservoir site using the daily flows developed as described inTask 1 and the environmental pass-through (releases) obtained as described in Task 2. Execute this model for conditions with and without the environmental pass-through assumptions to calculate the firm yield of the proposed reservoir.

Table 4.3-3 presents the results of the updated firm yield analysis and a comparison of the most recent previous analysis with environmental pass-through.

Table 4.3-2 Pass-Through (Release) Requirements for Prairie Creek (cubic feet/second)

Zone	*Goal*	*JAN.*	*FEB.*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
1	Median	39.0	47.0	53.0	41.0	37.0	18.0	8.0	5.0	7.0	8.0	16.0	33.0
2	25%	21.0	30.0	33.0	25.0	18.0	9.0	5.0	3.0	4.0	4.0	11.0	16.0
3	7Q2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Table 4.3-3 Updated Firm Yield for Prairie Creek

Updated FIRM Yield				*Previous Analysis (KSA, 1994)*	
W/O Environmental Releases		***WITH Environmental Releases***		*WITH Environmental Releases*	
Acre Feet/Year	***MGD****	***Acre Feet/Year***	*GD**	*Acre Feet/Year*	*MGD**
20,675	**18.5**	**17,215**	**15.4**	19,700	17.56

*Million Gallons per Day

The updated study shows an increase in yield from the previous study. It should also be re-stated that since no WAM model is currently available for the Sabine River the updated yield studies do not consider basin-wide water rights diversion which are considered in the WAM based analyses for George Parkhouse II and Marvin Nichols I.

4.3.1.8 Other Potential Benefit

4.3.1.9 Land Acquisition and Easement Requirements

The acquisition of land includes the purchase of land to elevation 318.0 feet msl, which is the conservation pool elevation. At this elevation, the reservoir acreage is 2,280 acres. In addition, an easement will be required for the scalping operation structures. This is explained further in Section 4.3.1.10.1.

4.3.1.9.1 Potential Land Use Conflicts

This section discusses the results of field reconnaissance studies made to locate potential conflicts in terms of roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. The following Table 4.3-4 shows the probable conflicts and associated resolutions for the reservoir development.

Table 4.3-4 Reservoir Conflicts Table

CONFLICT	*RESOLUTION*
State Highway 135	**Relocation at Prairie Creek and Caney Creek crossings.**
Old Kilgore Highway	**Relocation at Caney Creek crossing.**
FM 1252	**Relocation and widening at Prairie Creek and Caney Creek.**
Gas Well	**Relocation**
Powerline	**Relocation**
2 Gas Pipelines	**Relocation**
Telephone Lines	**Relocation**
Oil Producing Wells & Gas wells	**Scheduled to be abandoned and plugged before proposed initial reservoir filling (1993)**

4.3.1.9.2 Local, State, and Federal Permitting Requirements

A 1996 study discusses the need for the following four permits: 1) Water rights permits from the Texas Water Commission, 2) Section 404 permit from the U.S. Army Corps of Engineers, including all NEPA compliance, 3) Antiquities Permit from the Texas Antiquities Committee, and 4) Sand and Gravel Permit from the Texas Parks and Wildlife Department[5]. A summary of the requirements to obtain these permits is presented in Table 4.3-6.

Table 4.3-5 Permitting Requirements

Permit	*Issuing Agency*	*Purpose*
Water Rights	Texas Department of Water Resources	Approval of preliminary project design and water rights acquisition.
Section 404*/Section 10	U.S. Army Corps of Engineers	Project approval.

* Includes Section 401 Certification of Water Quality from Sate Agency (TWC)

No hydroelectric facilities are proposed for Prairie Creek, therefore a license from the Federal Energy Regulatory Commission (FERC) is not required.

4.3.1.10 Updated Project Costs

Opinions of probable project cost for the Prairie Creek Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in December 1998.[5] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in “Exhibit B” as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Items Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher capital cost estimate than the initial analysis, which estimated the project cost at $56,403,000 without the pipe diversion and $68,307,000 with the diversion. Please refer to

Table 4.3-6 for the Updated Project Cost without the diversion, Table 4.3-7 for the Updated Project Cost with the diversion and Table 4.2-10 for the Construction Cost.

The 90-inch pipeline from Toledo Bend Reservoir would raise the total capital cost to $174,553,000 (1998 dollars) to achieve a firm yield of 115,000 acre-feet/year. The feasibility of the pipeline has been increased because the Sabine River Authority is constructing a pipeline along a portion or the proposed route to serve an industrial customer.

4.3.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in

Table 4.3-6 and Table 4.3-7. The assumed average developed cost per acre of land for the reservoir was $2,300/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 2,280 acres plus the additional surface area attained for land easements above the conservation pool elevation, which together is approximately 2,850 ac.

4.3.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in

Table 4.3-6 and Table 4.3-7.

4.3.1.10.3 Construction Costs

As shown in Table 4.2-10, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

This Space Intentionally Left Blank

Table 4.3-6 Updated Project Cost without Pipe Diversion

Description	*Quantity*	*Unit*	*Unit Price ($)*	*Cost ($)*	*Total Cost ($)*
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$18,183,600
Relocations (conflict resolution)		L.S.			$10,848,540
Construction Capital Costs (CCC) Subtotal:					**$29,032,200**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$10,161,300
Land Cost	2,850	Ac.	$2,300.00		$6,555,000
Studies, Mitigation, Permitting					$7,266,800
Mitigation Costs (equal to land cost)		L.S.		$6,555,000	
Permitting & Studies					
Low classification (2% of Capital + Land)				$711,800	
Interest During Construction					$2,940,000
Other Project Costs Subtotal:					**$26,923,100**
			Dec. 1998 Subtotal:		$55,955,300
20-City Average Escalation Factor	0.8%				$447,650
OPINION OF PROBABLE PROJECT COST					**$56,403,000**

Notes:
1. Original cost estimates were taken from F&N, 1999.
2. Two tables listing the project costs with and without the pipeline diversion are included.
3. Interest during construction was added.
4. Engineering and other fees were increased to 35% of the Construction Costs.

Table 4.3-7 Updated Project Costs with Pipe Diversion

Description	*Quantity*	*Unit*	*Unit Price ($)*	*Cost ($)*	*Total Cost ($)*
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$18,183,600
Pipe Diversion (Aug. 1984 cost)		L.S.		$6,070,000	
20-City Average Index Factor Increase from Aug. 1984 to Dec. 1998	42.0%				$8,619,400
Relocations (conflict resolution)		L.S.			$10,848,540
Construction Capital Costs (CCC) Subtotal:					**$37,651,600**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$13,178,100
Land Cost	2,850	Ac.	$2,300.00		$6,555,000
Studies, Mitigation, Permitting					$7,439,200
Mitigation Costs (equal to land cost)		L.S.		$6,555,000	
Permitting & Studies					
Low classification (2% of Capital + Land)				$884,200	
Interest During Construction					$2,940,000
Other Project Costs Subtotal:					**$30,112,300**
			Dec. 1998 Subtotal:		$67,763,900
20-City Average Escalation Factor	0.8%				$542,120
OPINION OF PROBABLE PROJECT COST					**$68,307,000**

Notes:
5. Original cost estimates were taken from F&N, 1999.
6. Two tables listing the project costs with and without the pipeline diversion are included.
7. Interest during construction was added.
8. Engineering and other fees were increased to 35% of the Construction Costs.
9. Additional environmental mitigation may be required to offset impacts of diversion structure and pipeline.

Table 4.3-8 Construction Costs

Item #	Description	Quantity	Unit	Unit Price ($)	Total Cost ($)
	Dam Embankment				
1	Diversion & Care of Water		L.S.		$720,000
2	Clearing & Grubbing	33	Ac.	$864.00	$28,512
3	Excavation, Stripping	53,200	C.Y.	$2.88	$153,216
4	Compacted Fill	1,362,000	C.Y.	$2.88	$3,922,560
5	Slurry Trench	173,000	S.F.	$5.76	$996,480
6	Soil Cement	65,800	C.Y.	$28.80	$1,895,040
7	Embankment Drainage & Instrumentation		L.S.		$423,360
8	Topsoil	10,100	C.Y.	$14.40	$145,440
9	Hydromulch	660,000	S.F.	$0.10	$66,000
10	Roadway		L.S.		$110,880
	Spillway				
11	Clearing & Grubbing	10	Ac.	$864.00	$8,640
12	Excavation	356,000	C.Y.	$2.88	$1,025,280
13	Piles	590	ea.	$864.00	$509,760
14	Concrete, weir	1,330	C.Y.	$300.00	$399,000
15	Concrete, slabs	2,200	C.Y.	$250.00	$550,000
16	Concrete, walls	7,190	C.Y.	$325.00	$2,336,750
17	Tainter Gates	2	ea.	$319,000.00	$638,000
18	Superstructure & Hoists		L.S.		$144,000
19	Drainage System		L.S.		$72,000
20	Riprap Bedding	960	C.Y.	$21.60	$20,736
21	Riprap	9,620	Ton	$43.20	$415,584
22	Hydromulch	75,000	S.F.	$0.10	$7,500
23	Fencing	800	L.F.	$21.60	$17,280
	Outlet Works				
24	Concrete, Intake Structure	250	C.Y.	$504.00	$126,000
25	66" Conduit	500	L.F.	$324.00	$162,000
26	Concrete, Stilling Basin	160	C.Y.	$250.00	$40,000
27	Riprap	110	Ton	$43.20	$4,752
28	Excavation	4,200	C.Y.	$2.88	$12,096
29	Gates & Access Bridge		L.S.		$108,000
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$15,058,870**
	Mobilization (5% of BCS)				$752,950
			Subtotal:		$15,811,820
	OH & P (15% of Subtotal)				$2,371,780
	Construction Capital Cost Subtotal (CCC)				**$18,183,600**

4.3.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 17,215 acre-feet/year without the pipe diversion and 29,685 acre-feet/year with the pipe diversion, as derived from reservoir operation studies, and has a total project cost of $56,403,000 and $68,247,790 (

Table 4.1-5 Updated Firm Yield for George Parkhouse II.), respectively. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost.

For Prairie Creek Reservoir Project without the diversion, the O&M is $435,490 and the annualized debt service is $3,993,500. The firm yield is then divided into the total annualized cost of $4,428,990 to yield a unit cost of $257.28 per acre-foot ($0.79/1,000 gal) of firm yield.

For Prairie Creek Reservoir Project with the diversion, the O&M is $564,780 and the annualized debt service is $4,836,400. The firm yield is then divided into the total annualized cost of $5,401,180 to yield a unit cost of $181.95 per acre-foot ($0.56/1,000 gal) of firm yield.[5]

For Prairie Creek Reservoir Project with the 90” pipeline from the Toledo Bend Reservoir, the O&M is $6,498,167 and the annualized debt service is $12,681,067. The firm yield is then divided into the total annualized cost of $19,179,234 to yield a unit cost of $166.78 per acre-foot ($0.51/1,000 gal) of firm yield.[5]

These annualized costs are summarized in contained in the executive summary.

4.3.2 Environmental Overview –Affected Environment and Environmental Consequences

4.3.2.1 Geological Elements

4.3.2.1.1 Physiography

The proposed reservoir is located within the Pineywoods of Texas. The Pineywoods area is comprised of approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods lie entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dalisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

4.3.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River Counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[6]

The area of the proposed reservoir was formed during the Eocene period. This area is composed primarily of Queen City Formation and some Alluvium.

Queen City Formation consists of quartz sand, with thin beds of clay and sandy clay, and ironstone concretions. The quartz sand is fine grained and medium grained locally. It is massive, cross-bedded, and light gray. The weathers are grayish orange pink. Queen City Formation can also be clay and sandy clay, thinly bedded and locally carbonaceous. The weathers can also be very light gray to white. It is 100-300 feet thick and thins eastward.

4.3.2.1.3 Soils

The area of the proposed reservoir contains three major soils groups.[9] These groups are Bowie-Cuthbert-Kirvin, Iuka-Guyton-Mantachie, and Lilbert-Darco-Briley. Approximately 45 percent of the area consists of Bowie-Cuthbert-Kirvin, 53 percent Iuka-Guyton-Mantachie, and two percent Lilbert-Darco-Briley. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation etc.) generally associated with the location where the soil types are found within the projected reservoir site.

Bowie

The Bowie series consists of very deep, well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain deposits. These soils are on broad very gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The climate is humid; mean annual precipitation ranges from 40 to 50 inches; and mean annual temperature from 64 to 69 degrees F. The Thornthwaite annual P.E. index exceeds 64. The frost-free days range from 220 to 250. Elevation ranges from 150 to 600 feet above msl. Runoff is low on 1 to 3 percent slopes, medium on 3 to 5 percent slopes, and high on 5 to 8 percent slopes. A perched water table is at a depth of 3.5 to 5 feet during winter and early spring in most years. The principal use is for pasture and forest. Some areas are used for growing corn, peanuts, sweet potatoes, peaches, watermelons and other vegetables or fruit crops. Pasture is mainly bermudagrass or bahiagrass. Forests consists of loblolly and shortleaf pines, sweetgum, red oak, and hickory trees with tall and midgrasses.

Briley

The Briley series consists of very deep, sandy, well-drained, moderately permeable soils that formed in sandy and loamy Coastal Plain sediments. These soils are on gently sloping to moderately steep broad interstream divides. Slopes are dominantly 2 to 5 percent, but range from 1 to 20 percent. Mean annual rainfall ranges from 40 to 48 inches and is evenly distributed throughout the year. Frost-free days range from 240 to 275 days and elevation ranges from 350 to 600 feet above msl. Mean annual temperature ranges from 64 degrees to 69 degrees F., and the Thornthwaite P-E index exceeds 64. The soil type is used mainly for woodlands of loblolly and shortleaf pine and for pastures of improved bermudagrass.

Cuthbert

The Cuthbert series consists of soils that are moderately deep to weakly consolidated sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on strongly sloping to steep uplands. Slopes are dominantly 8 to 25 percent, but range from 5 to 40 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 56 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 750 feet above msl. Mean annual temperature ranges from 63 to 67 degrees F, and Thornthwaite annual P-E indexes exceed 64. Runoff is medium for slopes of 5 to 20 percent and high for slopes greater than 20 percent. Cuthbert soils are used mainly for woodland and pastureland. The principal trees are shortleaf and loblolly pine, red oak, sweetgum, and other hardwoods. Pastures include common and improved bermudagrass, bahiagrass, and weeping lovegrass.

Darco

The Darco series consists of very deep, somewhat excessively drained, moderately permeable soils that formed in sandy and loamy deposits on uplands. It is gently sloping to steep and slopes range from 1 to 25 percent. The climate is warm and humid. The average annual rainfall ranges from 40 to 50 inches. Frost-free days range from 230 to 260. Elevation ranges from 400 to 700 feet above msl. The frost-free rainfall ranges from 25 to 30 inches. The mean annual temperature ranges from 63 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 84. Runoff is negligible on 1 to 3 percent slopes, very low on 3 to 5 percent slopes, low on 5 to 20 percent slopes, and medium on slopes greater than 20 percent. Most of the soil is used for pasture or woodland. Pastures are mainly in coastal bermudagrass or weeping lovegrass. Native trees include loblolly pine, shortleaf pine, red oak, and hickory. Watermelons, peanuts, small grain for grazing, and vegetables are grown in some areas.

Guyton

The Guyton series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in thick loamy sediments. These soils are on Coastal Plain local stream floodplains and in depressional areas on late Pleistocene age terraces. Slopes range from 0 to 1 percent. The climate is warm and humid. Mean annual temperature ranges from 60 to 70 degrees F. Average annual rainfall ranges from 42 to 62 inches. Where runoff is ponded, drainage is very poor. Runoff is slow to ponded. A seasonal high water table is at 0 to 1.5 feet below the surface from December through May, except where ponded. Where ponded, it is from 1 foot above the surface to 0.5 foot below the surface most of the time. In places, the soils are subject to rare, occasional, or frequent flooding. Most areas are in woodland. Water oak, bald cypress, water tupelo, loblolly pine, and shortleaf pine are dominant in the drainageways. On broad terraces, bald cypress and water tupelo generally are absent and sweetgum dominates. Some areas are used as pastureland or cropland.

Iuka

The Iuka series consists of deep, moderately well-drained, moderately permeable soils that formed in stratified loamy and sandy alluvial sediments. These soils are on nearly level floodplains. They are saturated with water at depths of 1 foot to 3 feet below the surface during wet seasons and are subject to flooding. Slopes range from 0 to 2 percent. The climate is warm and humid. Near the type location the average daily temperature for January is 42 degrees F., the average daily temperature for July is 79 degrees F., the mean annual temperature is about 61 degrees F., and the mean annual precipitation is about 54 inches. Iuka soils are rarely to commonly flooded. A water table is at depths of 12 or more inches, and the soil is commonly saturated with water between 12 and 40 inches during some season of most years. Much of the soil has been cleared and cultivated. It is cropped to corn, soybeans, small grains, truck crops, and hay or is in pasture. Native vegetation is forest of water oak, willow, beech, sweetgum, hickory, maple, ironwood, eastern cottonwood, alder, white oak, and in some places, pine.

Kirvin

The Kirvin series consists of soils that are deep to stratified sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on gently sloping to moderately steep convex uplands. Slope is dominantly 2 to 8 percent, but ranges from 1 to 15 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 48 inches, with frost-free rainfall of 25 to 30 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 650 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. Runoff is very low on 1 to 3 percent slopes, low on 3 to 5 percent slopes, and medium on 5 to 15 percent slopes. Principal use is for pastureland and woodland. Bermudagrass is the main pasture grass. Forests are of shortleaf, slash, and loblolly pine, red oak, sweetgum, and other hardwood trees. A few areas are used for growing truck crops, cotton, corn, and oats.

Lilbert

The Lilbert series consists of very deep, well-drained, moderately slowly permeable soils. These soils formed in sandy and loamy deposits on uplands. Water runs off the surface slowly. Slopes range from 1 to 8 percent. A perched water table may occur in late winter to early spring from 3 to 6 feet below the soil surface. Average annual temperature ranges from 64 to 69 degrees F., the mean annual precipitation ranges from 40 to 50 inches. Frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 240 to 275. Elevation ranges from 350 to 600 feet above msl. The Thornthwaite P-E index is 66 to about 80. Runoff is slow. The areas where this soil type occurs are used mainly for woodland and pasture. However, some areas are used for cropland. Native vegetation consists of loblolly pine, shortleaf pine, hickory, sweetgum, red oak, and other hardwoods.

Mantachie

The Mantachie series consists of somewhat poorly drained, moderately permeable soils. They formed in loamy alluvium. These soils are on floodplains. They usually flood late in winter and early in spring. The seasonal high water table is at a depth of 1.0 to 1.5 feet. Slope is dominantly less than 1 percent but ranges to 3 percent. Near the type location the mean annual temperature is about 63 degrees F., and the mean annual precipitation is about 53 inches. These soils are subject to rare, occasional, or frequent flooding for brief to long duration, unless protected. The water table is within 1.0 to 1.5 feet of the surface during periods of high rainfall. Most areas of these soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture, and hay. Some areas are in bottomland hardwoods. Common trees are green ash, eastern cottonwood, cherrybark oak, loblolly pine, sweetgum, and yellow-poplar.

4.3.2.2 Hydrological Elements

4.3.2.2.1 Surface Water

The proposed reservoir would be within the Sabine River Basin. It would have a normal pool elevation of 320 msl. This portion of the Sabine River Basin is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0505 (Sabine River above Toledo Bend Reservoir). This 104-mile stream segment originates at a point immediately upstream of the confluence of Murvaul Creek in Panola

County to a point 330 feet downstream of US 271 in Gregg County. This segment is classified as "water quality limited" and designated uses include contact recreation, high aquatic life, and public water supply.

Total permitted facilities along this segment are described as in the following table[7]:

Table 4.3-9 Permitted Facilities

Type	***Quantity***	***Volume***
Domestic	23 outfalls	30.27 MGD*
Industrial	27 outfalls	3659.50 MGD
Agricultural	0 outfalls	0.00 MGD
Total	**50 outfalls**	**3689.77 MGD**

* MGD = Million Gallons per Day

As a result of occasional depressed dissolved oxygen concentrations, the high aquatic life use is only partially attained in a stretch of the segment from downstream of State Highway 149 in Panola/Gregg Counties to approximately 25 miles upstream around the confluence with Potter's creek in Harrison/Panola Counties. Elevated levels of nitrate plus nitrite, as well as total orthophosphorus, are a concern in a 40-mile stretch of the segment from upstream of the IH 20 bridge in Gregg County to the confluence with Potter's Creek in Harrison/Panola County.

Due to elevated levels of dissolved cadmium and lead in the water, the designated high aquatic life use is not attained in the lower 25 miles of the segment. Elevated levels of PolyChlirinatedBiphenyls (PBCs) in fish tissue are a concern in a stretch of the segment from downstream of SH 149 in Panola/Gregg Counties to approximately 25 miles upstream.

4.3.2.2.2 Ground Water

Gregg and Smith Counties are located within the outcrop region of the Queen City Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. Some water-bearing formations dip below the surface and are covered by other formations. This is the downdip. This aquifer extends in a band across most of Texas from the Frio River in South Texas northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson County. Total pumpage for all uses in 1994 was 16,319 ac-ft.

Sand, loosely cemented sandstone, and interbeded clay units of the Queen City Formation of the Tertiary Claiborne Group make up the aquifer as delineated within Texas. These rocks dip gently to the south and southeast toward the Gulf Coast. Although total aquifer thickness is usually less than 500 feet, it can approach 700 feet in some areas of northeast Texas. In the outcrop area, water occurs under water-table conditions while in the downdip subsurface, where the Queen City is covered by younger, non water-bearing rocks, the water is under artesian conditions. Usable quality water is generally found within the outcrop and for a few miles downdip, but in some areas it may occur down to depths of approximately 2,000 feet. Yields of individual wells are commonly low, but exceed 400 gal/min.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent however, quality deteriorates with depth in the downdip direction. The water may have high acidity (low pH) in much of northeast Texas and relatively high iron concentrations in localized areas. Hydrogen sulfide gas is sometimes present. Fortunately, each of these naturally occurring conditions may be treated relatively easily and economically.

While large amounts of usable quality groundwater are contained within the rocks of the Queen City, yields are low. Estimates of the availability of water from the Queen City Aquifer are based on recharge to the aquifer. Because of differences in topography, vegetative cover, and other factors, only two percent of the annual rainfall is estimated recharge in the Trinity, Colorado, Guadelupe, San Antonio and Neches River basins. Approximately five percent is estimated recharge in the Neches, Sulphur, Sabine, and Cypress Creek Basins. Total annual effective recharge to the aquifer is estimated to be 682,100 ac-ft.

4.3.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The proposed reservoir will cause water to be impounded on the Sabine River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river, as well as affected streams and tributaries.

The development of the proposed Prairie Creek reservoir would greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

4.3.2.4 Biological Elements

4.3.2.4.1 Vegetation

The proposed Prairie Creek reservoir is centrally located within the Austroriparian province[8] and is within the Pineywoods region.[9] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the proposed Prairie Creek reservoir location include Pine Hardwood (88%) and other (12%).

According to *Water and Wildlife, 1990*, the proposed Prairie Creek reservoir contains five cover types within its proposed boundaries. The resource categories are: hardwood pine forest (41%), grasses (38%), bottomland hardwood forest (12%), pine forest (6%), and other (3%).[10]

4.3.2.4.2 Fish and Wildlife

The proposed Prairie Creek reservoir would result in a decrease of stream and terrestrial habitat and an increase of deepwater and shoreline habitat.

The proposed Prairie Creek reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter.[11]

4.3.2.4.3 Endangered and Threatened Species

The U.S. Fish and Wildlife Service (USFWS) and TPWD combined lists for threatened, endangered, or rare species identify seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the proposed project location (Table 4.3-10). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 4.3-10 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Gregg and Smith Counties)

Common Name	*Scientific Name*	*USFWS Status*	*TPWD Status*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Western Sand Darter	*Etheostoma clarum*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*		T
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Louisiana Pine Snake	*Pituophis melanoleucus ruthveni*	C1	T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Rough-stem aster	*Aster puniceus* ssp. *Eliotti* var. *scabricaulis*		R
Texas Trillium	*Trillium pusillum* var. *texanum*		R

Sources: USFWS 1998, TPWD 1999.
USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE-Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range).
LT-Federally Listed Threatened (species which is likely to become endangered within the foreseeable future).
C1-Federal Candidate, Category 1; information supports proposing to list as endangered/threatened .
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance.
DL, PDL - Federally Delisted/Proposed Delisted.
TPWD: Texas Parks and Wildlife Department Status
E-Listed as Endangered in the State of Texas.

T-Listed as Threatened in the State of Texas.

R-Rare, but with no regulatory listing status.
(Texas Department of Transportation, Annotated County Lists of Rare Species for Gregg, Smith, and Upshur Counties, 1999.)

4.3.2.5 Ecologically Unique Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the Regional Water Plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the proposed Prairie Creek reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.3.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The regulatory definition of wetland used by the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) for administering the Clean Water Act Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on three mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline, or boundry of a wetland, was not performed at any site, within ot immediately adjacent to the proposed Marvin Nichols I reservoir location. A general preliminary determination was preformed on the probability of wetland occurrence based upon hydric soils preliminarydeterminations and USFWS National Wetlands Inventory (NWI) maps. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current Natural Resource Conservation Service (NRCS) data shows six hydric soil associations are within the proposed Marvin Nichols I reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

The USFWS's NWI maps were reviewed for the area to determine the following indications of wetland types.

Table 4.3-11 Existing Wetland Acreage Affected by Proposed Reservoir

Wetland Type	***Approximate Acreage***	***Percentage of Total Proposed Reservoir Area***
Palustrine Emergent	57	2%
Palustrine Forested	475	19%
Palustrine Open Water	5	≤ 1%
Palustrine Shrub/Scrub	9	≤ 1%
Total	***546***	***22%***

4.3.2.7 Wetland Mitigation Banks

Wetland Mitigation Banking is a method by which compensatory mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation Banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Bank includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation Bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins Mitigation Bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM Mitigation Bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of the potential Big Sandy reservoir in the Sabine River floodplain.

There are no known existing or proposed Wetland Mitigation Bank projects that are located near or adversely affected by the proposed Prairie Creek reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.3.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland hardwoods comprise almost one-third of the remaining native habitat of the state. The proposed Prairie Creek reservoir is located within the Sabine River basin, which represents approximately 22 percent of the remaining bottomland hardwood areas in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the USFWS. Within Texas, 62 bottomland hardwood sites were prioritized by the USFWS according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the North East Texas 19-County Regional Water Planning area. There are no bottomland hardwood areas located within or adjacent to the proposed Prairie Creek reservoir [15] USFWS priority designated *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

4.3.2.9 Conservation Easements

Conservation Easements, like Mitigation Banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, Conservation Easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no Conservation Easements located within the footprint of the proposed Prairie Creek reservoir.

4.3.2.10 Social and Economic Conditions

The proposed reservoir is located in Gregg and Smith Counties. The populations of these counties according to the 1990 Census are 104,948 for Gregg County and 151,309, for Smith County. The Texas State Data Center has estimated the 2020 population for these counties to be 126,613 and 203,158, respectively.[16] This corresponds to a 21 percent and 34 percent increase, respectively. The median household income in 1989 for Gregg County was $25,484 and $25,769 for Smith County.[12]

4.3.2.11 Historical or Archeological Resources

If identifiable cultural resources are discovered during project operation or construction, they would be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The proposed Prairie Creek reservoir will affect portions of Gregg, Smith, and Upshur Counties.

Historical and Archeological Resources for the three county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 4.3-12.[19]

Table 4.3-12 Historical and Archeological Resources for Prairie Creek

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Gregg	175	1	87	78	4	5
Smith	98	0	85	0	9	4
Upshur	183	1	182	0	0	0

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 4.3-13) details the results of previous cultural studies that have been performed in the area since 1879. Some counties have been investigated more thoroughly than other counties for cultural resources due to the federal mandated cultural resources and the construction of existing reservoirs and conveyance facilities. There is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Gregg, Smith, and Upshur Counties.[13]

Table 4.3-13 Evaluation of Existing Site Files, Northeast Texas Archeological Region

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Gregg	4	19	13	4	40
Smith	9	78	36	17	140
Upshur	18	30	24	12	84
Sub-total	31	127	73	33	264

* Significance refers to National Register criteria.
Source: THC, 1993.

4.3.2.11.1 Cultural History

Based on reported investigations of the archeological sites, a chronological framework for the Northeast Texas region has been determined and is presented in Table 4.3-14[5].

Table 4.3-14 Chronological Framework for the Northeast Texas Archeological Region

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggests that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition. Table 4.3-15 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 4.3-15 Archeological Resources with Associated Periods

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Gregg			1	4	7
Smith				16	13
Upshur			2	6	15

Source: THC, 1993, and Perttula T. K., 1999.[14]

4.3.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the region's archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

4.3.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the reservoir and within a one-mile buffer from the proposed reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is cropland and pasture. Table 4.3-16 depicts the percent coverage by major land uses within the proposed reservoir study area.[15]

Table 4.3-16 Land Use for the Proposed Prairie Creek Reservoir Study Area

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	27%
Deciduous Forest Land	3%
Mixed Forest Land	66%
Evergreen Forest Land	1%
Residential	2%
Transportation	1%

4.3.2.13 Regulated Materials

Available TNRCC data were used to determine the existance of recorded superfund clean up sites and municipal solid waste landfill sites, within reservoir study area. The reservoir study area includes an area within the proposed extent of the reservoir and within a one-mile buffer from the proposed reservoir extent. The analyses indicate that there are no recorded Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density at or near the proposed reservoir site.[16]

4.3.2.14 Potential Environmental Impact Summary

Table 4.3-17 Potential Environmental Impact Summary for Prairie Creek

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown

[1] Kindle, Stone & Associates. 1984.

[2] Freese & Nichols. Inc. Feasibility Report on the Belozora Landing Dam and Reservoir. May 1988

[3] United States Department of the Interior. Bureau of Reclamation. July 1990. Texas Big Sandy Study. Supporting Material. Volume A. Engineering and Geology.

[4] Texas Water Development Board. Water for Texas. August 1997.

[5] Freese & Nichols, Inc., and Texas Water Development Board. Comprehensive Sabine Watershed Management Plan. December 1999.

[6] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[7] Texas Natural Resource Conservation Commission (TNRCC). 1996. *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96.*

[8] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[9] Gould, F. W. 1975 Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[10] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[11] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[12] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[13] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[14] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[15] www.tnris.state.tx.us

[16] www.tnris.state.tx.us

5.0 POTENTIAL RESERVOIR SITES

The purpose of this study is to provide a summarized technical database developed from documents and reports of previous studies conducted for proposed and potential reservoir sites in the northeast Texas region. The strengths and weaknesses of the respective sites can be used for evaluation to help in determining implementation priorities. This work includes a search of available data, documents and reports of studies conducted by entities having interests in water supply development in the northeast Texas region.

This section summarizes key engineering and environmental data based on previous studies with respect to:

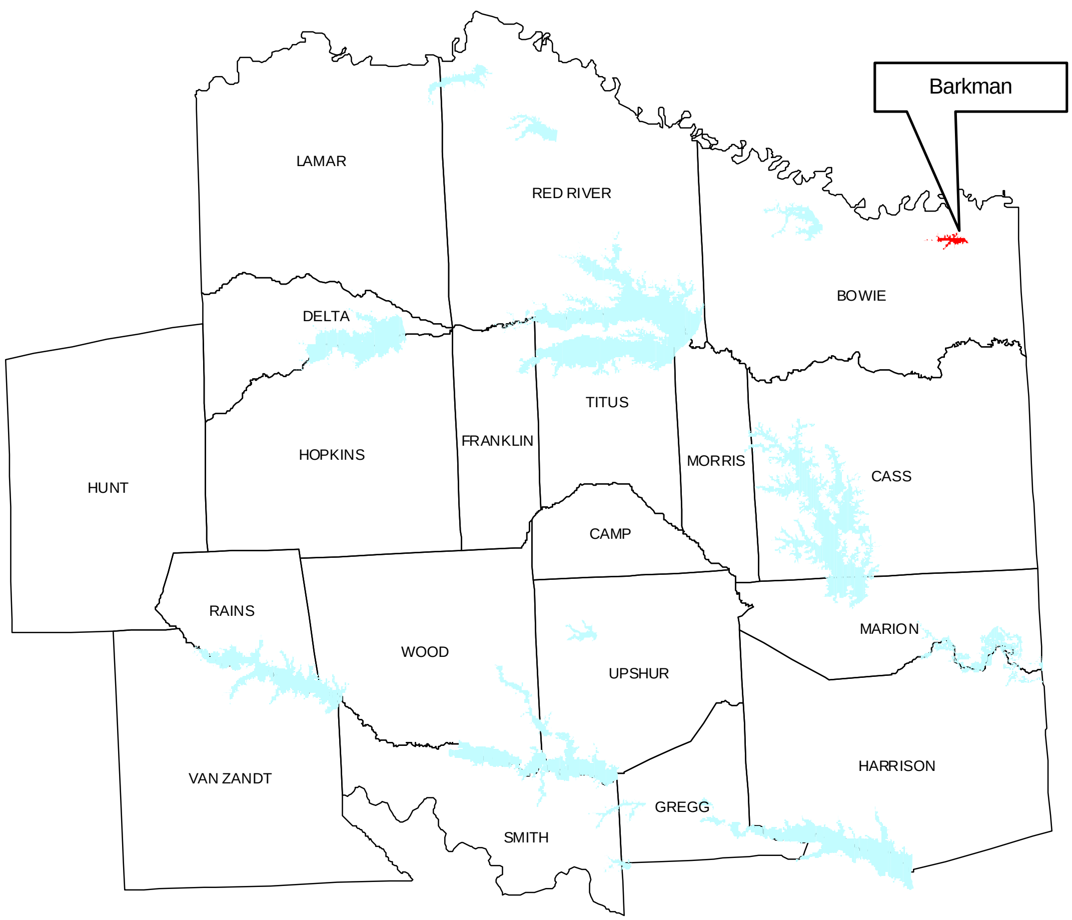
- *Location*
- *Impoundment size and volume*
- *Site geology and topography*
- *Dam type and size*
- *Hydrology and Hydraulics*
- *Water Quality*
- *Project yield for water supply*
- *Other potential benefits (e.g., flood control, irrigation, hydro power generation, recreation)*
- *Land Acquisition and Easement Requirements*
- *Potential land use conflicts*
- *Updated Project Costs (Engineering News Record Construction Cost Index,2nd Qtr. 1999)*
- *Geological Elements*
- *Hydrological Elements*
- *Biological Elements*
- *Ecologically Unique Stream Segments*
- *Wetlands*
- *Wetland Mitigation Banks*
- *Bottomland Hardwoods*
- *Conservation Easements*
- *Social and Economic Conditions*
- *Historical or Archeological Resources*
- *Land Use*
- *Regulated Materials*

5.1 BARKMAN

5.1.1 Summary of Prior Studies

5.1.1.1 Location

Figure 5.1-1 Location of Barkman within the Region D Planning Region



The Barkman potential reservoir is located in Bowie County near Texarkana (Figure 5.1-1). The site is in the Red River Basin *(See Appendix, Exhibit A, Vicinity Map).*

5.1.1.2 Impoundment Size and Volume

No information on impoundment size and volume was available for the Barkman Reservoir area.

5.1.1.3 Site Geology and Topography

No information on geology and topography was available for the Barkman Reservoir area. A surface area of 1814 acres was estimated from USGS Quadrangle maps.

5.1.1.4 Dam Type and Size

No information on dam type and size was available from previous studies for the Barkman Reservoir.

5.1.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the Barkman damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.1.1.6 Water Quality

No water quality information was available from previous studies on the potential Barkman Reservoir.

5.1.1.7 Project Yield for Water Supply

No yield information was available from previous studies on the potential Barkman Reservoir.

5.1.1.8 Other Potential Benefits

No potential benefit information was available from previous studies on the potential Barkman Reservoir.

5.1.1.9 Land Acquisition and Easement Requirements

No land acquisition and easement requirement information was available from previous studies on the potential Barkman Reservoir.

5.1.1.9.1 Potential Land Use Conflicts

No potential land use conflict information was available from previous studies on the potential Barkman Reservoir.

5.1.1.10 Project Costs

No project cost information was available from previous studies on the potential Barkman Reservoir.

Opinions of probable project cost for the Barkman Reservoir dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1975T he cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of

opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. Please refer to Table 1.1-1 for the Updated Project Cost.

5.1.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies. Too little information was provided in the initial cost estimate to estimate the land cost as a separate item in the other project costs.

5.1.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. Too little information was provided in the initial cost estimate to estimate the conflict resolution as a separate item in the other project costs.

5.1.1.10.3 Construction Costs

Construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included. Too little information was provided in the initial cost estimate to estimate the construction costs as a separate item.

5.1.1.10.4 Annual Cost

No annual cost information was available from previous studies on the potential Barkman Reservoir.

5.1.2 Environmental Overview –Affected Environment and Environmental Consequences

5.1.2.1 Geological Elements

5.1.2.1.1 Physiography

The potential Barkman reservoir is located within the Pineywoods of Texas. The Pineywoods area is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl.

The Pineywoods lie entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dalisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

5.1.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[1]

5.1.2.1.3 Soils

The area of the potential reservoir, Barkman Creek, contains six major soil groups.[9] These groups are Sawyer-Eyalu-Sacul and Whakana-Vesey-Ruston. Approximately 35 percent of the area is Sayer-Eylau-Sacul group, and 65 percent is Whakana-Vesey-Ruston. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the potential reservoir site.

Eylau

The Eylau series consists of deep, moderately well-drained, moderately slowly permeable soils that formed in thick loamy Coastal Plain sediments on uplands. Slopes are dominantly 1 to 2 percent but range from 0 to 5 percent. Mean annual precipitation ranges from 45 to 55 inches. Mean annual temperature ranges from 64 degrees to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64 inches. A perched water table is at 2 to 3 feet below the surface from February to May. Most of the acreage is in improved pasture of bermudagrass, bahiagrass, dallisgrass, and pine-oak woodland. A few areas are used for cropland. Native vegetation consists of loblolly pine, southern red oak, sweetgum, post oak, hickory, beaked panicum, longleaf uniola, and annuals.

Ruston

The Ruston series consists of very deep, well-drained, moderately permeable soils that formed in loamy marine or stream deposits on uplands of the Western and Southern Coastal Plains. These soils are on nearly level to moderately sloping uplands of the Western and Southern Coastal Plains on slope gradients of 0 to 8 percent. The climate is warm and humid with mean annual temperature of 65 degrees F., and mean annual precipitation of 59 inches near the type location. Principal use is woodland consisting of southern pine and some hardwoods with understories of shrubs or grasses. A small acreage is used for cotton, corn, soybeans, small grain, truck crops, and pasture. A considerable portion of the acreage formerly cultivated has been converted to pasture or southern pine woodland.

Sacul

The Sacul series consists of very deep, moderately well-drained, slowly permeable soils that formed in acid, loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 2 to 25 percent but range from 1 to 40 percent. The average annual air temperature ranges from about 60 to 66 degrees F and the average annual precipitation ranges from about 48 to 54 inches. Most of the acreage is in woodland, with some area in pasture. The forest vegetation is shortleaf and loblolly pine, red oak, sweetgum, and dogwood. Bermudagrass and bahiagrass are the principal pasture grasses used.

Sawyer

The Sawyer series consists of very deep, moderately well-drained, slowly permeable soils that formed in loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 1 to 8 percent but range to 25 percent. The average annual temperature ranges from about 60 to 66 degrees F. and the average annual precipitation ranges from about 48 to 54 inches. Most areas of this soil are in forests of loblolly and shortleaf pine. Cleared areas are dominantly used for pasture. The native vegetation was mixed shortleaf pine and hardwood forest.

Vesey

The Vesey series consists of deep, well-drained, moderately permeable soils on uplands and high stream terraces in loamy fluvial and marine sediments. Slopes are mainly 1to 5 percent, but range to 20 percent. At the type location, the average temperature is about 65 degrees F.; the mean annual rainfall is about 45 inches; and the Thornthwaite P-E index is about 76. Most of this soil is used for woodland and pasture. A few areas are used for growing corn, grain sorghum, soybeans, and watermelons. Native vegetation is mixed pine and hardwood forest that include shortleaf and loblolly pine, red oak, sweetgum, and post oak.

Whakana

The Whakana series consists of deep well-drained, moderately permeable soils on high terraces along the Red River formed in loamy alluvium. Slopes range from 0 to 20 percent but are mainly less than 5 percent. This soil is used mainly for pasture. A few areas are planted to corn and soybeans and a few areas are woodland. Native vegetation is hardwood and pine forest consisting of loblolly and shortleaf pine, red oak, sweetgum, and post oak with indiangrass, big bluestemgrass, little bluestemgrass, pinehill bluestemgrass, and longleaf uniola.

5.1.2.2 Hydrological Elements

5.1.2.2.1 Surface Water

The potential Barkman reservoir is located within the Red River Basin on Barkman Creek. Barkman Creek drains into the Red River. This portion of the Red River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality monitoring Program '96* as stream segment 201 (Lower Red River). This 49-mile segment originates at the Arkansas state line in Bowie County end extends to the Arkansas-Oklahoma state line in Bowie County. This segment is classified as "effluent limited" and designated uses are for contact recreation, high aquatic life, and public water supply. Elevated levels of orthophosphorus are present in the segment. These elevated nutrient levels do not appear to affect dissolved oxygen or chlorophyll *a*, but they have the potential to cause increased algal growth.[2]

5.1.2.2.2 Ground Water

Bowie County is located within the Nacatoch Aquifer. The Nacotoch Aquifer occurs in a narrow band in northeast Texas and extends eastward into Arkansas and Louisiana. Pumpage from the aquifer totaled 3,484 acre-feet in 1994, 74 percent of which was used for municipal purposes.

The Nacatoch Formation, composed of one to three sequences of sands separated by impermeable layers of mudstone or clay, was deposited in the East Texas basin during the Cretaceous Period. The aquifer also includes a hydrologically connected mantle of alluvium up to 80 feet thick where it covers the Nacatoch along major drainage ways. The south and east basinward dip of the formation is interrupted by the Mexia-Talco fault zone, which alters the normal flow direction and adversely affects the chemical quality of the groundwater. Groundwater in this aquifer is usually under artesian conditions except in shallow wells on the outcrop where water table conditions exist.

The quality of groundwater in the aquifer is generally alkaline, high in sodium bicarbonate, and soft. Dissolved solids concentrations increase in the downdip portion of the aquifer and are significantly higher downdip of faults. In areas where the Nacatoch occurs as multiple sand layers, the upper layer contains the best quality water. The water quality is generally acceptable for most uses, however, the high degree of mineralization precludes its use for irrigation in some areas.

Annual availability, equivalent to annual effective recharge, for the Nacatoch Aquifer is estimated to be 3,030 acre-feet. Recharge to the aquifer occurs mainly from precipitation on the outcrop. Aquifer water levels have been significantly lowered in some areas as a result of pumpage exceeding the effective recharge.[3]

5.1.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Barkman reservoir will cause water to be impounded on Barkman Creek as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river, as well as affected streams and tributaries.

The development of the potential Barkman reservoir would greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.1.2.4 Biological Elements

5.1.2.4.1 Vegetation

The potential Barkman reservoir is centrally located within the Austroriparian province[4] and is within the Pineywoods Region.[5] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, the Texas Parks and Wildlife Department (TPWD) divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Barkman reservoir location include pine hardwood (41%) and other (59%).

5.1.2.4.2 Fish and Wildlife

The potential Barkman reservoir would result in a decrease of stream and terrestrial habitat and an increase of deepwater and shoreline habitat.

The potential Barkman reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter. [6]

5.1.2.4.3 Endangered and Threatened Species

The U.S. Fish and Wildlife Service (USFWS) and TPWD combined lists for threatened, endangered, or rare species identify eight birds, three fish, two mammals, three reptiles, and one vascular plant to potentially occur or have habitat within the potential Barkman reservoir project location (Table 5.1-1). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.1-1 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Bowie County)

Common Name	*Scientific Name*	*USFWS Status*	*TPWD Status*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Cerulean Warbler	*Dendroica cerulea*		R
Henslow's Sparrow	*Ammodramus henslowii*		R
Least Tern	*Sterna antillarum***	LE	NL
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Arkansas meadow-rue	*Thalictrum arkansanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE-Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range).
LT-Federally Listed Threatened (species which is likely to become endangered within the foreseeable future).
C1-Federal Candidate, Category 1; information supports proposing to list as endangered/threatened .
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance.
DL, PDL - Federally Delisted/Proposed Delisted.

TPWD: Texas Parks and Wildlife Department Status
E-Listed as Endangered in the State of Texas.

T-Listed as Threatened in the State of Texas.
R-Rare, but with no regulatory listing status.

(Texas Department of Transportation, Annotated County Lists of Rare Species for Bowie County, 1999.)

5.1.2.5 Ecologically Unique Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the Regional Water Plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Barkman reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.1.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The regulatory definition of wetland used by the U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE) for administering the Clean Water Act Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on three mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline, or boundry of a wetland, was not performed at any site, within or immediately adjacent to the potential Barkman reservoir location. A general preliminary determination was preformed on the probability of wetland occurrence based upon hydric soils preliminarydeterminations and USFWS National Wetlands Inventory (NWI) maps. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current Natural Resource Conservation Service (NRCS) data shows six hydric soil associations are within the potential Barkman reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.1.2.7 Wetland Mitigation Banks

Wetland Mitigation Banking is a method by which compensatory mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation Banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Bank includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation Bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins Mitigation Bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM Mitigation Bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of the potential Big Sandy reservoir in the Sabine River floodplain.

There are no known existing or proposed Wetland Mitigation Bank projects that are located near or adversely affected by the potential Barkman reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.1.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland hardwoods comprise almost one-third of the remaining native habitat of the state.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the USFWS. Within Texas, 62 bottomland hardwood sites were prioritized by the USFWS according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the North East Texas 19-County Regional Water Planning area. There are no bottomland hardwood areas located within or adjacent to the potential

Barkman reservoir [15] USFWS priority designated *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.1.2.9 Conservation Easements

Conservation Easements, like Mitigation Banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, Conservation Easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no Conservation Easements located within the footprint of the potential Barkman reservoir.

5.1.2.10 Social and Economic Conditions

The potential Barkman reservoir is located in Bowie County. The population of this county according to the 1990 Census is 81,665. The Texas State Data Center has estimated the 2020 population to be approximately 89,105. This corresponds to a nine-percent growth in Bowie County.[7] The median household income for Bowie County in 1989 was $24,237.[8]

5.1.2.11 Historical or Archeological Resources

If identifiable cultural resources are discovered during project operation or construction, they would be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Barkman reservoir will affect portions of Bowie Counties.

Historical and Archeological Resources for these counties were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.1-2.[19]

Table 5.1-2 Historical and Archeological Resources for Barkman

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Bowie	155	NA	97	46	11	1

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.1-3) details the results of previous cultural studies that have been performed on the area since 1879. Although Bowie County has been investigated more thoroughly than other counties for cultural resources due to federal mandated cultural surveys, there is the potential that additional archeological sites could be discovered within the area of the potential reservoir during the construction of the reservoir.[9]

Table 5.1-3 Evaluation of Existing Site Files, Northeast Texas Archeological Region

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Bowie	53	126	52	21	252
Sub-total	53	126	52	21	252

* Significance refers to National Register criteria.
Source: THC, 1993.

5.1.2.11.1 Cultural History

Based on reported investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.1-4.

Table 5.1-4 Chronological Framework for the Northeast Texas Archeological Region

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.1-5 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.1-5 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Bowie	0	0	11	7	23

Source: THC, 1993, and Perttula T. K., 1999.[10]

5.1.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the region's archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that

have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.1.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is cropland and pasture. Table 5.1-6 depicts the percent coverage by major land uses within the reservoir study area.[11]

Table 5.1-6 Land Use for the Potential Barkman Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	34%
Deciduous Forest Land	18%
Mixed Forest Land	41%
Evergreen Forest Land	1%
Forested Wetland	2%
Residential	3%

5.1.2.13 Regulated Materials

Available TNRCC data were used to determine the existence of recorded superfund clean up sites and municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the reservoir and within a one-mile buffer from the potential reservoir extent. The analyses indicate that there are no recorded Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density at or near the proposed site.[23]

5.1.2.14 Potential Environmental Impact Summary

Table 5.1-7 Potential Environmental Impact Summary for Barkman Reservoir

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown

[1] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[2] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96*. Austin, Texas. TNRCC.

[3] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan*. Austin, Texas. TWDB.

[4] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[5] Gould, F. W. 1975. Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas

[6] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[7] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[8] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[9] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[10] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

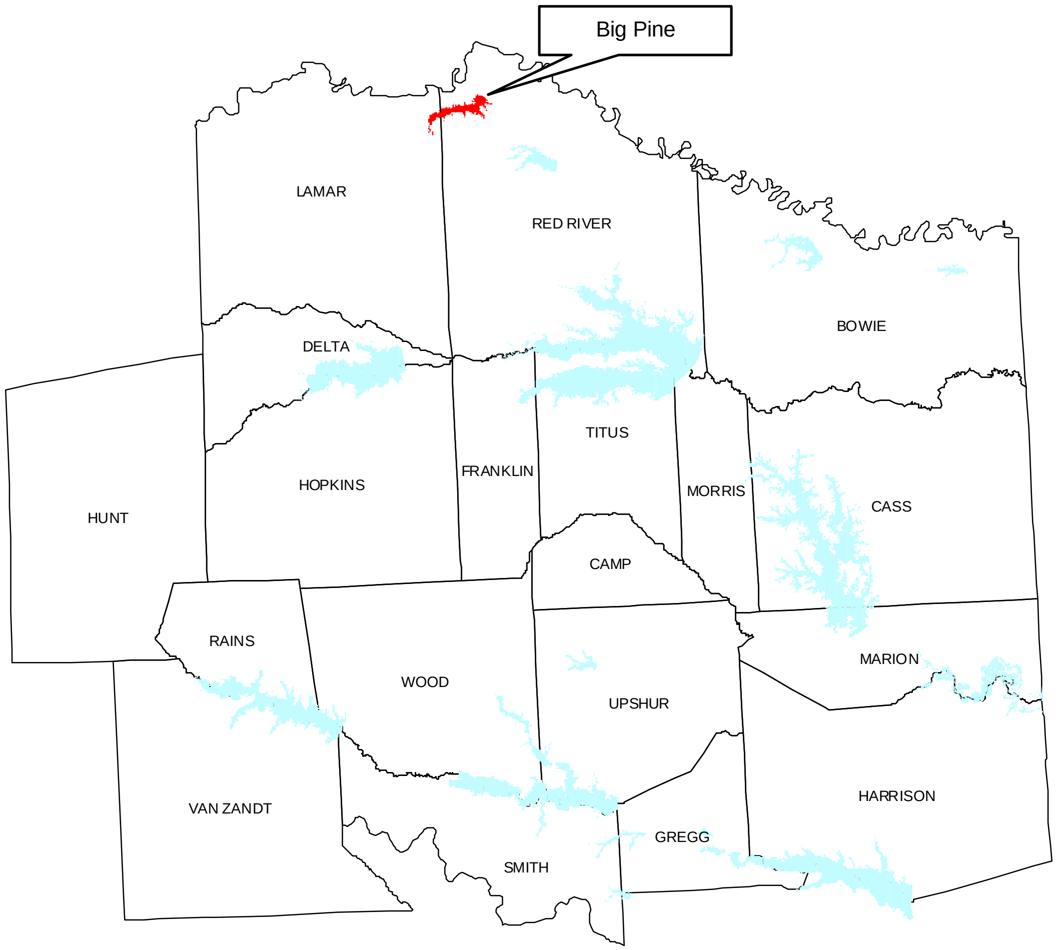
[11] www.tnris.state.tx.us

5.2 BIG PINE

5.2.1 Summary of Prior Studies

5.2.1.1 Location

Figure 5.2-1 Location of Big Pine within the Region D Planning Region



For additonal information about location, see Appendix, Exhibit A, Vicinity Map.

5.2.1.2 Impoundment Size and Volume

The land requirement for the project is approximately 9200 acres.[1]

5.2.1.3 Site Geology and Topography

No information on geology and topography was available from previous studies for the Big Pine Reservoir area.

5.2.1.4 Dam Type and Size

No information on dam type and size was available from previous studies for the Big Pine Reservoir.

5.2.1.5 Hydrology and Hydraulics

The total watershed is approximately 87 square miles. The amount and distribution of naturalized streamflows throughout the basin tributary to the Big Pine damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

The project would provide protection from the 50 year flood.

5.2.1.6 Water Quality

No information on water quality was available from previous studies.

5.2.1.7 Project Yield for Water Supply

The Big Pine Reservoir will provide a water supply of 35,840 ac-ft/yr. (32 MGD).[1]

5.2.1.8 Other Potential Benefits

The project would provide recreation facilities for about 440,000 annual visitors.

5.2.1.9 Land Acquisition and Easement Requirements

The total land requirement is 9200 acres.[3] The damsite is located upstream of high quality wetlands and 1,400 acres would be acquired in flowage easement and not be disturbed.

5.2.1.9.1 Potential Land Use Conflicts

There are approximately 50 archeological sites that would be inundated by the project.

5.2.1.10 Project Costs

Opinions of probable project cost for the Big Pine Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1975.[1] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise.

5.2.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies. Too little information was provided in the initial cost estimate to estimate the land cost as a separate item in the other project costs.

5.2.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. Too little information was provided in the initial cost estimate to estimate the conflict resolution as a separate item in the other project costs.

5.2.1.10.3 Construction Costs

Construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included. Too little information was provided in the initial cost estimate to estimate the construction costs as a separate item.

Table 5.2-1 Updated Project Cost

Description	*Quantity*	*Unit Price ($)*	*Total Cost ($)*
		1975 Subtotal:	$19,200,000
20-City Average Escalation Factor	173.0%		$33,216,000
OPINION OF PROBABLE PROJECT COST			**$52,416,000**

Notes:
1. Original cost estimate was taken from *Statement of Findings*. [1]
2. The Project Cost is listed as a lump sum and we assumed it includes Engineering Fees, Conflict Resolution, Land Costs, Studies, Mitigation, Permitting and Interest during construction.

5.2.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 35,840 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $52,416,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Big Pine Reservoir, the O&M is $786,240 and the annualized debt service is $3,711,200. The firm yield is then divided into the total annualized cost of $4,497,440 to yield a unit cost of $125.49 per acre-foot ($0.39/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 contained in the executive summary.

5.2.2 Environmental Overview –Affected Environment and Environmental Consequences

5.2.2.1 Geological Elements

5.2.2.1.1 Physiography

The potential Big Pine reservoir is located in the Post Oak Savannah. The Post Oak Savannah covers approximately 6.85 million acres of land. It averages 30-45 inches of precipitation annual with 235 to 280 frost-free days. The topography is nearly level to gently rolling with an elevation of 300-800 feet above msl. The Post Oak Savannah lies just to the west of the Pineywoods and mixes considerably with the Blackland prairies area in the south. The Post Oak Savannah, is a gently rolling, moderately dissected wooded plain.

Upland soils are gray, slightly acid sandy loams commonly shallow over gray, mottled or red, firm clayey subsoils. They are generally droughty and have claypans at varying depth, restricting moisture percolation. The bottomland soils are reddish brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial. Short oak trees occur in association with tallgrasses. Thicketization occurs in the absence of recurring fires or other methods of woody plant suppression.

5.2.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita

Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[2]

The area of the potential reservoir was formed in the Pleistocene period. The area is composed of Fluviatile terrace deposits. These deposits consist of gravel, sand, silt, and some silty clay. Basal gravel is well sorted, cross-bedded and grades upward into well-bedded sand and silt with some beds of silty clay. It is mostly red to reddish tan and the surface is smooth, and not greatly dissected. The soils are relative immature, and show distinct zonation. Both fresh-water and terrestrial molluscan faunas are identified. The maximum thickness is 30 feet.

5.2.2.1.3 Soils

The area of the potential reservoir contains three major soil groups.[9] These groups are Annon-Freestone-Woodtell, Severn-Billyhaw-Oklared, and Whakana-Vesey-Ruston. Approximately 52.2 percent of the area is Annona-Freestone-Woodtell, 39.7 percent Sever-Billyhaw-Oklared, and 8.1 percent Whakana-Vesey-Ruston. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Annona

The Annona series consists of very deep, moderately well-drained, very slowly permeable soils. On nearly level to moderately sloping Pleistocene terraces, soils formed in clayey alluvial terrace sediments. Mean annual temperature ranges from 64 to 68 degrees F., mean annual precipitation ranges from 40 to 48 inches, and the summer rainfall is about 25 to 30 inches. Frost-free days range from 230 to 280. The elevation ranges from 200 to 500 feet above msl. Thornthwaite annual P-E index ranges from 64 to 78. Runoff is low for 0 to 1 percent slopes, medium on 1 to 3 percent slopes, high on 3 to 5 percent slopes, and very high on 5 to 8 percent slopes. A saturated zone is perched above the Bt horizon for short periods following heavy rains. Almost all of this soil is in pasture and woodland. Forests are mixed hardwood and pine. Major hardwood species are red oak, post oak, sweetgum, and hickory. Needleleaf trees are shortleaf and loblolly pine. Pastures include improved bermudagrass, common bermudagrass, bahiagrass, with arrowleaf clover, crimson clover, and vetch overseeded. Some areas are used for growing corn, soybeans, grain sorghum, wheat, or hay crops.

Billyhaw

The Billyhaw series consists of very deep, moderately well-drained, very slowly permeable soils that formed in clayey alluvium on floodplains. Slopes range from 0 to 5 percent. Mean annual precipition ranges from 42 to 55 inches, and mean annual temperature ranges from 63 to 65 degrees F. Frost-free days range from 220 to 260 days and elevations range from 250 to 450 days. Thornthwaite P-E indexes exceed 64. This soil is used mainly for cropland. Main crops are soybeans, cotton, and wheat. Some areas are in pasture of common bermudagrass, improved bermudagrass, or tall fescue. Native vegetation is pecan, green ash, osage orange, elm, cottonwood, cherrybark oak, water oak, and willow oak, with an understory of grasses and shrubs.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Oklared

The Oklared series consists of very deep, well-drained, moderately rapidly permeable soils that formed in calcareous loamy and sandy alluvium on floodplains of streams that carry sediments mainly from Permian and Pennsylvanian Age geological materials. These soils occur in the Western Coastal Plain and Arkansas Valley and Ridges. These soils are on the outer edge of smooth to slightly concave and convex floodplains. Slope gradients are 0 to 3 percent. Mean annual precipitation ranges from 40 to 52 inches. Mean annual air temperature ranges from 60 degrees to 64 degrees F. Thornthwaite annual P-E indexes range from 64 to 80. Frost-free days range from 200 to 230. This soil has endosaturation (apparent water table) below a depth of 40 inches of the surface most of the year and ranges from 40 to 60 inches. These soils are rarely or commonly flooded for very brief periods mainly during January to July unless protected. Most areas have been cleared and are used for growing tame pasture, alfalfa, soybeans, grain sorghums, cotton, wheat, and peanuts. Native vegetation is eastern cottonwood, willow, common hackberry, and pecan with an understory of grasses.

Ruston

The Ruston series consists of very deep, well-drained, moderately permeable soils that formed in loamy marine or stream deposits on uplands of the Western and Southern Coastal Plains. These soils are on nearly level to moderately sloping uplands of the Western and Southern Coastal Plains on slope gradients of 0 to 8 percent. The climate is warm and humid with mean annual temperature of 65 degrees F., and mean annual precipitation of 59 inches near the type location. Principal use is woodland consisting of southern pine and some hardwoods with understories of shrubs or grasses. A small acreage is used for cotton, corn, soybeans, small grain, truck crops, and pasture. A considerable portion of the acreage formerly cultivated has been converted to pasture or southern pine woodland.

Servern

The Severn series consists of very deep, well-drained, moderately rapidly permeable soils that formed in silty alluvium on level to very gently undulating floodplains mostly in the Western Coastal Plains and Arkansas Valley and Ridges. Mean annual precipitation is 48 inches. Mean annual temperature is 62 degrees F. Slopes are 0 to 6 percent. Average annual precipitation ranges from 38 to 52 inches. Mean annual temperature ranges from 59 degrees to 65 degrees F. The Thornthwaite annual P-E indices are 64 to 80. They are rarely flooded in protected areas or commonly flooded for very brief or brief periods during January though October. Average frost-free days range from 210 to 240. Elevation ranges from 100 to 800 feet. Most areas have been cleared and are used for growing tame pasture, cotton, grain sorghums, soybeans, and alfalfa. Native vegetation is cottonwood, sycamore, hackberry, and pecan with an understory of grasses.

Vesey

The Vesey series consists of deep, well-drained, moderately permeable soils on uplands and high stream terraces in loamy fluvial and marine sediments. Slopes are mainly 1to 5 percent, but range to 20 percent. At the type location, the average temperature is about 65 degrees F.; the mean annual rainfall is about 45 inches; and the Thornthwaite P-E index is about 76. Most of this soil is used for woodland and pasture. A few areas are used for growing corn, grain sorghum, soybeans, and watermelons. Native vegetation is mixed pine and hardwood forest that include shortleaf and loblolly pine, red oak, sweetgum, and post oak.

Whakana

The Whakana series consists of deep well-drained, moderately permeable soils on high terraces along the Red River formed in loamy alluvium. Slopes range from 0 to 20 percent but are mainly less than 5 percent. This soil is used mainly for pasture. A few areas are planted to corn and soybeans and a few areas are woodland. Native vegetation is hardwood and pine forest consisting of loblolly and shortleaf pine, red oak, sweetgum, and post oak with indiangrass, big bluestemgrass, little bluestemgrass, pinehill bluestemgrass, and longleaf uniola.

Woodtell

The Woodtell series consists of soils that are deep to stratified shale and loamy materials on gently sloping stream divides. They are well-drained and very slowly permeable. The slope ranges from 1 to 20 percent. Woodtell soils are strongly to moderately steep side slopes of uplands. Slope gradients are mainly 2 to 12 percent but range from 1 to 20 percent. The soils formed in materials weathered from unconsolidated, stratified loamy, clayey, and shaly materials of Eocene age mainly in the Wilcox and Cook Mountian formations. The average annual rainfall ranges from 40 to 46 inches. The mean annual temperature is about 62 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 78. Frost-free days range from 230 to 270 and elevation ranges from 300 to 650 feet above msl. These soils are used mainly for pasture. Native vegetation is mainly post oak, blackjack oak, elm and red oak in a fairly dense savannah. In open areas tall and mid grasses such as bluestems, tridens and panicums are common with longleaf uniola under the tree canopy. American beautyberry and hawthorn species are also a part of the understory. The main pasture plants are bermudagrass and bahiagrass with crimson and arrowleaf clovers. There are scattered shortleaf and loblolly pine with small plantations and a some dense pine areas on the eastern side of the series province. Some areas are planted to small grain for winter grazing.

5.2.2.2 Hydrological Elements

5.2.2.2.1 Surface Water

The potential Big Pine reservoir is located within the Red River Basin. The reservoir would cover approximately 4,053 acres with a normal pool elevation of 420 feet above msl. Pine Creek drains into the Red River. This portion of the Red River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 202 (Red River below Lake Texoma). This 194-mile segment originates from the Arkansas-Oklahoma State Line in Bowie County to Denison Dam in Grayson County. This segment is classified as "water quality limited" and designated uses are for contact recreation, high aquatic life, and public water supply.[10]

5.2.2.2.2 Ground Water

The potential reservoir is located within both the outcrop and downdip portion of the Woodbine Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. Some water-bearing formations dip below the surface and are covered by other formations. This is the downdip.

The woodbine Aquifer extends from McLennan County in north-central Texas northward to Cooke County and eastward to Red River County, paralleling the Red River. Water produced from the aquifer furnishes municipal, industrial, domestic and livestock, and small irrigation supplies throughout this extensive north Texas region. Total public use for all purposes in 1994 was 15,572 acre-feet. The largest user of groundwater for public supply purposes is the City of Sherman.

The Woodbine Aquifer of cretaceous age is composed of water-bearing sand and sandstone beds interbedded with shale and clay. The water in storage is under water-table conditions in the outcrop and under artesian conditions in the subsurface. The aquifer reaches a maximum depth of 2,500 feet below land surface and maximum thickness of approximately 700 feet.

5.2.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Big Pine reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Big Pine reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.2.2.4 Biological Elements

5.2.2.4.1 Vegetation

The potential Big Pine reservoir is centrally located within the Texan province[3] and is within the Post Oak Savannah region.[4] The Post Oak Savannah vegetation area typically has a gently rolling to hilly topography, with moderately dissected wooded plain. The soil composition for this community consists of gray, slightly acidic sandy loams, and reddish brown to dark gray, slightly acidic to calcareous, loamy to clayey alluvial. The Post Oak Savannah soils support short oak trees and tallgrasses. Trees in the region consist of post oak and blackjack oak, elms, junipers, hackberries, and hickories. Yaupon, American beautyberry, coralberry, greenbriar, and grapes are shrubs and vines that are characteristic to the area.

Grasses in the area includes little bluestem, indiangrass, switchgrass, silver bluestem, Texas wintergrass, purpletop, narrowleaf wildoats, beaked panicum, brownseed paspalum, threeawn, broomsedge bluestem, splitbeard bluestem, rosette grasses, and lovegrasses. Forbs in the region consist of wild indigo, indigobrush, sennas, tickclover, lespedeza, prairie-clovers, western ragweed, crotons, and sneezeweeds. There has been some vegetation introduced into the area, including bermudagrass, bahiagrass, weeping lovegrass, and clover.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Big Pine reservoir location include Pine Hardwood (83%) and Other (17%).

In accordance to *Water and Wildlife, 1990*, The potential Big Pine reservoir contains four cover types within its proposed boundaries. The resource categories are: Mixed Bottomland Hardwood Forest (59%), Post Oak Forest (16%), Grasses (15%), and Other (10%).[5]

5.2.2.4.2 Fish and Wildlife

The result of the potential Big Pine reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Big Pine reservoir is located within the Prairies and Lakes Eco-region. Some of the common wildlife in this region includes the plains pocket gopher, beaver, raccoon, porcupine, Texas kangaroo rat, hispid cotton rat, ornate box turtle, green-winged teal, bobwhite quail, red-shouldered hawk, scissortail flycatcher, white-tailed deer, Brazilian freetail bat, ringtail, nine-banded armadillo, eastern hognose snake, tarantula, Texas horned lizard, golden cheeked warbler, black-capped vireo, northern mockingbird, and guadelupe bass. [6]

5.2.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.2-2). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Table 5.2-2 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Lamar and Red River Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Eskimo Curlew	*Numenius borealis*	LE	E
Least tern	*Sterna antillarum***	LE	NL
Fishes			
Blue Sucker	*Cycleptus elongatus*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Shovelnose sturgeon	*Scaphirhychus platorynchus*		T
Western Sand Darter	*Etheostoma clarum*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Mollusks			
Ouachita rock-pocketbook mussel	*Arkansia wheeleri*	LE	E
Reptiles			
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Arkansas meadow-rue	*Thalictrum arkansanum*		R

Sources: USFWS 1998, TPWD 1999.
USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Lamar and Red River Counties, 1998a.)

5.2.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Big Pine reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.2.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows no hydric soil associations within the potential Big Pine reservoir footprint.

5.2.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Big Pine reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.2.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the nineteen-county study area. The potential Big Pine reservoir is located within the Red River basin, which represents a negligible quantity of the remaining bottomland hardwood in Texas. The potential Big Pine reservoir is within and adjacent to the Sulphur River Bottom West site and listed as priority one[7] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.2.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within or adjacent to the proposed footprint of the potential Big Pine reservoir.

5.2.2.10 Social and Economic Conditions

The potential reservoir is located in Lamar and Red River counties. The population of these counties according to the 1990 Census is 43,949 in Lamar County and 14,317 in Red River County. The Texas State Data Center has estimated the 2020 population to be approximately 50,340 in Lamar County and 15,077 in Red River County.[16] This corresponds to a 14 percent and 5 percent growth, respectively.

5.2.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Big Pine reservoir will affect portions of Lamar and Red River.

Historical and Archeological Resources for the two county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.2-3.[19]

Table 5.2-3 Historical and Archeological Resources for Big Pine.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Lamar	56	1	11	NA	41	3
Red River	115	1	108	NA	6	NA

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.2-4) details the results of previous cultural studies that have been performed on the area since 1879.

Some counties have been investigated more thoroughly than other counties for cultural resources. This is important to note because there is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Lamar and Red River counties.[8]

Table 5.2-4 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Lamar	32	52	22	17	123
Red River	32	104	30	18	184
Sub-total	64	156	52	35	307

* Significance refers to National Register criteria.
Source : THC, 1993.

5.2.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.2-5.

Table 5.2-5 Chronological Framework Northeast Texas Archeological Region.

Period	***Dates***
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggests that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.2-6 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.2-6 Archeological Resources with Associated Periods.

County	***Paleoindian***	***Archiac***	***Early Ceramic***	***Formative Caddoan Early Caddoan Middle Caddoan***	***Late Caddoan***
Lamar	1*		4	10	2
Red River			5	12	14

* Not sufficiently determined. Could be Late Archiac Period.
Source: THC, 1993, and Perttula T. K., 1999.[9]

5.2.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison[20]

5.2.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the potential extent of the reservoir and within a one-mile buffer from the potential reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.2-7 depicts the percent coverage by major land uses within the potential reservoir study area.[10]

Table 5.2-7 Land Use for the Potential Big Pine Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	55%
Deciduous Forest Land	9%
Mixed Forest Land	33%
Evergreen Forest Land	2%
Forested Wetland	1%
Other	1%

5.2.2.13 Regulated Materials

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites and municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are no Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within the reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the potential reservoir.[11]

5.2.2.14 Potential Environmental Impact Summary

Table 5.2-8 Potential Environmental Impact Summary for Big Pine Reservoir.

Environmental Parameter	*Potential Impact Magnitude*
USFWS Priority 1 – Bottomland Hardwood Area	Moderate
Several Threatened and Endangered Species	Unknown

---

[1] Driskill, Jonh G., Colonel, CE, District Engineer 11 February 1975. "Statement of Findings, Big Pine Lake, Big Pine Creek, Texas." Alternative 3.

[2] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[3] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[4] Gould, F. W. 1975. Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas

[5] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[6] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[7] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[8] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[9] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[10] Land

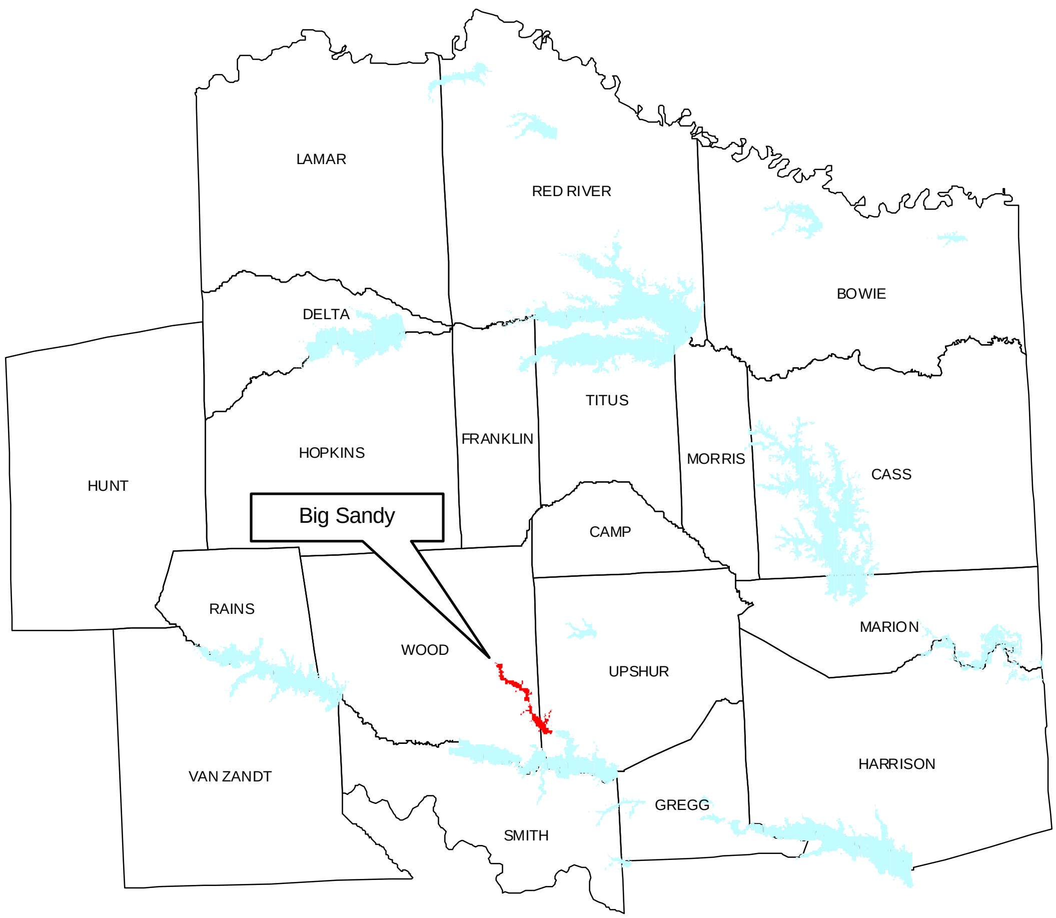
[11] www.tnris.state.tx.us

5.3 BIG SANDY

5.3.1 Summary of Prior Studies

5.3.1.1 Location

Figure 5.3-1 Location of Big Sandy within the Region D Planning Region



The Big Sandy Reservoir Dam is located at River Mile 10.6 on the Big Sandy Creek north of the City of Big Sandy. Big Sandy Creek is within the Sabine River Basin above the Toledo Bend Reservoir and is within Wood and Upshur Counties *(See Appendix, Exhibit A, Vicinity Map).*

5.3.1.2 Impoundment Size and Volume

With a conservation pool Elevation of 336 ft msl, the reservoir will have a storage of 69,300 acre-ft, a surface area of 4,400 acres. The approximated sediment storage in 50 years is 2,100 acre-ft with a corresponding storage capacity of 67,200 ac-ft.

5.3.1.3 Site Geology and Topography

A freshwater marsh called “the floating glade” exists upstream of the Big Sandy Reservoir inundation area.[1] Of concern is the effects backwater will have on the marsh, which is one reason the original damsite river mile was relocated from RM 15.7 to 10.6.

Basin soils consist of the Black land Prairie, East Texas Timberland, and Coastal Prairie types. Higher erosion susceptibility due to their sloping nature and clay texture has caused greater sediment production rates, a matter to be taken into consideration for reservoir operation analyses.[2]

Tertiary deposits of poorly consolidated sandstone, clay, and shale are the majority of the soils located within the study area. The two major groups are the Claiborne and Wilcox. The rocks forming the Wilcox Group were deposited about 52 million years ago and have two main formations which contain sandstone, shale and lignite. The rocks of the younger Clairborne Group were deposited from about 48 to 43 million years ago. Eight formations make up the Clairborne Group, two of which, the Carrizo and Queen City, are important aquifers for the region. The Carrizo-Wilcox aquifer is by far the best supply of good quality water.[3]

5.3.1.4 Dam Type and Size

The dam is a 54 ft high earth fill dam with a crest length of 2,175 ft.[3] It will have an uncontrolled broadcrested weir. The outlet works has one 10 ft diameter conduit controlled by two 4.5 by 10 ft gates.[4]

5.3.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the Big Sandy damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

The total contributing area to the reservoir is 223 square miles. Input used in the reservoir operation study for Big Sandy Lake included the following:

- spills from Lake Winnsboro
- intervening flows between Lake Winnsboro and the damesite
- lake evaporation
- sediment volume
- area-capacity curve data

Operation study criteria did not include diversions or releases for upstream or downstream prior rights other than what was reflected in the historic record.[1]

Streamflows, evaporation, adjusted area-capacity relationship which reflect sedimentation and water rights information for streamflow maintenance are the major factors into the reservoir operation study for firm yield determination. A computer program, SIMYLD-II, developed by the Texas Water Development Board was used for reservoir studies within the Sabine River Basin.[4] It was used for its effectiveness in analyzing water data in multi-basin systems.

5.3.1.5.1 Reservoir Inflows

A period of record from January 1941 through December 1979 from USGS recording gauges throughout the study area was used to estimate reservoir inflows on a monthly basis. Adjustments for depletions of flow were made for known historic reservoir operation studies in which only reservoirs with a capacity of 5,000 ac-ft or greater were considered.[1] Adjustments for land treatment measures, farm ponds and minor reservoirs, floodwater-retarding structures and urbanization when determining natural runoff estimates. The critical drought period for the study area was from 1955 to 1956. Lag time was excluded due to difficulty in accuracy of determination.

The Big Sandy Reservoir encompasses a drainage area of 223 square miles. Data for the hydrologic studies of the reservoir inflows was obtained from the USGS Water Data Storage and Retrieval System (WATSTORE) in Reston, Virginia. Monthly streamflow records from the existing vegetative region within the Sabine Watershed were used to estimate natural inflows. Naturalized streamflows represent streamflow conditions without man-made effects. The computer simulation model accounted for the effects of upstream reservoirs and water demands.[4]

5.3.1.5.2 Lake Evaporation

A period of record from January 1941 through December 1979 from the National Weather Service precipitation/evaporation stations throughout the study area was used to estimate net lake evaporation. Adjustments were made using contour maps broken into quadrangles.[1]

5.3.1.5.3 Sediment Volume

Data for suspended sediment load of Texas streamed was obtained from TDWR and USGS. Suspended-sediment rating curves and flow-duration curves were used to estimate sediment volume where an assumed unit weight of 70 lb/cf for particle size was used. [1]

See Table 5.3-1 for future projected sediment volumes.

Table 5.3-1 Sediment Estimates

Year	***1980***	***1990***	***2000***	***2010***	***2020***	***2030***
Sediment (ac-ft)	0.0	400.0	800.0	1300.0	1700.0	2100.0

5.3.1.5.4 Area Capacity Data

The elevation-area-capacity relationship (also referred to as area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. The relationship is based upon existing topographic characteristics of the land taken from USGS quad map topography to be inundated by the reservoir. Also taken into account is the accumulation of sedimentation that will occur over the 50 year life of the reservoir from 1980 up to the year 2030. [1]

5.3.1.5.5 Pass-Through Flows for Downstream Maintenance

Minimum discharge is important to protect downstream environmental requirements. With firm yield operation of the reservoir, a minimum flow of 56 cfs would be maintained to help protect downstream habitat. This is more than the required 20 cfs minimum streamflow to sustain aquatic habitat as specified by the environmental mitigation plan. Higher flows will be released for short periods during historic low flow periods.[3]

5.3.1.6 Water Quality

Water from the Carrizo-Wilcox aquifer is generally good; however, corrosive water with high iron content can occur within the northeastern part of the aquifer.[5]

5.3.1.7 Project Yield for Water Supply

The project firm yield is 46,600 ac-ft/yr.[1] An additional 12,000 ac-ft/yr. can be acquired if unappropriated water from the Sabine River is diverted in a method called “scalping”. This is implementable with Big Sandy Reservoir due to its close local to the main stem of the Sabine River. This will increase the yield to approximately 59,000 ac-ft/yr. The critical drought for the Big Sandy Reservoir is from August 1954 to May 1957.[4]

5.3.1.7.1 Water Rights

Of the Upper and Lower Sabine Basin, the majority of the existing water rights exist in the upper basin, totaling 163 just in the area between Toledo Bend reservoir and Lake Fork and Iron Bridge Dams. This is the area of highest demand, and even the currently unused rights in the area will not be made available as they are being saved for future use.[2]

5.3.1.8 Other Potential Benefits

Potential benefits associated with construction of the Big Sandy Reservoir include water supply and recreation such as swimming and fishing.

5.3.1.9 Land Acquisition and Easement Requirements

About 500 acres of farmland would be lost. About half the surface area that would be inundated contains bottomland hardwoods.[2] Of the types of terrestrial habitat which would be affected by the creation of the reservoir, the most affected would be deciduous forested wetland (DFW).[3]

Lignite reserves in the area are considered to be too deep to mine or are likewise inadequate to be commercially mineable. The majority of the oil and gas wells in the area of concern were noted in the February 1981 C.O.E. report and estimated to be depleted by construction of the reservoir dam, thus reducing the cost of conflict.[5]

5.3.1.9.1 Potential Land Use Conflicts

Approximately 140 prehistoric and historic sites are located in the reservoir area, and about half the surface area contains bottomland hardwoods.[2] It is believed that these sites contain potentially significant archeological and geological records from approximately 8,000 B.C. to the present. Work on these sites would be continued during different stages of the Big Sandy project.[3] See Table 5.3-2 for the reservoir conflict summarization.

Table 5.3-2 Reservoir Conflicts Table

No.	*Conflict*	*Proposed Resolution*	*Cost*
1	Main Highways		$15,048,000
2	Light-Duty Roads		$3,352,000
3	Unimproved Roads		$0
4	Pipelines		$2,125,000
5	Oil Wells		$843,800
6	Dwellings		$400,000
		Total:	**$21,768,800**

5.3.1.9.2 Local, State and Federal Permitting Requirements

Among the permitting requirements for water resource projects are environmental rules. These rules are listed in the following Table 5.3-3.

Table 5.3-3 Major Permitting Requirements

Permit	*Issuing Agency*	*Summary of Requirements*
Section 404 Permit, Clean Water Act of 1972	U.S. Army Corps of Engineers (COE)	Applicable to all new dams in the United States because they add new dredge or fill material to U.S. waters.
Section 10 Permit, Rivers & Harbors Act of 1899	U.S. Army Corps of Engineers	Usually applied for in conjunction with Section 404. Congressional approval required for construction of obstructions on navigable waters.
Section 7 Consultation & Section 10 Permit	U.S. Department of the Interior, Fish & Wildlife Service (USFWS)	Required for the incidental taking of endangered or threatened species. Mitigation is also generally a requirement as a condition of the permit.
Water Rights Permit	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone wanting to divert, use or store surface waters, or transfer surface water between basins. Includes environmental, hydrologic and conservation assessments.
Section 401 Certification, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Certification that projects obtaining a 404 permit will not degrade water quality below state standards.
TPDEX Discharge Permit, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone who discharges wastewater into the Sabine Basin.
Grant of Easement	Texas General Land Office	Requirement for projects that cross or impact state owned waterways.

5.3.1.10 Updated Project Costs

Opinions of probable project cost for the Big Sandy Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1998.[2] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of

opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.

- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher capital cost estimate than the initial analysis. Please refer to Table 5.3-4 for the Updated Project Cost and Table 5.3-5 for the Construction Cost.

Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in Table 5.3-4. The assumed average developed cost per acre of land for the reservoir was $2,300/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 4,400 acres plus the additional surface area attained at above the conservation pool elevation, which together is approximately 5,06 ac.

5.3.1.10.1 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in Table 5.3-4.

5.3.1.10.2 Construction Costs

As shown in Table 5.3-5, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

Table 5.3-4 Updated Project Costs

Description	***Quantity***	***Unit***	***Unit Price ($)***	***Cost ($)***	***Total Cost ($)***
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$14,145,900
Relocations (conflict resolution)		L.S.			$21,768,800
Construction Capital Costs (CCC) Subtotal:					**$35,914,700**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$12,570,200
Land Cost	5,506	Ac.	$2,300.00		$12,663,800
Studies, Mitigation, Permitting					$15,578,600
Mitigation Costs (equal to land cost)		L.S.		$12,663,800	
Permitting and Studies Land)				$2,914,800	
Interest During Construction (4 yrs.)					$2,287,000
Other Project Costs Subtotal:					**$43,099,600**
		December 1998 Subtotal:			$79,014,300
20-City Average Escalation Factor	0.8%				$632,120
OPINION OF PROBABLE PROJECT COST					**$79,647,000**

Notes:
1. Original cost estimates were taken from F&N, 1999.
2. Interest during construction was included.
3. The engineering and other fees were increased to 35%.

Table 5.3-5 Construction Costs

Item #	*Description*	*Quantity*	*Unit*	*Unit Price ($)*	*Total Cost ($)*
	Dam Embankment				
1	Diversion & Care of Water		L.S.		$720,000
2	Clearing & Grubbing	50	Ac.	$864.00	$43,200
3	Excavation, Stripping	273,944	C.Y.	$2.88	$788,959
4	Compacted Fill	1,362,000	C.Y.	$2.88	$1,929,151
5	Riprap Bedding	5,647	C.Y.	$21.60	$121,975
6	Riprap	18,824	Ton	$43.20	$813,197
7	Slurry Trench	10,900	S.F.	$5.76	$62,784
8	Soil Cement	11,000	C.Y.	$28.80	$316,800
9	Embankment Drainage & Instrumentation		L.S.		$330,000
10	Topsoil	9,153	C.Y.	$14.40	$131,803
11	Hydromulch	494,250	S.F.	$0.10	$49,425
12	Roadway	65,250	S.F.	$4.50	$293,625
	Spillway				
13	Clearing & Grubbing	5	Ac.	$864.00	$4,320
14	Excavation	38,000	C.Y.	$2.88	$109,440
15	Piles	308	ea.	$864.00	$266,112
16	Concrete, weir	950	C.Y.	$300.00	$285,000
17	Concrete, slabs	460	C.Y.	$250.00	$115,000
18	Concrete, walls	2,280	C.Y.	$325.00	$741,000
19	Tainter Gates	4	ea.	$715,000.00	$2,860,000
20	Superstructure & Hoists		L.S.		$288,000
21	Drainage System		L.S.		$73,000
22	Riprap Bedding	1,700	C.Y.	$21.60	$36,720
23	Riprap	9,000	Ton	$43.20	$388,800
24	Hydromulch	36,000	S.F.	$0.10	$3,600
25	Fencing	600	L.F.	$21.60	$12,960
	Outlet Works				
26	Concrete, Intake Structure	130	C.Y.	$504.00	$65,520
27	66" Conduit	500	L.F.	$324.00	$162,000
28	Concrete, Stilling Basin	2,300	C.Y.	$250.00	$575,000
29	Riprap	120	Ton	$43.20	$5,184
30	Excavation	4,300	C.Y.	$2.88	$12,384
31	Gates & Access Bridge		L.S.		$110,000
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$11,714,960**
	Mobilization (5% of BCS)				$585,750
				Subtotal:	$12,300,710
	OH & P (15% of Subtotal)				$1,845,110
	Construction Capital Cost Subtotal (CCC)				**$14,145,900**

5.3.1.10.3 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 46,600 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $79,647,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Big Sandy Reservoir, the O&M is $538,730 and the annualized debt service is $5,639,300. The firm yield is then divided into the total annualized cost of $6,178,030 to yield a unit cost of $132.58 per acre-foot ($0.41/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 contained in the executive summary.

5.3.2 Environmental Overview –Affected Environment and Environmental Consequences

5.3.2.1 Geological Elements

5.3.2.1.1 Physiography

The potential Big Sandy reservoir is located within the Pineywoods vegetative region of Texas. The Pineywoods area is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods vegetative-region lies entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods vegetative-region. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dalisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

5.3.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes.

This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[6]

5.3.2.1.3 Soils

The area of the potential Big Sandy reservoir contains three major soil groups.[9] These groups are Bowie-Cuthbert-Kirvin, iuka-Guyton-Mantachie, and Lilbert-Darco-Briley. Approximately 12.3 percent of the area is Bowie-Cuthbert-Kirvin, 70.9 percent Iuka-Guyton-Mantachie, and 16.8 percent Lilbert-Darco-Briley. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the potential reservoir site.

Bowie

The Bowie series consists of very deep, well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain deposits. These soils are on broad very gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The climate is humid; mean annual precipitation ranges from 40 to 50 inches; and mean annual temperature from 64 to 69 degrees F. The Thornthwaite annual P.E. index exceeds 64. The frost-free days range from 220 to 250. Elevation ranges from 150 to 600 feet above msl. Runoff is low on 1 to 3 percent slopes, medium on 3 to 5 percent slopes, and high on 5 to 8 percent slopes. A perched water table is at a depth of 3.5 to 5 feet during winter and early spring in most years. The principal use is for pasture and forest. Some areas are used for growing corn, peanuts, sweet potatoes, peaches, watermelons and other vegetables or fruit crops. Pasture is mainly bermudagrass or bahiagrass. Forests consists of loblolly and shortleaf pines, sweetgum, red oak, and hickory trees with tall and midgrasses.

Briley

The Briley series consists of very deep, sandy, well-drained, moderately permeable soils that formed in sandy and loamy Coastal Plain sediments. These soils are on gently sloping to moderately steep broad interstream divides. Slopes are dominantly 2 to 5 percent, but range from 1 to 20 percent. Mean annual rainfall ranges from 40 to 48 inches and is evenly distributed throughout the year. Frost-free days range from 240 to 275 days and elevation ranges from 350 to 600 feet above msl. Mean annual temperature ranges from 64 degrees to 69 degrees F., and the Thornthwaite P-E index exceeds 64. The soil type is used mainly for woodlands of loblolly and shortleaf pine and for pastures of improved bermudagrass.

Cuthbert

The Cuthbert series consists of soils that are moderately deep to weakly consolidated sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on strongly sloping to steep uplands. Slopes are dominantly 8 to 25 percent, but range from 5 to 40 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 56 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 750 feet above msl. Mean annual temperature ranges from 63 to 67 degrees F, and Thornthwaite annual P-E indexes exceed 64. Runoff is medium for slopes of 5 to 20 percent and high for slopes greater than 20 percent. Cuthbert soils are used mainly for woodland and pastureland. The principal trees are shortleaf and loblolly pine, red oak, sweetgum, and other hardwoods. Pastures include common and improved bermudagrass, bahiagrass, and weeping lovegrass.

Darco

The Darco series consists of very deep, somewhat excessively drained, moderately permeable soils that formed in sandy and loamy deposits on uplands. It is gently sloping to steep and slopes range from 1 to 25 percent. The climate is warm and humid. The average annual rainfall ranges from 40 to 50 inches. Frost-free days range from 230 to 260. Elevation ranges from 400 to 700 feet above msl. The frost-free rainfall ranges from 25 to 30 inches. The mean annual temperature ranges from 63 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 84. Runoff is negligible on 1 to 3 percent slopes, very low on 3 to 5 percent slopes, low on 5 to 20 percent slopes, and medium on slopes greater than 20 percent. Most of the soil is used for pasture or woodland. Pastures are mainly in coastal bermudagrass or weeping lovegrass. Native trees include loblolly pine, shortleaf pine, red oak, and hickory. Watermelons, peanuts, small grain for grazing, and vegetables are grown in some areas.

Guyton

The Guyton series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in thick loamy sediments. These soils are on Coastal Plain local stream floodplains and in depressional areas on late Pleistocene age terraces. Slopes range from 0 to 1 percent. The climate is warm and humid. Mean annual temperature ranges from 60 to 70 degrees F. Average annual rainfall ranges from 42 to 62 inches. Where runoff is ponded, drainage is very poor. Runoff is slow to ponded. A seasonal high water table is at 0 to 1.5 feet below the surface from December through May, except where ponded. Where ponded, it is from 1 foot above the surface to 0.5 foot below the surface most of the time. In places, the soils are subject to rare, occasional, or frequent flooding. Most areas are in woodland. Water oak, bald cypress, water tupelo, loblolly pine, and shortleaf pine are dominant in the drainageways. On broad terraces, bald cypress and water tupelo generally are absent and sweetgum dominates. Some areas are used as pastureland or cropland.

Iuka

The Iuka series consists of deep, moderately well-drained, moderately permeable soils that formed in stratified loamy and sandy alluvial sediments. These soils are on nearly level floodplains. They are saturated with water at depths of 1 foot to 3 feet below the surface during wet seasons and are subject to flooding. Slopes range from 0 to 2 percent. The climate is warm and humid. Near the type location the average daily temperature for January is 42 degrees F., the average daily temperature for July is 79 degrees F., the mean annual temperature is about 61 degrees F., and the mean annual precipitation is about 54 inches. Iuka soils are rarely to commonly flooded. A water table is at depths of 12 or more inches, and the soil is commonly saturated with water between 12 and 40 inches during some season of most years. Much of the soil has been cleared and cultivated. It is cropped to corn, soybeans, small grains, truck crops, and hay or is in pasture. Native vegetation is forest of water oak, willow, beech, sweetgum, hickory, maple, ironwood, eastern cottonwood, alder, white oak, and in some places, pine.

Kirvin

The Kirvin series consists of soils that are deep to stratified sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on gently sloping to moderately steep convex uplands. Slope is dominantly 2 to 8 percent, but ranges from 1 to 15 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 48 inches, with frost-free rainfall of 25 to 30 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 650 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. Runoff is very low on 1 to 3 percent slopes, low on 3 to 5 percent slopes, and medium on 5 to 15 percent slopes. Principal use is for pastureland and woodland. Bermudagrass is the main pasture grass. Forests are of shortleaf, slash, and loblolly pine, red oak, sweetgum, and other hardwood trees. A few areas are used for growing truck crops, cotton, corn, and oats.

Lilbert

The Lilbert series consists of very deep, well-drained, moderately slowly permeable soils. These soils formed in sandy and loamy deposits on uplands. Water runs off the surface slowly. Slopes range from 1 to 8 percent. A perched water table may occur in late winter to early spring from 3 to 6 feet below the soil surface. Average annual temperature ranges from 64 to 69 degrees F., the mean annual precipitation ranges from 40 to 50 inches. Frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 240 to 275. Elevation ranges from 350 to 600 feet above msl. The Thornthwaite P-E index is 66 to about 80. Runoff is slow. The areas where this soil type occurs are used mainly for woodland and pasture. However, some areas are used for cropland. Native vegetation consists of loblolly pine, shortleaf pine, hickory, sweetgum, red oak, and other hardwoods.

Sacul

The Sacul series consists of very deep, moderately well-drained, slowly permeable soils that formed in acid, loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 2 to 25 percent but range from 1 to 40 percent. The average annual air temperature ranges from about 60 to 66 degrees F and the average annual precipitation ranges from about 48 to 54 inches. Most of the acreage is in woodland, with some area in pasture. The forest vegetation is shortleaf and loblolly pine, red oak, sweetgum, and dogwood. Bermudagrass and bahiagrass are the principal pasture grasses used.

5.3.2.2 Hydrological Elements

5.3.2.2.1 Surface Water

The potential Big Sandy reservoir is located on Big Sandy Creek and drains into the Sabine River. This portion of the Sabine River is included in the Texas natural Resource Conservation Commission (TNRCC) – *State of Texas Water Quality Inventory Surface Water Quality Monitoring Program* as stream segment 0514 (Big Sandy Creek). This 34-mile segment originates from the confluence with the Sabine River in Upshur County to a point 1.6 miles upstream of SH 11 in Hopkins County. This segment is classified as “effluent limited” and designated uses are for contact recreation, high aquatic life, and public water supply. Due to elevated levels of fecal coliform bacteria, the contact recreation use is partially supported in the lower 25 miles of the segment.[10]

5.3.2.2.2 Ground Water

The potential Big Sandy reservoir is located in Upshur and Wood Counties within both the Carrizo-Wilcox Aquifer and the Queen City Aquifer. The potential reservoir is located in the outcrop region of the Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeasterm part of the aquifer.

This aquifer extends in a band across most of the state from the Frio River in South Texas Northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson County. Total pumpage for all uses in 1994 was 16,319 ac-ft.

The potential reservoir is also within the Queen City Aquifer. Sand, loosely cemented sandstone, and interbeded clay units of the Queen City Formation of the Tertiary Claiborne Group make up the aquifer as delineated within Texas. These rocks dip gently to the south and southeast toward the Gulf Coast. Although total aquifer thickness is usually less than 500 feet, it can approach 700 feet in some areas of northeast Texas. In the outcrop area, water occurs under water-table conditions while in the downdip subsurface, where the Queen City is covered by younger, non water-bearing rocks, the water is under artesian conditions. Usable quality water is generally found within the outcrop and for a few miles downdip, but in some areas it may occur down to depths of approximately 2,000 feet. Yields of individual wells are commonly low, but exceed 400 gal/min.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent however, quality deteriorates with depth in the downdip direction. The water may have high acidity (low pH) in much of northeast Texas and relatively high iron concentrations in localized areas. Hydrogen sulfide gas is sometimes present. Fortunately, each of these naturally occurring conditions may be treated relatively easily and economically.

While large amounts of usable quality groundwater are contained within the rocks of the Queen City, yields are low. Estimates of the availability of water from the Queen City Aquifer are based on recharge to the aquifer. Because of differences in topography, vegetative cover, and other factors, only two percent of the annual rainfall is estimated recharge in the Trinity, Colorado, Guadelupe, San Antonio and Neches River basins. Approximately five percent is estimated recharge in the Neches, Sulphur, Sabine, and Cypress Creek Basins. Total annual effective recharge to the aquifer is estimated to be 682,100 ac-ft.[7]

5.3.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Big Sandy reservoir will cause water to be impounded on Big Sandy Creek as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Big Sandy reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.3.2.4 Biological Elements

5.3.2.4.1 Vegetation

The potential Big Sandy reservoir is centrally located within the Austroriparian province[8] and is within the Pineywoods Region.[9] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Big Sandy reservoir location include Pine Hardwood (78%), and Other (22%).

In accordance to *Water and Wildlife, 1990*, The potential Big Sandy reservoir contains five cover types within its proposed boundaries. The resource categories are: Bottomland Hardwood Forest (43%), Hardwood-Pine Forest (34%), Grassland/Savannah (14%), Pine Hardwood Forest (8%), and Cropland (1%).[10]

5.3.2.4.2 Fish and Wildlife

The result of the potential Big Sandy reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Big Sandy reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter. [11]

5.3.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the proposed project location (Table 5.3-6). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Table 5.3-6 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Upshur and Wood Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Louisiana Pine Snake	*Pituophis melanoleucus ruthveni*	C1	T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Rough-stem aster	*Aster puniceus* ssp. *Eliotti* var. *scabricaulis*		R
Texas Trillium	*Trillium pusillum* var. *texanum*		R

Sources: USFWS 1998, TPWD 1999.
USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status

(Texas Department of Transportation, Annotated County Lists of Rare Species for Upshur and Wood Counties, 1999.)

5.3.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Big Sandy reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts)*.

5.3.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows two hydric soil associations are within the potential Big Sandy reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.3.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Big Sandy reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.3.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Big Sandy reservoir is located within the Sabine River basin, which represents approximately 22% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the USFWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the nineteen-county study area. The potential Big Sandy reservoir is within and adjacent to two Priority 2 sites.[12] According to the TPWD, these sites contain habitat of high value to waterfowl and other wildlife, and includes the largest reported freshwater marsh in Texas. This marsh area has previously been identified as a candidate for National Historic Landmark Status.

5.3.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within or adjacent to the proposed footprint of the potential Big Sandy reservoir.

5.3.2.10 Social and Economic Conditions

The potential Big Sandy reservoir is located in Wood and Upshur Counties. The population of Wood County according to the 1990 Census is 29,380 and Upshur County 31,370. The Texas State Data Center has estimated the 2020 population to be approximately 50,366 for Wood County and 45,293 for Upshur County.[13] This corresponds to a 71 percent growth in Wood County and 44 percent growth in Upshur County. The median household income for Wood County in 1989 was $20,927 and $21,889 for Upshur County.[14]

5.3.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Big Sandy reservoir will affect portions of Upshur and Wood County.

Historical and Archeological Resources for the two county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.3-7.[19]

Table 5.3-7 Historical and Archeological Resources for Big Sandy.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Upshur	183	1	182	0	0	0
Wood	139	1	88	42	7	1

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.3-8) details the results of previous cultural studies that have been performed on the area since 1879. Although Wood County has been investigated more thoroughly than other counties for cultural resources due to federal mandated cultural surveys, there is a potential that additional sites might be discovered in the vicinity of the potential reservoir. There is an even greater potential for more archeological sites being discovered in counties that have not been excessively studied, such as Upsher County.[15]

Table 5.3-8 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Upshur	18	30	24	12	84
Wood**	42	101	21	20	184
Sub-total	60	401	45	32	268

* Significance refers to National Register criteria.
** County tabulations are incomplete.
Source : THC, 1993.

5.3.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the Northeast Texas region has been determined and is presented in Table 5.3-9.

Table 5.3-9 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.3-10 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.3-10 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Upshur			2	6	15
Wood			1	7	21

Source: THC, 1993, and Perttula T. K., 1999.[16]

5.3.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.3.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.3-11 depicts the percent coverage by major land uses within the reservoir study area.[17]

Table 5.3-11 Land Use for the Potential Big Sandy Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	22%
Deciduous Forest Land	9%
Mixed Forest Land	59%
Evergreen Forest Land	3%
Transitional Areas	6%
Other	1%

5.3.2.13 REGULATED MATERIALS

Superfund cleanup sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, and air quality monitoring stations were determined to be within the resrvoir study area using existing TNRCC data. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there is one municipal solid waste landfill site, and no Superfund sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within the reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[18]

5.3.2.14 Potential Environmental Impact Summary

Table 5.3-12 Potential Environmental Impact Summary for Big Sandy Reservoir.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
One Municipal Solid Waste Landfill Site	Minimal
Two – Priority Two USFWS Priority Bottomland Hardwood Areas	Moderate

This Space Intentionally Left Blank

[1] U.S. Department of the Interior, Bureau of Reclamation. July 1990. Texas Big Sandy Study Supporting Materials, Volume E – Hydrology.

[2] Freese and Nichols, Comprehensive Sabine Watershed Management Plan, December, 1999.

[3] U.S. Army Corps of Engineers, Fort Worth District, Executive Summary Report on Texas Big Sandy Study, Texas, April, 1991.

[4] U.S. Army Corps of Engineers, Fort Worth District, Big Sandy Lake General Design Information, 1980-1985.

[5] U.S. Army Corps of Engineers, Fort Worth District, Big Sandy Lake Stage 2 Documentation Report, February, 1981.

[6] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[7] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan*. Austin, Texas. TWDB.

[8] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[9] Gould, F. W. 1975. Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas

[10] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[11] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[12] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[13] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[14] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[15] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[16] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[17] www.tnris.state.tx.us

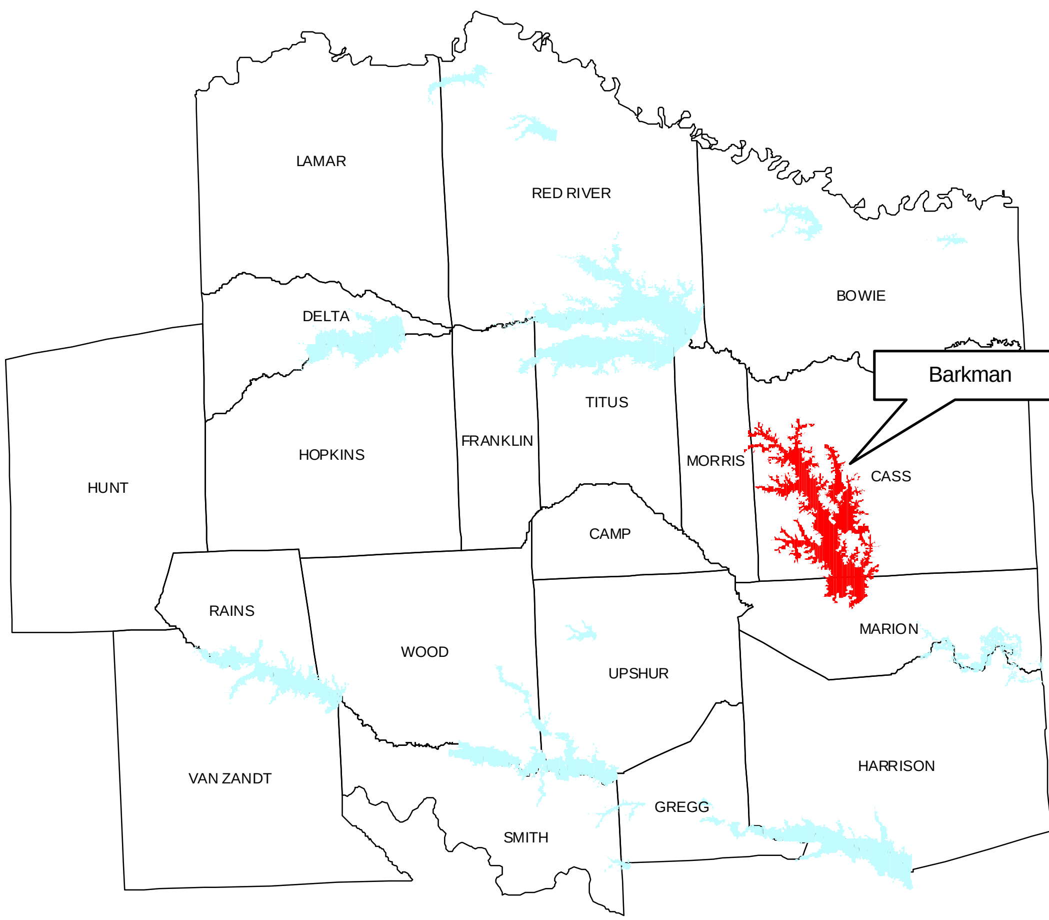
[18] WWW.TNRIS.STATE.TX.US

5.4 BLACK CYPRESS

5.4.1 Summary of Prior Studies

5.4.1.1 Location

Figure 5.4-1 Location of Black Cypress within the Region D Planning Region



The Black Cypress Reservoir Dam is located at River Mile 17.0 in the Black Cypress Creek Watershed on the Black Cypress Bayou north of Lake O' the Pines in Marion and Cass counties. This is approximately 7 miles northwest of the City of Jefferson.[1] The Black Cypress Bayou is a tributary that joins the Big Cypress Bayou approximately 2 miles east of Jefferson. No existing impoundments are located upstream of the reservoir site *(See Appendix, Exhibit A, Vicinity Map).*

5.4.1.2 Impoundment Size and Volume

Preliminary analyses initially settled on a conservation pool Elevation of 253.0 ft msl, which will give the reservoir a storage capacity of 447,262 ac-ft and a surface area of 21,951 ac. The 230,000 ac-ft flood control pool elevation is 262.0 ft msl. The subsequent flood control storage at elevation 262.0 ft msl is approximately 230,000 ac-ft with a total capacity of 680,000 ac-ft and a surface area of 29,214 ac.[2] The maximum design water surface elevation is 270.98 ft msl, which gives a capacity of 972,206 ac-ft and a surface area of 38,329 ac.

5.4.1.3 Site Geology and Topography

The Cypress Bayou Basin is underlain by southeasterly dipping sand, clay, glauconite and lignite of the Wilcox and Claiborne Groups of the Tertiary age. Most of the Texas iron ore production comes from formations within the basin.[2]

5.4.1.4 Dam Type and Size

The dam elevation is 274.59 ft msl with a maximum design surface water elevation of 270.89 feet msl. The dam is a 74.59 ft high earth fill dam with a freeboard height of 3.7 ft. The spillway is a high crest ogee overflow with a crest elevation 262.0 ft and crest length of 600.0 ft with a vertical upstream face. The outlet works has one 10 foot diameter conduit and two 4.5 ft by 10 ft gates.[2]

5.4.1.5 Hydrology and Hydraulics

The Black Cypress Reservoir would encompasses a drainage area of 342 square miles. Reservoir inflows are used in conjunction with area-capacity characteristics of the reservoir site to determine the design flood for the spillway. "The spillway design flood is one-half of the probable maximum flood followed in four days by the probable maximum flood."[2] The "Watershed Runoff Computer Model for Historical and Hypothetical Storm Events" developed by the Southwestern Division was used in a HEC-5 model for all alternatives considered for the Little Cypress Reservoir. Spillway design crest elevation is taken at the top of the flood control pool for all reservoir alternatives considered.[2]

Determination of the hydraulic characteristics used mathematical models of the existing conditions taken from USGS quad map topography, bridge and levee survey supplements, sounding equipment, degradation ranges. Information for the Manning formula came from field investigation, photograph inspection and correlation with recorded gauge data all used in HEC-2 analyses of water surface profiles.[2] Comparisons were made of conditions with and without flood control measures in the lake. Several water supply yields and flood storage capacities were evaluated for stream maintenance, water supply, and cost benefits.

Discharge frequencies were developed to determine the effects of a lake on flood flows in the basin. A 50-yr storage plus 21-day reserve with an assumed release rate of 2,000 cfs during the 21-day reserve were the data used in calculating the flood control storage for Black Cypress Reservoir. From this information the depth versus frequency curves was established from which the storage capacity was taken.[2]

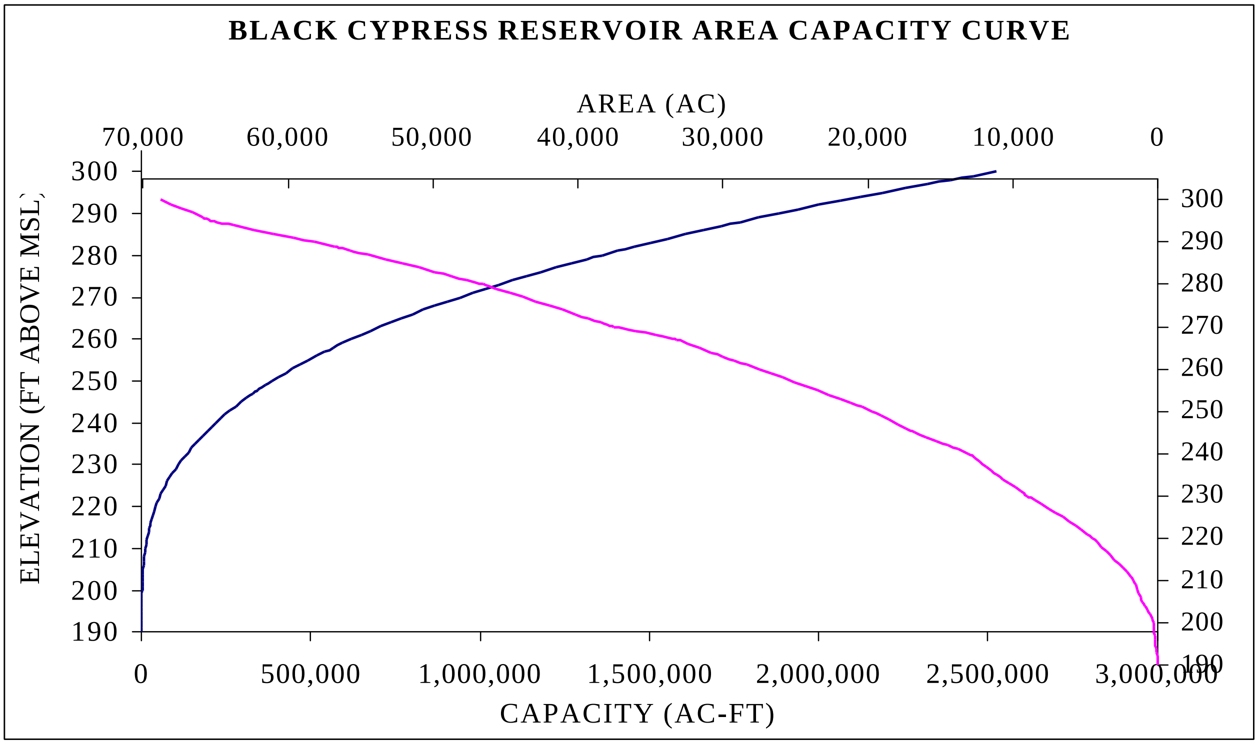
5.4.1.5.1 Pass-Through Flows

Mitigation will be required for regulation of streamflow to provide maintenance for downstream aquatic and terrestrial habitat.

5.4.1.5.2 Area Capacity Data

The elevation-area-capacity relationship (also referred to as area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. See Figure 5.4-2 for the Little Cypress Reservoir Area Capacity Curve[2]. The relationship is based upon existing topographic characteristics of the land taken from USGS quad maps to be inundated by the reservoir. Also taken into account is the accumulation of sedimentation that will occur over the life of the reservoir up to the year 2040.

Figure 5.4-2 Area Capacity Curve



5.4.1.6 Water quality

Water quality in the area is generally good, and analyses indicate the good quality will be maintained in the reservoir. The Cypress Valley Basin experiences some industrial waste discharges, chromium and zinc, and oilfield brine disposal is carefully monitored.[1]

5.4.1.7 Project Yield for Water Supply

The amount and distribution of naturalized streamflows throughout the basin tributary to the Black Cypress damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.4.1.7.1 Definition of Firm Yield

The Texas Water Development Board guidelines 31 TAC 357.7(a)(3) requires "an evaluation of adequacy of current water supplies available to the regional water planning area for use during drought of record. This evaluation shall consider surface water and groundwater data from the State Water Plan, existing water rights, contracts and option agreements, other planning and water supply studies, and analysis of water supplies currently available to the regional water planning area. Analysis of surface water available during drought of record from reservoirs shall be based on firm yield analysis of reservoirs." The water availability based on firm yield must satisfy full utilization of senior water rights.

5.4.1.8 Previous Yield Studies

Preliminary analyses of several different possibilities with water supply, recreation, and flood control storage presented several yields. The Corps of Engineers, 1981 report focused on a 244 cfs yield for Black Cypress Reservoir. Later investigations abandoned any further in-depth studies of the reservoir in favor of Little Cypress Reservoir because a cost to benefits analyses revealed that the only alternative to give a positive net benefits was a reservoir yielding 125 cfs, which is less than the projected 2040 water demand. As a result, a reservoir operations analyses was not reported for a yield of 200 cfs (129 mgd), the projected 2040 water supply needs for the basin.

5.4.1.9 Other Potential Benefits

Potential benefits associated with construction of the Little Cypress Reservoir include water supply, recreation, flood control and hydropower generation.

5.4.1.9.1 Hydropower

Analyses of hydropower generation were also taken into consideration as part of the multipurpose lake operations and estimated that 0.5 MW and 4.0 MW would be feasible. The 0.5 MW was not considered because at less than 2.0 MW, it will not be considered for Federal development. The 4.0 MW was not further analyzed when later studies of the Black Cypress and Little Cypress reservoirs determined that the Little Cypress Reservoir would be better suited for development.[1]

5.4.1.10 Land Acquisition and Easement Requirements

A 1982 study by the Department of Interior, Bureau of Mines estimated that deposits of approximately 6 million tons of lignite were near the Black Cypress damsite.[1] However, larger and more profitable sites exist elsewhere, rendering those in the damsite of little interest. As a result, no cost for lignite has been included.

Compensation for bottomland hardwood and riparian habitat losses will be required.

5.4.1.10.1 Potential Land Use Conflicts

According to The Army Corps of Engineers, 1987, the Little Cypress Reservoir site contained several oil and gas fields as of 1979. A few of these fields fall below elevation 255.0, which was the conservation pool elevation according to The Army Corps of Engineers, 1981 preliminary design. The conservation pool elevation now stands at elevation 233.1 feet msl with a maximum water surface elevation 252.0 as mentioned earlier.

5.4.1.10.2 Updated Project Costs

Opinions of probable project cost for the Black Cypress Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1984.[1] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in “Exhibit B” as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

According to July 1984 values, the economic project cost was $184,904,500, the total annual cost was $19,577,700 and the annual benefits yield was estimated at $16,749,500, which resulted in an excess annual benefit of -$2,828,200 and a corresponding benefit to cost ratio of 0.9.[1] Refer to Table 5.4-1 and Table 5.4-2 for updated Project and construction costs. The earlier mentioned changes resulted in a higher cost estimate than the initial analysis, which estimated the project cost at $350,631,000. Please refer to Table 5.4-1 for the Updated Project Cost and Table 5.4-2 for the Construction Cost.

5.4.1.10.3 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in Table 5.4-1. The land cost for the reservoir was taken as a lump sum for the land purchase, easement and recreation specific.

5.4.1.10.4 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in Table 5.4-1.

5.4.1.10.5 Construction Costs

As shown in Table 5.4-2, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

This Space Intentionally Left Blank

Table 5.4-1 Updated Project Costs

Description	*Unit*	*Cost ($)*	*Total Cost ($)*
CONSTRUCTION CAPITAL COST SUBTOTAL			
Dams & Reservoirs			$49,945,800
Relocations (conflict resolution)	L.S.		$50,500,000
Construction Capital Costs (CCC) Subtotal:			**$100,445,800**
OTHER PROJECT COSTS			
Engineering & Other Fees (35% of Total Construction)			$35,156,100
Land Cost			$80,144,900
Land Purchase	L.S.	$35,566,800	
Mitigation	L.S.	$43,401,100	
Recreation Specific	L.S.	$1,177,000	
Studies, Mitigation, Permitting			$18,059,100
High classification (10% of Capital + Land)		$18,059,100	
Interest During Construction (4 yrs.)			$8,075,000
Other Project Costs Subtotal:			**$141,435,100**
			$241,880,900
20-City Average Escalation Factor			$108,749,660
OPINION OF PROBABLE PROJECT COST			**$350,631,000**

Notes:

1. Original cost estimates were taken from USACE, 1984.[1]
2. Permitting and studies costs are included.
3. The engineering and design costs are part of the 35% engineering and other fees.
4. The supervision and administration are part of the 35% overhead and profit.

Table 5.4-2 Construction Costs

Item #	*Description*	*Unit*	*Total Cost ($)*
1	Reservoirs	L.S.	$3,600,000
2	Dams	L.S.	$23,900,000
3	Roads, Railroads, Bridges	L.S.	$487,000
4	Recreation Facilities	L.S.	$11,439,800
5	Cultural Resource Preservation	L.S.	$1,355,100
6	Buildings, Grounds, Utilities	L.S.	$378,000
7	Operation Equipment	L.S.	$203,000
	Base Construction Capital Cost Unescalated Subtotal (BCS)		**$41,362,900**
	Mobilization (5% of BCS)		$2,068,150
		Subtotal:	$43,431,050
	OH & P (15% of Subtotal)		$6,514,660
	Construction Capital Cost Subtotal (CCC)		**$49,945,800**

5.4.1.10.6 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 176,770 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $350,631,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Black Cypress Reservoir, the O&M is $1,506,690 and the annualized debt service is $24,825,700. The firm yield is then divided into the total annualized cost of $26,332,390 to yield a unit cost of $148.97 per acre-foot ($0.46/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 contained in the executive summary.

5.4.2 Environmental Overview –Affected Environment and Environmental Consequences

5.4.2.1 Geological Elements

5.4.2.1.1 Physiography

The potential Black Cypress reservoir is located within the Pineywoods vegetative region of Texas. The Pineywoods vegetative region is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods vegetative region lies entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods vegetative region. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dalisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

5.4.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[3]

5.4.2.1.3 Soils

The area of the potential reservoir, Black Cypress, contains fourteen major soil groups.[9] These groups are Bowie-Cuthbert-Kirvin, Cuthbert-Red Springs-Elrose, Iuka-Guyton-Mantachie, Lilbert-Darco-Briley, and Sacul-Bowie-Kullit. Approximately 7 percent of the area is Bowie-Cuthbet-Kirvin, 2 percent Cuthbert-Red Springs-Elrose, 25 percent Iuka-Guyton-Mantachie, 65 percent Libert-Darco-Briley, and 0.4 percent Sacul-Bowie-Kullit. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Bowie

The Bowie series consists of very deep, well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain deposits. These soils are on broad very gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The climate is humid; mean annual precipitation ranges from 40 to 50 inches; and mean annual temperature from 64 to 69 degrees F. The Thornthwaite annual P.E. index exceeds 64. The frost-free days range from 220 to 250. Elevation ranges from 150 to 600 feet above msl. Runoff is low on 1 to 3 percent slopes, medium on 3 to 5 percent slopes, and high on 5 to 8 percent slopes. A perched water table is at a depth of 3.5 to 5 feet during winter and early spring in most years. The principal use is for pasture and forest. Some areas are used for growing corn, peanuts, sweet potatoes, peaches, watermelons and other vegetables or fruit crops. Pasture is mainly bermudagrass or bahiagrass. Forests consists of loblolly and shortleaf pines, sweetgum, red oak, and hickory trees with tall and midgrasses.

Briley

The Briley series consists of very deep, sandy, well-drained, moderately permeable soils that formed in sandy and loamy Coastal Plain sediments. These soils are on gently sloping to moderately steep broad interstream divides. Slopes are dominantly 2 to 5 percent, but range from 1 to 20 percent. Mean annual rainfall ranges from 40 to 48 inches and is evenly distributed throughout the year. Frost-free days range from 240 to 275 days and elevation ranges from 350 to 600 feet above msl. Mean annual temperature ranges from 64 degrees to 69 degrees F., and the Thornthwaite P-E index exceeds 64. The soil type is used mainly for woodlands of loblolly and shortleaf pine and for pastures of improved bermudagrass.

Cuthbert

The Cuthbert series consists of soils that are moderately deep to weakly consolidated sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on strongly sloping to steep uplands. Slopes are dominantly 8 to 25 percent, but range from 5 to 40 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 56 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 750 feet above msl. Mean annual temperature ranges from 63 to 67 degrees F, and Thornthwaite annual P-E indexes exceed 64. Runoff is medium for slopes of 5 to 20 percent and high for slopes greater than 20 percent. Cuthbert soils are used mainly for woodland and pastureland. The principal trees are shortleaf and loblolly pine, red oak, sweetgum, and other hardwoods. Pastures include common and improved bermudagrass, bahiagrass, and weeping lovegrass.

Darco

The Darco series consists of very deep, somewhat excessively drained, moderately permeable soils that formed in sandy and loamy deposits on uplands. It is gently sloping to steep and slopes range from 1 to 25 percent. The climate is warm and humid. The average annual rainfall ranges from 40 to 50 inches. Frost-free days range from 230 to 260. Elevation ranges from 400 to 700 feet above msl. The frost-free rainfall ranges from 25 to 30 inches. The mean annual temperature ranges from 63 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 84. Runoff is negligible on 1 to 3 percent slopes, very low on 3 to 5 percent slopes, low on 5 to 20 percent slopes, and medium on slopes greater than 20 percent. Most of the soil is used for pasture or woodland. Pastures are mainly in coastal bermudagrass or weeping lovegrass. Native trees include loblolly pine, shortleaf pine, red oak, and hickory. Watermelons, peanuts, small grain for grazing, and vegetables are grown in some areas.

Elrose

The Elrose series consists of very deep, well drained, moderately permeable soils on uplands, formed in marine sediments high in glauconite. Slopes range from 1 to 12 percent. Elrose soils occur on gently sloping to strongly sloping uplands in the western part of the Southern Coastal Plain. The soils developed in stratified sediments of marine origin that contain a high content of glauconite mainly from the Weches Geologic Formation. Average annual temperature ranges from 64 to 67 degrees F. Frost-free days range from 235 to 270. Elevation ranges from 350 to 750 feet above msl. The annual average rainfall ranges from 39 to 48 inches and the Thornthwaite P-E index is about 68. Most of the Elrose soils are used for pastureland or woodland. A few areas are cropped to corn, oats, peanuts, peas, and hay. Native vegetation is mixed pine and oak forests consisting of shortleaf pine, Southern red oaks, and sweetgum.

Guyton

The Guyton series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in thick loamy sediments. These soils are on Coastal Plain local stream floodplains and in depressional areas on late Pleistocene age terraces. Slopes range from 0 to 1 percent. The climate is warm and humid. Mean annual temperature ranges from 60 to 70 degrees F. Average annual rainfall ranges from 42 to 62 inches. Where runoff is ponded, drainage is very poor. Runoff is slow to ponded. A seasonal high water table is at 0 to 1.5 feet below the surface from December through May, except where ponded. Where ponded, it is from 1 foot above the surface to 0.5 foot below the surface most of the time. In places, the soils are subject to rare, occasional, or frequent flooding. Most areas are in woodland. Water oak, bald cypress, water tupelo, loblolly pine, and shortleaf pine are dominant in the drainageways. On broad terraces, bald cypress and water tupelo generally are absent and sweetgum dominates. Some areas are used as pastureland or cropland.

Iuka

The Iuka series consists of deep, moderately well-drained, moderately permeable soils that formed in stratified loamy and sandy alluvial sediments. These soils are on nearly level floodplains. They are saturated with water at depths of 1 foot to 3 feet below the surface during wet seasons and are subject to flooding. Slopes range from 0 to 2 percent. The climate is warm and humid. Near the type location the average daily temperature for January is 42 degrees F., the average daily temperature for July is 79 degrees F., the mean annual temperature is about 61 degrees F., and the mean annual precipitation is about 54 inches. Iuka soils are rarely to commonly flooded. A water table is at depths of 12 or more inches, and the soil is commonly saturated with water between 12 and 40 inches during some season of most years. Much of the soil has been cleared and cultivated. It is cropped to corn, soybeans, small grains, truck crops, and hay or is in pasture. Native vegetation is forest of water oak, willow, beech, sweetgum, hickory, maple, ironwood, eastern cottonwood, alder, white oak, and in some places, pine.

Kirvin

The Kirvin series consists of soils that are deep to stratified sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on gently sloping to moderately steep convex uplands. Slope is dominantly 2 to 8 percent, but ranges from 1 to 15 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 48 inches, with frost-free rainfall of 25 to 30 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 650 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. Runoff is very low on 1 to 3 percent slopes, low on 3 to 5 percent slopes, and medium on 5 to 15 percent slopes. Principal use is for pastureland and woodland. Bermudagrass is the main pasture grass. Forests are of shortleaf, slash, and loblolly pine, red oak, sweetgum, and other hardwood trees. A few areas are used for growing truck crops, cotton, corn, and oats.

Kullit

The Kullit series consists of deep, moderately well drained, moderately slowly permeable soils that formed in loamy and clayey sediments of Cretaceous or Quaternary age, on nearly level to gently sloping ridge crest of uplands in the Western Coastal Plains. An apparent water table occurs between 2 and 3 feet during the winter and spring months. Slopes range from 0 to 5 percent. Mean annual precipitation is 45 inches. Mean annual temperature is 63 degrees F. The soils are used mainly for tame pasture or growing trees. Some areas are used for growing corn, grain sorghum, soybeans, cotton, and peanuts. Native vegetation is shortleaf pine, loblolly pine, sweetgum, red oak, and hickory trees with an understory of mid and tall grasses.

Lilbert

The Lilbert series consists of very deep, well-drained, moderately slowly permeable soils. These soils formed in sandy and loamy deposits on uplands. Water runs off the surface slowly. Slopes range from 1 to 8 percent. A perched water table may occur in late winter to early spring from 3 to 6 feet below the soil surface. Average annual temperature ranges from 64 to 69 degrees F., the mean annual precipitation ranges from 40 to 50 inches. Frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 240 to 275. Elevation ranges from 350 to 600 feet above msl. The Thornthwaite P-E index is 66 to about 80. Runoff is slow. The areas where this soil type occurs are used mainly for woodland and pasture. However, some areas are used for cropland. Native vegetation consists of loblolly pine, shortleaf pine, hickory, sweetgum, red oak, and other hardwoods.

Mantachie

The Mantachie series consists of somewhat poorly drained, moderately permeable soils. They formed in loamy alluvium. These soils are on floodplains. They usually flood late in winter and early in spring. The seasonal high water table is at a depth of 1.0 to 1.5 feet. Slope is dominantly less than 1 percent but ranges to 3 percent. Near the type location the mean annual temperature is about 63 degrees F., and the mean annual precipitation is about 53 inches. These soils are subject to rare, occasional, or frequent flooding for brief to long duration, unless protected. The water table is within 1.0 to 1.5 feet of the surface during periods of high rainfall. Most areas of these soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture, and hay. Some areas are in bottomland hardwoods. Common trees are green ash, eastern cottonwood, cherrybark oak, loblolly pine, sweetgum, and yellow-poplar.

Redsprings

The Redsprings series consists of soils that are deep to mixed marine sediments on gently sloping to steep uplands. Slopes are mainly 2 to 15 percent, but range from 2 to 40 percent. Slopes are slightly convex, and tend to be complex on the steeper gradients Climate is warm and humid. Mean annual precipitation ranges from 40 to 46 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 240 to 260 and elevation is 300 to 500 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and Thornthwaite annual P-E index ranges from 64 to 84. Redsprings soils are well drained. Runoff is low on 2 to 5 percent slopes, medium on 5 to 20 percent slopes, and high on slopes over 20 percent. Redsprings soils are used predominantly for woodland and pasture. Forests consists mainly of red oak, post oak, hickory, loblolly and shortleaf pine trees with an understory of American beauty berry, greenbriar, native forbs and grasses. Pasture grasses are mainly improved species of bermudagrass and bahiagrass.

Sacul

The Sacul series consists of very deep, moderately well-drained, slowly permeable soils that formed in acid, loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 2 to 25 percent but range from 1 to 40 percent. The average annual air temperature ranges from about 60 to 66 degrees F and the average annual precipitation ranges from about 48 to 54 inches. Most of the acreage is in woodland, with some area in pasture. The forest vegetation is shortleaf and loblolly pine, red oak, sweetgum, and dogwood. Bermudagrass and bahiagrass are the principal pasture grasses used.

5.4.2.2 Hydrological Elements

5.4.2.2.1 Surface Water

The potential reservoir is located within the Cypress Creek Basin on Black Cypress Bayou. Black Cypress Bayou drains into Cypress Creek. This portion of Cypress Creek is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0402 (Big Cypress Creek below Lake O' the Pines). This 63-mile segment originates from a point 7.6 miles downstream of SH 43 in Harrison/Marion County to Ferrell's Bridge Dam in Marion County. This segment is classified as "effluent limited" and designated uses are contact recreation, high aquatic life, and public water supply. Depressed oxygen concentrations allow only partial support of the high aquatic life use in the lower 15 miles of the segment. Orthophosphorus levels and pH values are a concern in the segment, but sluggish flow and organic loading from natural sources and wastewater discharges likely contribute to the problem.[4]

5.4.2.2.2 Ground Water

Cass and Marion counties are located within the outcrop region of the Queen City Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. Some water-bearing formations dip below the surface and are covered by other formations. This is the downdip. This aquifer extends in a band across most of the state from the Frio River in South Texas northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson County. Total pumpage for all uses in 1994 was 16,319 ac-ft.

Sand, loosely cemented sandstone, and interbeded clay units of the Queen City Formation of the Tertiary Claiborne Group make up the aquifer as delineated within Texas. These rocks dip gently to the south and southeast toward the Gulf Coast. Although total aquifer thickness is usually less than 500 feet, it can approach 700 feet in some areas of northeast Texas. In the outcrop area, water occurs under water-table conditions while in the downdip subsurface, where the Queen City is covered by younger, non water-bearing rocks, the water is under artesian conditions. Usable quality water is generally found within the outcrop and for a few miles downdip, but in some areas it may occur down to depths of approximately 2,000 feet. Yields of individual wells are commonly low, but exceed 400 gal/min.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent however, quality deteriorates with depth in the downdip direction. The water may have high acidity (low pH) in much of northeast Texas and relatively high iron concentrations in localized areas. Hydrogen sulfide gas is sometimes present. Fortunately, each of these naturally occurring conditions may be treated relatively easily and economically.

While large amounts of usable quality groundwater are contained within the rocks of the Queen City, yields are low. Estimates of the availability of water from the Queen City Aquifer are based on recharge to the aquifer. Because of differences in topography, vegetative cover, and other factors, only two percent of the annual rainfall is estimated recharge in the Trinity, Colorado, Guadelupe, San Antonio and Neches River basins. Approximately five percent is estimated recharge in the Neches, Sulphur, Sabine, and Cypress Creek Basins. Total annual effective recharge to the aquifer is estimated to be 682,100 ac-ft.[5]
Floodplains

5.4.2.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Black Cypress reservoir will cause water to be impounded on the Big Cypress Creek as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Black Cypress reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.4.2.3 Biological Elements

5.4.2.3.1 Vegetation

The potential Black Cypress reservoir is centrally located within the Austroriparian province[6] and is within the Pineywoods Region.[7] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sands or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Black Cypress reservoir location include Pine Hardwood (62%), Willow Oak Water Oak (30%), and Other (7%).*Fish and Wildlife*

The result of the potential Black Cypress reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Black Cypress reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter. [8]

5.4.2.3.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.4-3). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Table 5.4-3 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Cass, Marion, and Morris counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Blue Sucker	*Cycleptus elongatus*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*		T
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Arkansas meadow-rue	*Thalictrum arkansanum*		R
Southern Lady's-Slipper	*Cypripedium kentuckiense*		R
Texas Trillium	*Trillium pusillum var texanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Marion and Morris Counties, 1999.)
(Texas Department of Transportation, Annotated County Lists of Rare Species for Cass County, 1998a.)

5.4.2.4 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." The Black Cypress Bayou is a potential ecologically unique stream segment that would be in conflict with the development of the potential Black Cypress reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.4.2.5 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data show two hydric soil associations are within the potential Black Cypress reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.4.2.6 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Black Cypress reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.4.2.7 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Black Cypress reservoir is located within the Cypress Creek basin, which represents approximately 8% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;

- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-County study area. The potential Black Cypress reservoir is within and adjacent to the Black Cypress Bayou site and listed as priority one.[9] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.4.2.8 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within the footprint of the Black Cypress reservoir.

5.4.2.9 Social and Economic Conditions

The potential reservoir is located in Cass and Marion counties. The population of these counties according to the 1990 Census is 29,982 for Cass County and 9,984 for Marion County. The State Data Center has estimated the 2020 population to be approximately 34,777 for Cass County and 10,013 for Marion County. This corresponds to a 16 percent and 0.3 percent increase, respectively.[10] The median household income for Cass County in 1989 was $19,886 and for Marion County was $15,288.[11]

5.4.2.10 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Black Cypress reservoir will affect portions of Cass, Marion, and Morris counties.

Historical and Archeological Resources for the three county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.4-4.[19]

Table 5.4-4 Historical and Archeological Resources for Black Cypress.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Cass	177	1	149	25	2	NA
Marion	96	1	74	NA	17	4
Morris	26	1	24	NA	1	NA

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.4-5) details the results of previous cultural studies that have been performed on the area since 1879. Some counties have been investigated more thoroughly than other counties for cultural resources. This is important to note because there is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Cass, Marion, and Morris counties.[12]

Table 5.4-5 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Cass	15	84	25	13	137
Marion	8	23	18	3	52
Morris	5	6	6	9	26
Sub-total	28	113	49	25	215

* Significance refers to National Register criteria.
Source: THC, 1993.

5.4.2.10.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.4-6.

Table 5.4-6 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.4-7 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.4-7 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Cass			2	3	15
Marion	1*				12
Morris	5	6	6	9	26

Source: THC, 1993, and Perttula T. K., 1999.[13]

5.4.2.10.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.4.2.11 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.4-8 depicts the percent coverage by major land uses within the reservoir study area.[14]

Table 5.4-8 Land Use for the Potential Black Cypress Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	23%
Deciduous Forest Land	8%
Mixed Forest Land	42%
Evergreen Forest Land	27%
Other	1%

5.4.2.12 Regulated Materials

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites, municipal solid waste landfill sites, within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are three municipal solid waste landfills, and one Superfund site (ADCO-Avinger Development Company) in the reservoir study area. There are no permitted industrial and hazardous waste locations, or air quality monitoring stations in the subject area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[15]

5.4.2.13 Potential Environmental Impact Summary

Table 5.4-9 Resultant Environmental Impact Summary for Black Cypress.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
Potential Ecologically Unique Stream Segment	Moderate
USFWS Priority Bottomland Harwood Area	Moderate
3-Municipal Solid Waste Landfills	Moderate
1 – Superfund Site	Substantial

---

[1] COE. 1987. Fort Worth District, U.S. Army Corps of Engineers, Feasibility Report of Cypress Bayou Basin, Texas, February, 1987.

[2] COE. 1981. Fort Worth District, U.S. Army Corps of Engineers, Cypress Bayou Basin Study Reconnaissance Report, July, 1981.

[3] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[4] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96.* Austin, Texas. TNRCC.

[5] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the Stte Water Plan.* Austin, Texas. TWDB.

[6] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[7] Gould, F.W. 1975. Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[8] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[9] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[10] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[11] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[12] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[13] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[14] www.tnris.state.tx.us

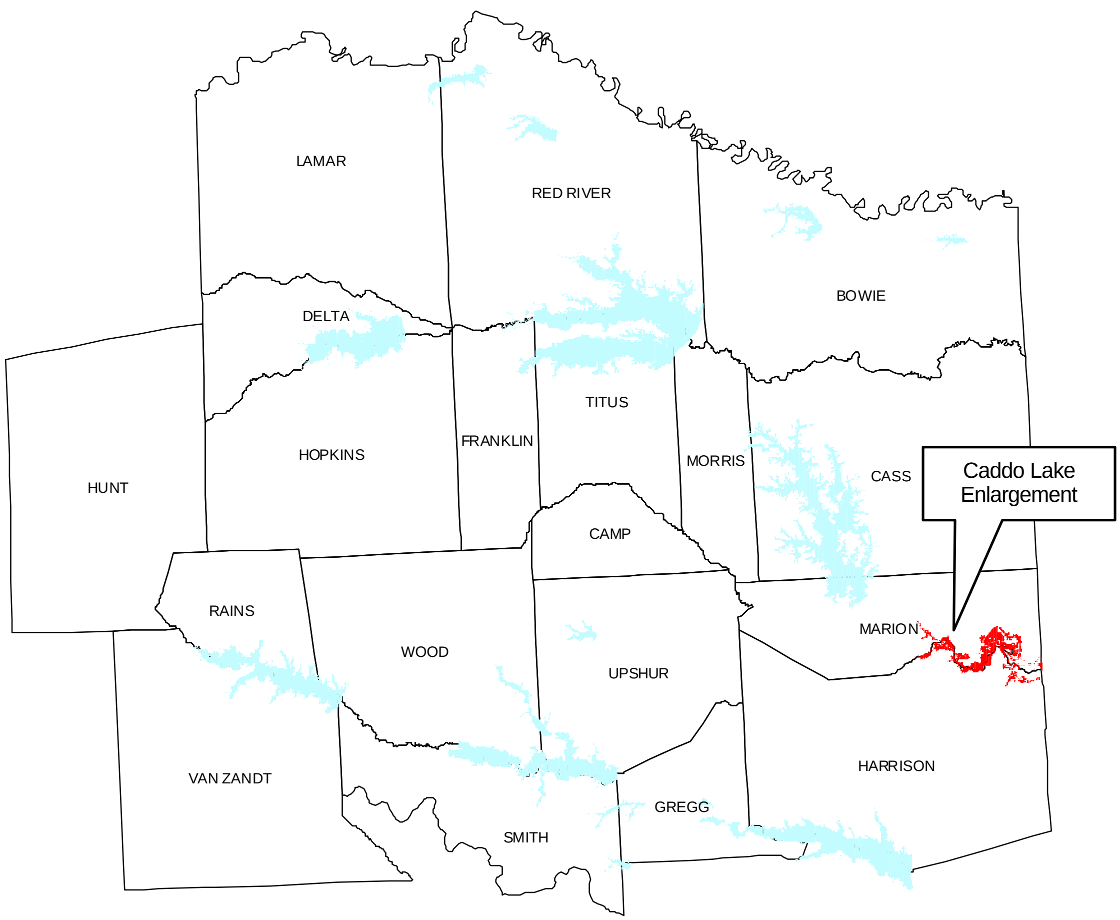
[15] www.tnris.state.tx.us

5.5 CADDO LAKE ENLARGEMENT

5.5.1 Summary of Prior Studies

5.5.1.1 Location

Figure 5.5-1 Location of Caddo Lake Enlargement within the Region D Planning Region



For additional information on location see Appendix, Exhibit A, Vicinity Map.

5.5.1.2 Impoundment Size and Volume

Caddo Lake currently holds storage of 128, 600 ac-ft and occupies a surface area of 25,400 acres with a mean lake elevation of 168.5 ft msl.[1] Raising Caddo Lake by 2 ft will provide 186,500 additional ac-ft of storage and supply an 84 mgd yield.[2]

5.5.1.3 Site Geology and Topography

Wetlands exist in the upper reaches of Caddo Lake with several thousand acres of bald cypress swamp and bottomland hardwood forest, which are classified as “Resource Category 1”. They support 216 bird species, 47 mammals, 90 reptiles and amphibians and 44 animals that are endangered, threatened, or rare.[1]

The Cypress Bayou Basin is underlain by southeasterly dipping sand, clay, glauconite and lignite of the Wilcox and Claiborne Groups of the Tertiary age. Most of the Texas iron ore production comes from formations within the basin.[3]

5.5.1.4 Dam Type and Size

The Caddo Lake Dam and spillway are located in Caddo Parish, Louisiana at the head of the Twelvemile Bayou. The existing spillway has a 860 ft long low section at elevation 168.5 ft msl and two adjouning high sections at elevation 170.5 ft msl. The combined use of a labyrinth weir and tainter gates will allow ability to increase the pool elevation 2 ft and to better control drawdown.[4] This alternative, however, considers environmental restoration and not increased water supply to be the primary purpose.

5.5.1.5 Hydrology and Hydraulics

5.5.1.5.1 Surface Water

The amount and distribution of naturalized streamflows throughout the basin tributary to the Caddo Lake damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.5.1.5.2 Water Suppliers

The three major municipal and industrial water suppliers for the Cypress Bayou Basin are the Sulphur Municipal Water District, Northeast Texas Municipal Water District and Sabine River Authority.[4] The SRMWD serves Delta, Hopkins and Hunt counties and owns 26.3 percent of the storage space in Lake Cooper. The NTMWD serves Marion, Upshur, Morris, Cass and Camp counties and owns storage rights in Lake O' the Pines Reservoir. The SRA serves at least in part Rains, Woods, Gregg, Panola, Shelby, Savine, Newton, Orange and Jasper counties and owns Lake Fork and Lake Tawakoni. Municipal water customers include the Cities of Tyler, Longview, Texarkana, Paris, Marshall and Kilgore.[4]

5.5.1.5.3 Water Needs

Table 5.5-1[4] lists by county up to the year 2040 the projected water needs for the Cypress Bayou Basin.

Table 5.5-1. Water Supply Needs by County (mgd)

County	*1980*	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*
Camp							
Franklin							
Gregg						1.6	15.5
Harrison		1.4	5.9	11.5	18.6	25.3	33.6
Marion							
Morris		3.6	11.5	25.0	35.8	50.0	74.7
Titus							
Upshur			0.7	1.6	2.9	4.0	5.2
Wood							
Totals		5.0	18.1	38.1	57.3	80.9	129.0

5.5.1.5.4 Existing Permits

A total of 91 water rights permits equating 540,058 acre-feet of annual permitted water use exist for Cypress Bayou Basin. [4]

5.5.1.6 Water Quality

Water quality in the area is generally good. The Cypress Valley Basin experiences some industrial waste discharges, chromium and zinc, and oilfield brine disposal is carefully monitored.[2] Present in the upper reaches of Caddo Lake due to the dense aquatic growth of the bald cypress swamp are low levels of dissolved oxygen and excessive nutrient loading compounded with lack of flushing flows. [4]

5.5.1.7 Project Yield for Water Supply

A supply yield of 84 mgd will be acquired from raising the lake surface elevation 2 ft.[2]

5.5.1.8 Other Potential Benefits

Potential benefits associated with the enlargement of Caddo Lake Reservoir include increased water supply, recreation, and some amount of flood control.

5.5.1.9 Land Acquisition and Easement Requirements

Possible ruins and former occupation areas for prehistoric sites and historic sites are located all around Caddo Lake.[2]

5.5.1.9.1 Potential Land Use Conflicts

Extensive mitigation and bald cypress land compensation measures will be required with the current “Resource Category 1” listing for much of the upper reaches of Caddo Lake. Potential for lignite mines and gas and oil wells in the area may exist.[1]

5.5.1.10 Updated Project Costs

The updated project cost for a combined labyrinth weir and tainter gates with environmental protection as its primary purpose from October, 1998 prices to June, 1999 prices is $21,006,300. The 20 city average ENR index was used to update the costs 89%. The updated cost of raising Caddo Lake 2 ft for purposes of increased water supply taken from a 1987 report by the Corps of Engineers is $213,690,400 at a 38.8% increase.[2]

Table 5.5-2. Updated Project Cost

Description	*Quantity*	*Total Cost ($)*
Jan. 1987 Subtotal:		$154,000,000
20-City Average Escalation Factor	38.8%	$59,752,000
OPINION OF PROBABLE PROJECT COST		**$213,752,000**

Notes:
1. Original cost estimates were taken from COE, 1987.[2]
2. The Project Cost is listed as a lump sum and we assumed it includes Engineering Fees, Conflict Resolution, Land Costs, Studies, Mitigation, Permitting and Interest during construction.

5.5.1.10.1 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 94,160 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $213,752,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total project cost. For Caddo Lake Enlargement, the O&M is $3,206,280 and the annualized debt service is $15,134,300. The firm yield is then divided into the total annualized cost of $18,340,580 to yield a unit cost of $194.79 per acre-foot ($0.60/1,000 gal) of firm yield. These annualized costs are summarized in contained in the executive summary.

5.5.2 Environmental Overview –Affected Environment and Environmental Consequences

5.5.2.1 Geological Elements

5.5.2.1.1 Phisiography

The potential Caddo Lake reservoir is located within the Pineywoods of Texas. The Pineywoods area is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods lie entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dalisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

5.5.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in Northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[5] The area of the potential reservoir was formed during the Eocene Period. The area is composed primarily of Wilcox Group undivided and Alluvium.

The Wilcox Group undivided consists of mostly silty and sandy clay. It is very thinly bedded to massive and is locally cross-bedded. This portion is in part carbonaceous and calcareous. Siltstone and ironstone are common. It is various shades of gray. Local beds of clay, lignite, silt, and quartz sand are present. The weathers are various shades of gray, brown, yellow and red. Plant fossils are abundant. The Wilcox Group undivided has a thickness of approximately 700 feet.

Alluvium is also present. This consists of flood plain deposits from Cypress Creek.

5.5.2.1.3 Soils

The area of the reservoir contains three major soils groups.[9] These groups are Iuka-Guyton-Manachie, Latch-Mollville-Bienville, and Scotsville-Eastwood-Keithville. Approximately 41.2 percent of the area is Iuka-Guyton-Manachie, 18.8 percent Latch-Mollville-Bienville, and 8.5 percent Scotsville-Eastwood-Keithville. The remaining 31.5 percent of the area is water. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Bienville

The Bienville series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils, formed in sandy coastal plain sediments on nearly level or gently sloping stream terraces. The typical slope is dominantly 1 to 3 percent, but ranges from 0 to 5 percent. Bienville soils are on stream terraces in the Gulf Coastal Plains. A water table is at depths of 4 to 6 feet in late winter and early spring. These soils formed in sandy alluvium mainly from sandy coastal plain sediments. The climate is warm and humid. Mean annual precipitation ranges from 45 to 62 inches and mean annual temperature ranges from 60 to 70 degrees F. Most acreage is in woodland, dominantly mixed hardwood and pine. This soil series is typically used for cotton, corn, and truck crops within cleared areas.

Eastwood

The Eastwood series consists of deep, moderately well drained, very slowly permeable soils. They formed in weakly consolidated marine deposits of silty clay loam texture, on gently sloping to moderately steep uplands. Slopes range from 1 to 20 percent. Eastwood soils are on gently sloping interstream divides and on moderately steep sideslopes adjacent to drainageways. These soils mainly formed in loamy and shaly sediments of the Wilcox group of the Tertiary System The mean annual temperature ranges from about 64 to 68 degrees F., average annual precipitation from 45 to 52 inches, and frost-free precipitation ranges from 25 to 30 inches. This soil series is used mainly for woodland but some areas are used for improved pasture. Native vegetation includes loblolly pine, shortleaf pine, southern red oak, sweetgum and hickory, mid and tall grasses such as indiangrass, pinehill bluestem, longleaf uniola and panicums. American beautyberry, sumac, greenbriar and hawthorn species are dominant species within the understory. Improved pastures consist mainly of bermuda and bahiagrasses with crimson and arrowleaf clovers.

Guyton

The Guyton series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in thick loamy sediments. These soils are on Coastal Plain local stream floodplains and in

depressional areas on late Pleistocene age terraces. Slopes range from 0 to 1 percent. The climate is warm and humid. Mean annual temperature ranges from 60 to 70 degrees F. Average annual rainfall ranges from 42 to 62 inches. Where runoff is ponded, drainage is very poor. Runoff is slow to ponded. A seasonal high water table is at 0 to 1.5 feet below the surface from December through May, except where ponded. Where ponded, it is from 1 foot above the surface to 0.5 foot below the surface most of the time. In places, the soils are subject to rare, occasional, or frequent flooding. Most areas are in woodland. Water oak, bald cypress, water tupelo, loblolly pine, and shortleaf pine are dominant in the drainageways. On broad terraces, bald cypress and water tupelo generally are absent and sweetgum dominates. Some areas are used as pastureland or cropland.

Iuka

The Iuka series consists of deep, moderately well-drained, moderately permeable soils that formed in stratified loamy and sandy alluvial sediments. These soils are on nearly level floodplains. They are saturated with water at depths of 1 foot to 3 feet below the surface during wet seasons and are subject to flooding. Slopes range from 0 to 2 percent. The climate is warm and humid. Near the type location the average daily temperature for January is 42 degrees F., the average daily temperature for July is 79 degrees F., the mean annual temperature is about 61 degrees F., and the mean annual precipitation is about 54 inches. Iuka soils are rarely to commonly flooded. A water table is at depths of 12 or more inches, and the soil is commonly saturated with water between 12 and 40 inches during some season of most years. Much of the soil has been cleared and cultivated. It is cropped to corn, soybeans, small grains, truck crops, and hay or is in pasture. Native vegetation is forest of water oak, willow, beech, sweetgum, hickory, maple, ironwood, eastern cottonwood, alder, white oak, and in some places, pine.

Keithville

The Keithville series consists of deep, moderately well drained, very slowly permeable soils that formed in loamy over clayey sediment of Tertiary Age, on broad nearly level or gently sloping uplands of the coastal plains. Slopes range from 1 to 5 percent. Keithville soils are saturated above the clayey layers to a depth of 2 to 3 feet below the surface for intermittent periods totaling 2 to 6 weeks during winter and early spring. Keithville soils are on nearly level or gently sloping uplands of the Gulf Coastal Plain. The soils formed in loamy and clayey Coastal Plain sediments. The climate is warm and humid. The mean annual precipitation is 45 inches, and the mean annual temperature is 65 degrees F.. The soil typically has a perched water table at a depth of 2 to 3 feet for intermittent periods totaling 2 to 6 weeks during December through April. Most of the Keithville soils are used for pasture and urban development. A small area is in mixed hardwood and pine forest.

Latch

The Latch series consists of very deep, moderately well drained, moderately permeable soils on stream terraces. These nearly level to gently sloping soils formed in sandy alluvial sediments. Slopes range from 0 to 3 percent. These nearly level to gently sloping soils are on oblong and low oval mounds less than an acre to about 5 acres in size along stream terraces. They are typically mapped as a part of a soil complex. These soils formed on sandy alluvial terraces of late Pleistocene and Recent Age in the West Coastal Plains. Frost-free days range from 230 to 270 days and elevation ranges from 250 to 400 feet above msl. Mean annual precipitation is 42 to 50 inches. Mean annual temperature ranges from 64 degrees to 66 degrees F. and the Thornthwaite annual P-E indices ranges from 68 to 80. Latch soils are moderately well drained. There is a perched water table for brief periods during the winter and spring seasons. This soil series is used mainly for forest and pasture. Forest vegetation includes loblolly pine, sweetgum, post oak, willow oak, water oak, and elm with an understory of American beautyberry, southern bayberry, green briar, and shade tolerant forbs and grasses.

Manachie

The Mantachie series consists of somewhat poorly drained, moderately permeable soils. They formed in loamy alluvium. These soils are on floodplains. They usually flood late in winter and early in spring. The seasonal high water table is at a depth of 1.0 to 1.5 feet. Slope is dominantly less than 1 percent but ranges to 3 percent. Near the type location the mean annual temperature is about 63 degrees F., and the mean annual precipitation is about 53 inches. These soils are subject to rare, occasional, or frequent flooding for brief to long duration, unless protected. The water table is within 1.0 to 1.5 feet of the surface during periods of high rainfall. Most areas of these soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture, and hay. Some areas are in bottomland hardwoods. Common trees are green ash, eastern cottonwood, cherrybark oak, loblolly pine, sweetgum, and yellow-poplar.

Mollville

The Mollville series consists of very deep, poorly drained, slowly permeable soils that formed in thick stratified sandy and loamy sediments, in nearly level or depressional areas on terraces. Mollville soils are typically on first level terraces. However, they are on third or higher level terraces of some large river systems. Slopes are less than 1 percent with plain or concave surfaces. The soils formed in sandy and loamy alluvial sediments. The surfaces typically have been reworked by wind. The climate is humid. The mean annual precipitation ranges from 42 to 56 inches. The mean annual temperature is from 64 to 68 degrees F. Frost-free days range from 220 to 260 and the elevation ranges from 150 to 450 feet above msl. The soil is ponded during the winter and spring mainly for brief to long durations after heavy or prolonged rainfall. A perched water table is at a depth of 0 to 12 inches for brief to long periods to include a cumulative annual duration of 2 to 4 months during most years. During the other years the soil is typically wet for longer periods. The soil is mainly in hardwood forest of water oak, sweetgum, blackgum, and post oak.

Scottsville

The Scottsville series consists of very deep, moderately well drained, very slowly permeable soils that formed in thin loamy sediments over clayey deposits, on broad nearly level to very gently sloping uplands. Slopes range from 0 to 3 percent. Scottsville soils are on broad nearly level to very gently sloping uplands of the Gulf Coastal Plains. These soils occur on very gently undulating stream divides. The soils formed in thin loamy sediments and clayey deposits of the Wilcox Formation of the Tertiary period. The climate is warm and humid. The mean annual temperature ranges from 64 to 68 degrees F.

The annual precipitation ranges from 44 to 54 inches. The Thornthwaite P-E index is about 74. The frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 220 to 250. A perched water table from a depth of 1 to 3 feet intermittently occurs from the fall to spring months. Most of the Scottsville soils are used for timber production and for pasture or hayland. A few areas are used for cropland. Native vegetation consists of loblolly pine, hickory, sweetgum and southern red oak, with mid and tall grasses such as pinehill bluestem, longleaf uniola and panicums. American beautyberry, sumac, greenbriar and hawthorn species are part of the understory. Improved pastures consist mainly of coastal bermudagrass or bahiagrass commonly overseeded with arrowleaf clover. Many areas are replanted to loblolly pine for maximum timber production.

5.5.2.2 Hydrological Elements

5.5.2.2.1 Surface Water

The potential reservoir is within the Cypress Creek River Basin. The portion of the Cypress Creek River Basin is included in the Texas Natural Resource Conservation Commission (TNRCC) – The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96 as stream segment 0401 (Caddo Lake). This 12-mile, 26,800 acre portion of Caddo Lake originates from the Louisiana state line in Harrison/Marion County to a point 7.6 miles downstream of SH 43 in Harrison/Marion County, up to the normal pool elevation of 168.5 feet. This segment is classified as "water quality limited" and designated uses include contact recreation, high aquatic life, and public water supply.

Elevated levels of chlorophyll *a* are a concern and may reflect high levels of primary production that likely contribute to periodic pH exceedances in the segment. Water temperature values occasionally exceed criteria in the segment.

Due to elevated concentrations of dissolved zinc in water, the middle reach of the lake does not support the designated high aquatic life use. The upper end of the lake partially supports the designated high aquatic life use due to the elevated concentration of dissolved mercury in a water sample collected in 1986. Elevated concentrations of barium, manganese, mercury, nickel, and zinc in sediments are a concern in the lake.[10]

5.5.2.2.2 Ground Water

The potential reservoir is located in Harrison and Marion counties in the outcrop region of the Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeastern part of the aquifer.

Extremely large water-level declines have occurred in northeast Texas around Tyler and the Lufkin-Nacogdoches area. Much of the pumpages has been for municipal supply, but industrial pumpage is also significant.

5.5.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and “provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses.” Additionally, the act “required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas.” The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which “added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA).”

The potential reservoir will cause water to be impounded on the Caddo Lake as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Caddo Lake reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.5.2.4 Biological Elements

5.5.2.4.1 Vegetation

The potential Caddo Lake reservoir is centrally located within the Austroriparian province[6] and is within the Pineywoods Region.[7] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Caddo Lake reservoir location include Cypress, Water T (34%); Pine Hardwood (28%), and Willow Oak Water (4%).

5.5.2.4.2 Fish and Wildlife

The result of the potential Caddo Lake reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Caddo Enlargement reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter. [8]

5.5.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.5-3). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.5-3 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Harrison and Marion Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Bluehead Shiner	*Notropis hubbsi*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*		T
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Harrison and Marion Counties, 1999.)

5.5.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." The development of the potential Caddo Lake Reservoir would affect two ecologically unique streams, Black Cypress Creek and Cypress Creek *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.5.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows three hydric soil associations are within the potential Caddo Lake reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.5.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Caddo Lake reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.5.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Caddo Lake reservoir is located within the Cypress Creek basin, which represents approximately 8% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-County study area. The potential Caddo Lake reservoir is within and adjacent to a Priority 1 site and a Priority 2 site.[9] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.5.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. Various private, state, or federal entities often manage these easements. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within the footprint of the potential Caddo Lake reservoir.

5.5.2.10 Social and Economic Conditions

The potential Caddo Lake reservoir is located on the border of Harrison and Marion counties. The populations of these counties according to the 1990 census are 57,483 and 9,984, respectively. The Texas State Data Center has estimated the 2020 population to be approximately 72,814 and 10,013.[16] This corresponds to a 27 percent growth in Harrison County and 0.3 percent growth in Marion County. The median household income in 1989 for Harrison County was $22,625 and Marion County was $15,288.[10]

5.5.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Caddo Lake reservoir will affect portions of Harrison and Marion counties.

Historical and Archeological Resources for the two county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.5-4.[19]

Table 5.5-4 Historical and Archeological Resources for Caddo Lake.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Harrison	239	1	115	100	17	6
Marion	96	1	74	NA	17	4

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.5-5) details the results of previous cultural studies that have been performed on the area since 1879. Although Harrison County has been investigated more thoroughly than other counties for cultural resources, there is the potential for the discovery of additional archeological sites within the area of the potential reservoir. There is an even greater potential for more archeological sites being discovered in counties that have not been excessively studied, such as Marion County.[11]

Table 5.5-5 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Harrison**	84	59	23	5	171
Marion	8	23	18	3	52
Sub-total	88	82	41	8	221

* Significance refers to National Register criteria.
** County tabulations are incomplete.
Source: THC, 1993.

5.5.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the Northeast Texas region has been determined and is presented in Table 5.5-6.

Table 5.5-6 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.5-7 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.5-7 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Harrison			2	6	13
Marion	1*				12

Source: THC, 1993, and Perttula T. K., 1999.[12]

5.5.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that

have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.5.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.5-8 depicts the percent coverage by major land uses within the reservoir study area.[13]

Table 5.5-8 Land Use for the Potential Caddo Lake Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Commercial and Services	1%
Cropland and Pasture	6%
Deciduous Forest Land	16%
Mixed Forest Land	46%
Evergreen Forest Land	9%
Forested Wetland	13%
Reservoirs	8%
Other	1%

5.5.2.13 REGULATED MATERIALS

Superfund cleanup sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, and air quality monitoring stations were determined to be within the resrvoir study area using existing TNRCC data. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there is one municipal solid waste landfill sites and one Superfund sites (Longhorn Army Ammunition Plant) located within the reservoir study area. There are no permitted industrial and hazardous waste locations, or air quality monitoring stations within the subject area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[14]

5.5.2.14 Potential Environmental Impact Summary

Table 5.5-9 Potential Environmental Impact Summary for Caddo Lake.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
2- Potential Ecologically Unique Stream Segments	Moderate
2- USFWS Priority Bottomland Hardwood Areas	Moderate

[1] TPWD. 1993. Texas Parks and Wildlife Department, Chapman, Jim, Congressman, Caddo Lake and Associated Watershed: A Proposal for Environmental Initiatives and Sustainable Development, October, 1993.

[2] COE. 1987. U.S. Army Corps of Engineers, Fort Worth District, Cypress Bayou Basin, Texas Feasibility Report, February, 1987.

[3] COE. 1987. U.S. Army Corps of Engineers, Fort Worth District, Cypress Bayou Basin Study, Reconaissance Report, July, 1981.

[4] COE. 1987. U.S. Army Corps of Engineers, Fort Worth District, Cypress Valley Watershed Resource Department, November, 1998.

[5] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[6] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[7] Gould, F.W. 1975. Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas

[8] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[9] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[10] United States Census Bureau. “Median Household Income by County: 1969, 1979, 1989” [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[11] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[12] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[13] www.tnris.state.tx.us. GIS

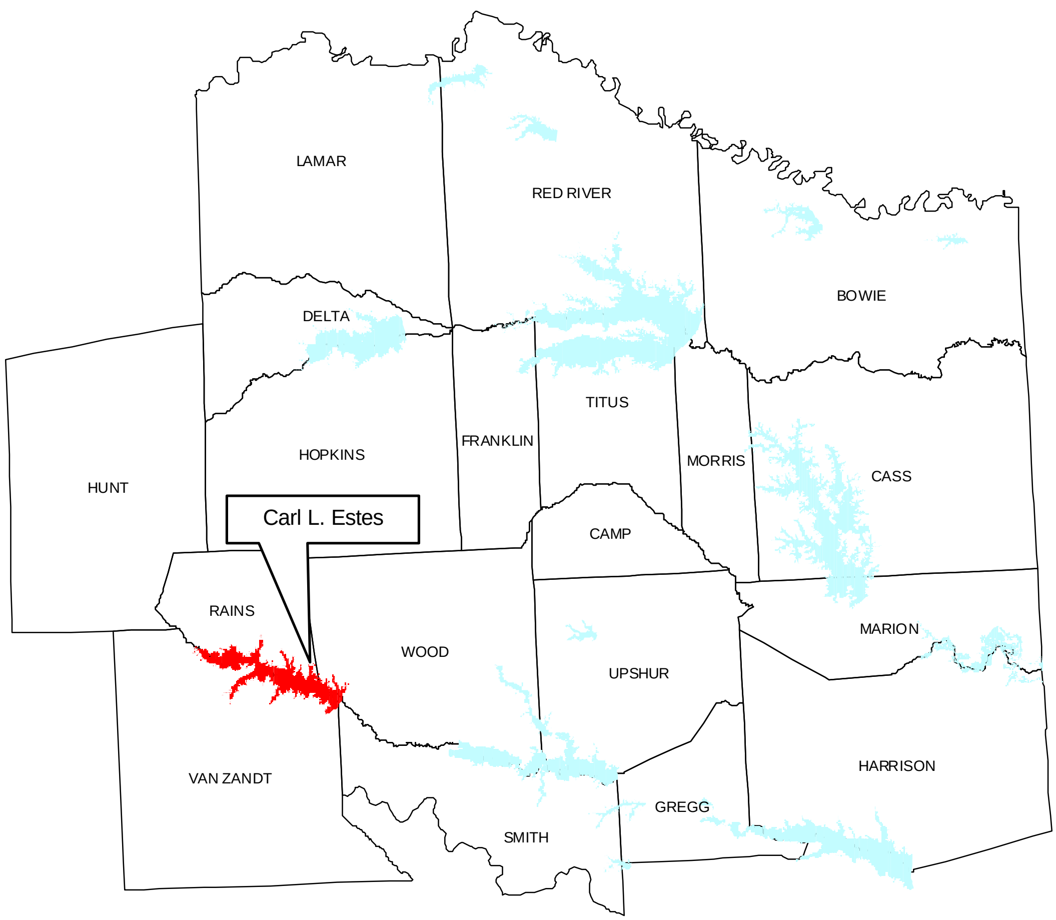
[14] WWW.TNRIS.STATE.TX.US data GIS.

5.6 CARL ESTES

5.6.1 Summary of Prior Studies

5.6.1.1 Location

Figure 5.6-1 Location of Carl L. Estes within the Region D Planning Region



The Carl L. Estes Reservoir has a damsite[1] located at river mile 479.7 on the Sabine River approximately 8 miles west of Mineola and 55 miles east of Dallas in Wood, Rains, and Van Zandt counties. Development of the reservoir, as intended, should provide service to a seven county area within the vicinity of the project as well as to water users within the Trinity River Basin *(See Appendix, Exhibit A, Vicinity Map).*

5.6.1.2 Impoundment Size and Volume

At the top of conservation storage elevation of 379.0 feet msl, the storage capacity and surface area of Carl L. Estes is 393,000 acre-feet and 24,900 acres respectively.[1] At the maximum design flood (PMF) elevation of 420.4 feet msl, the reservoir surface area is 66,500 acres requiring a storage capacity of 2,151,300 acre-feet.[1] At the top of flood control pool elevation of 403.0 ft msl, the storage capacity is 1,205,200 acre-feet with a surface area of 44,000 acres. Reservoir area and capacity relationships shown below are based on planimeter measurements of surface areas and corresponding elevations from U.S. Geological Survey 1:24,000 contour maps.

5.6.1.3 Site Geology and Topography

The Carl L. Estes dam and lake will be founded on bedrock belonging to the Wilcox group and overlaying Claiborne group, both of Tertiary age. These groups are similar in composition, both consisting of fine sand and clay strata predominantly. The Wilcox group includes a few thin lignite beds. The regional dip of the strata is to the southeast. Overburden material in the flood plain consists of silty clay and clayey sand. Overburden in the upland is sparse, seldom exceeding more than a few inches in thickness.[2]

The basin is relatively long and narrow and the topography varies from undulating and gently rolling in the extreme upper ends to flat in the lower reaches of the basin.

5.6.1.4 Dam Type and Size

The Carl L. Estes reservoir embankment will be constructed of compacted earthfill approximately 15,800 feet in length. The elevation of the top of the dam will be 428.5 feet msl, an embankment crest width of 46 feet, and embankment side slopes of 3H:1V to elevation 408.5 ft msl, after which the side slopes lessen to 10H:1V. Slope protection extending from near the top of flood control pool elevation 403.0 ft msl to the top of dam on the upstream face will protect the embankment along the dam from erosion due to wave runup. A cutoff trench extending from 35± feet below the natural grade will reduce seepage through the embankment and foundation.[2]

The potential service spillway will be an uncontrolled ogee shaped spillway with the crest elevation at 403.0 ft msl. During the spillway design flood, the potential service spillway will convey the peak discharge of 55,200 cfs at a maximum water surface elevation of 420.4 feet msl. The stilling basin will dissipate increasing energy from the spillway chute using baffle blocks and an end sill. The outlet works will consist of a multi-level opening, a 180 inch diameter conduit through the dam embankment, and a stilling basin.2

5.6.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the Carl L. Estes damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.6.1.5.1 Reservoir Inflows

Daily reservoir inflows have been developed by the U.S. Bureau of Reclamation (USBR) in connection with its Texas Basins studies for the periods 1941-1957 for many of the subbasins of the Sabine River. This data was used for this study where applicable, and gauge records and correlation procedures were used to extend the records to include the missing periods from 1924 to 1972.[2] The tributary drainage area at River Mile 479.7 is 1,128 square miles including the 756 square miles for Iron Bridge Dam (Lake Tawakoni).[2] From the 1975 U.S. Army Corps of Engineers' study, the mean of the estimated monthly inflows is 217,600 acre-feet with a maximum runoff/inflow of 1,169,700 acre-feet and a minimum of 0 acre-feet.[2]

Inflow equations used often in estimating reservoir inflows for simulation models are generally based on drainage area ratios which vary depending on the location and size of the potential reservoir and the corresponding location and size of the nearby U.S. Geological Survey (USGS) gaging stations. Updates could include expansion of the period of record to capture more recent inflow data, changes to water rights since the previous study was completed, and changes to the environmental flow requirements.

5.6.1.5.2 Firm Yield

The Texas Water Development Board 31 TAC 357.7(a)(3) requires "an evaluation of adequacy of current water supplies available to the regional water planning area for use during drought of record. This evaluation shall consider surface water and groundwater data from the State Water Plan, existing water rights, contracts and option agreements, other planning and water supply studies, and analysis of water supplies currently available to the regional water planning area. Analysis of surface water available during drought of record from reservoirs shall be based on firm yield analysis of reservoirs".[3]

Firm yield studies are summarized for Carl L. Estes in the section below entitled, "Project Yield for Water Supply."

5.6.1.5.3 Reservoir Evaporation

Reservoir evaporation data was estimated for Carl L. Estes Reservoir using averages of nearby evaporation stations in conjunction with curves of annual rainfall versus net evaporation to develop the annual net evaporation loss for the area. The net evaporation used in the reservoir operation studies have been calculated as the difference between gross reservoir evaporation and precipitation, with positive values representing conditions when evaporation exceeds precipitation. Evaporation values are assumed to be constant within each month. The reservoir evaporation effects have been reflected in the reservoir inflow records.[2]

5.6.1.5.4 Area Capacity Data

The elevation-area-capacity relationship (also referred to as an area-capacity curve) for a reservoir is generally developed during the reservoir planning phase.[2] The relationship is based on the topographic characteristics of the land to be inundated by the reservoir. Reservoir area and capacity relationships and are based on planimeter and digitizer measurements of area and elevation from U.S. Geological Survey 1:24,000 contour maps. The curve was developed above Carl L. Estes damsite to elevation 424.0 ft msl.

During the life of the reservoir, sediment deposition within the reservoir typically alters that relationship and reduces the capacity of the reservoir. Sediment deposition is distributed in various zones of a reservoir at differing rates, depending on the shape of the reservoir and other factors such as the type of sediment from the tributary basin. It was determined that 20,400 acre-feet of storage would be required for the accumulation of 100 years of sediment. It was estimated that 3,700 acre-feet of sediment would be deposited in the flood control pool between elevation 379.0 and 403.0, and the remaining 16,700 acre-feet would be deposited below elevation 379.0 in the conservation pool.[2]

5.6.1.6 Water Quality

The examination of water quality is based upon existing water quality and streamflow data provided by the U.S. Geological Survey (USGS).

5.6.1.7 Project Yield for Water Supply

Firm yield as described in the SB1 Regional Water Plan by the State of Texas is "the maximum amount of water supply, based upon simulation, that a reservoir could have produced each year if it had been in place during the drought of record. Firm yield analyses reported in the 1997 Water for Texas and any other equivalent existing analyses are acceptable. All water availability based on firm yield must satisfy full utilization of senior water rights. Where special conditions exist, such as the Rio Grande Project, water available based on operating procedures during the drought of record conditions will be used in place of reservoir firm yield analysis."[3]

The basic procedures required in analyzing water availability in the river basin involve simulating on a monthly basis the ability of individual water rights to satisfy their authorized diversions or storage quantities under historical, but naturalized characteristics. By taking into account the wide range of historical naturally occurring streamflow conditions, the results provide a meaningful indication of the water available for the future. The Texas Water Development Board has criteria for determining firm yield analyses, which outlined in Exhibit B of the SB1 Regional Water Plan.

Optimization of the water supply was developed holding the 50-year flood control constant and varying the water supply. Maximum development is approximately 148 cfs yield due to the physical constraints on the reservoir. The lowest cost per 1,000 gallons occurs at approximately 95,630 ac-ft/yr. (132 cfs) dependable yield. Apparently, the Sabine River Authority has expressed the desire for water supply development at Carl L. Estes Lake to this level. After 100 years of sediment deposition, the dependable yield is reduced to 130 cfs.[1]

5.6.1.8 Land Acquisition and Easement Requirements

The land acquisition policy was used in determining the area required for the damsite, lake, and areas designated for public use. The area required will be a blocked perimeter that encompasses the guide acquisition line of 408.0 ft msl, or the limits of the backwater effects, whichever is greater. The guide acquisition line is established by increasing the top of flood storage elevation by 5 feet to provide freeboard for induced surcharge operations and for adverse effects of saturation, wave action, bank erosion and similar factors. When the 5-foot increase projected horizontally on the plane is less than a 300-foot horizontal offset, or the limits of the backwater effects, then the guideline is increased to that extent.[1] The project take area for purpose of this study is defined in Section 5.6.1.11.1.

5.6.1.9 Potential Land Use Conflicts

Separate criteria for relocations have been established based on the 50-yr-flood pool elevation plus a 3-foot additional freeboard, which brings the relocation elevation to 406.0 ft msl. Relocations for Carl L. Estes dam and lake would involve 23 miles of roads and highways, 1 mile of railroad, 12 miles of pipelines, 61 miles of communication lines, 2 cemeteries, 1 refinery, and 107 homes.[1]

5.6.1.10 Local, State, and Federal Permitting Requirements

There has been no discussion of the required permitting for the Carl L. Estes project. Experience indicates the need for, at least, the following four permits: 1) Water rights permits from the Texas Water Commission, 2) Section 404 permit from the U.S. Army Corps of Engineers, including all NEPA compliance, 3) Antiquities Permit from the Texas Antiquities Committee, and 4) Sand and Gravel Permit from the Texas Parks and Wildlife Department.

No hydroelectric facilities are proposed for Carl L. Estes, therefore a license from the Federal Energy Regulatory Commission (FERC) is not required.

5.6.1.11 Updated Project Costs

Opinions of probable project cost for the Carl L. Estes Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1998.[4] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan,* 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 <u>Sabine Watershed Management Plan</u> deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher capital cost estimate than the initial analysis. Please refer to Table 5.6-1 for the Updated Project Cost and Table 5.6-2 for the Construction Cost.

5.6.1.11.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in Table 5.6-1. The assumed average developed cost per acre of land for the reservoir was $2,300/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 24,900 acres plus the additional surface area attained above the conservation pool elevation, which together is approximately 31,125 ac.

5.6.1.11.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in Table 5.6-1.

5.6.1.11.3 Construction Costs

As shown in Table 5.6-2, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

This Space Intentionally Left Blank

Table 5.6-1 Updated Project Costs

Description	*Quantity*	*Unit*	*Unit Price ($)*	*Cost ($)*	*Total Cost ($)*
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$109,873,700
Relocations (conflict resolution)		L.S.			$36,681,620
Construction Capital Costs (CCC) Subtotal:					**$146,555,400**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$51,294,400
Land Cost	31,125	Ac.	$2,300.00	$71,587,500	$71,587,500
Studies, Mitigation, Permitting					$84,676,100
Mitigation Costs (equal to land cost)		L.S.		$71,587,500	
Permitting & Studies					
Medium classification (6% of Capital + Land)				$13,088,600	
Interest During Construction					$17,763,000
Other Project Costs Subtotal:					**$225,321,000**
		Dec. 1998 Subtotal:			$371,876,400
20-City Average Escalation Factor	0.8%				$2,975,020
OPINION OF PROBABLE PROJECT COST					**$374,852,000**

Notes:
1. Original cost estimates were taken from F&N, 1999.[4]
2. Interest during construction was included.
3. The engineering and other fees were increased to 35%.

Table 5.6-2 Construction Costs

Item #	Description	Quantity	Unit	Unit Price ($)	Total Cost ($)
	Dam Embankment				
1	Diversion and Care of Water		L.S.		$720,000
2	Clearing and Grubbing	600	Ac.	$864.00	$518,400
3	Excavation	3,303,333	C.Y.	$2.88	$9,513,600
4	Compacted Fill	7,448,999	C.Y.	$2.88	$21,453,120
5	Impervious Fill (core)	2,194,332	C.Y.	$2.88	$6,319,680
6	Riprap Bedding	68,206	C.Y.	$21.60	$1,473,250
7	Riprap	227,354	Ton	$43.20	$9,821,700
8	Slurry Trench	130,500	S.F.	$5.76	$751,680
9	Embankment Drainage and Instrumentation		L.S.		$950,000
10	Topsoil	110,700	C.Y.	$14.40	$1,594,080
11	Hydromulch	5,977,800	S.F.	$0.10	$597,780
12	Roadway	789,000	S.F.	$4.00	$3,156,000
	Spillway				
13	Clearing and Grubbing	5	Ac.	$864.00	$4,320
14	Excavation	205,000	C.Y.	$2.88	$590,400
15	Piles	260	Ea.	$864.00	$224,640
16	Concrete Weir	30,000	C.Y.	$300.00	$9,000,000
17	Concrete Slab	900	C.Y.	$250.00	$225,000
18	Concrete Walls	2,300	C.Y.	$325.00	$747,500
19	Concrete Stilling Basin	2,500	C.Y.	$250.00	$625,000
20	Tainter Gates (40' x 35')	5	Ea.	$924,000.00	$4,620,000
21	Superstructure and Hoists		L.S.		$500,000
22	Non-Overflow Section	52,600	C.Y.	$325.00	$17,095,000
23	Drainage System		L.S.		$70,000
24	Riprap Bedding	1,200	C.Y.	$21.60	$25,920
25	Riprap	8,200	Ton	$43.20	$354,240
26	Hydromulch	44,000	S.F.	$0.10	$4,400
27	Fencing	600	L.F.	$21.60	$12,960
28	4'-0" x 8'-0" Sluice Gates	2	Ea.	$12,000.00	$24,000
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$90,992,670**
	Mobilization (5% of BCS)				$4,549,640
			Subtotal:		$95,542,310
	OH & P (15% of Subtotal)				$14,331,350
	Construction Capital Cost Subtotal (CCC)				**$109,873,700**

5.6.1.11.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 95,630 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $374,852,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Carl L. Estes Reservoir, the O&M is $2,198,340 and the annualized debt service is $26,540,600. The firm yield is then divided into the total annualized cost of $28,738,940 to yield a unit cost of $300.53 per acre-foot ($0.93/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 contained in the executive summary.

5.6.2 Environmental Overview –Affected Environment and Environmental Consequences

5.6.2.1 Geological Elements

5.6.2.1.1 Phisiography

The potential reservoir is located in the Post Oak Savannah vegetative region. The Post Oak Savannah vegetative region covers approximately 6.85 million acres of land. It averages 30-45 inches of precipitation annual with 235 to 280 frost-free days. The topography is nearly level to gently rolling with an elevation of 300-800 feet above msl. The Post Oak Savannah vegetative region lies just to the west of the Pineywoods vegetative region and mixes considerably with the Blackland Prairies vegetative region in the south. The Post Oak Savannah vegetative region, is a gently rolling, moderately dissected wooded plain.

Upland soils are gray, slightly acid sandy loams commonly shallow over gray, mottled or red, firm clayey subsoils. They are generally droughty and have claypans at varying depth, restricting moisture percolation. The bottomland soils are reddish brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial. Short oak trees occur in association with tallgrasses. Thicketization occurs in the absence of recurring fires or other methods of woody plant suppression.[5]

5.6.2.1.2 Geology

Soil surface outcroppings in the Northeast Texas Region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in Northeast Texas. For the past 60 million years, the Northeast Texas Region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the Northeast Texas Region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[6]

5.6.2.1.3 Soils

The area of the potential reservoir contains twelve major soil groups,[9] These groups are the Kaufman-Gladewater-Texark, Nahatche-Crockett-Woodtell, and Woodtell-Freestone-Bernaldo. Approximately, 69.5 percent of the area is Kaufman-Gladewater-Texark, 7.1 percent Nahatche-Crockett-Woodtell, and 23.5 percent Woodtell-Freestone-Bernaldo.

Bernaldo

The Bernaldo series consists of very deep, well-drained, moderately permeable soils that formed in loamy alluvial deposits. The soils are on nearly level to moderately sloping stream terraces. Slopes are dominantly less than 5 percent but range from 0 to 8 percent. Bernaldo soils are on nearly level to moderately sloping areas about 10 to 130 feet above present streams. The average annual precipitation ranges from 40 to 48 inches and the mean annual temperature ranges from 64 to 68 degrees F. Frost-free days range from 240 to 260 and elevation ranges from 200 to 550 feet above msl. Thornthwaite annual P-E indexes range from 64 to 84. Most acreage is in woodland with dominant pine species of loblolly and shortleaf and many oak species and other southern hardwoods. Some areas are in pasture. Pastures are mainly in improved or common bermudagrass, bahiagrass, overseeded with legumes of crimson and arrowleaf clovers, vetch or singletary peas. Small areas are farmed to corn, small grains for grazing, sorghum for grazing and hay, and truck crops.

Crockett

The Crockett series consists of nearly level to moderately sloping soils that are deep to weathered shale. They are moderately well-drained, and very slowly permeable, on uplands. Slopes are dominantly 1 to 5 percent, but range from 0 to 10 percent. Mean annual temperatures ranges from 64 to 70 degrees F., and mean annual precipitation ranges from 32 to 45 inches. Frost-free days range from 230 to 275 days, and elevation ranges from 200 to 800 feet. Thornthwaite P- E indexes range from 50 to 75. The soil is mainly used for growing cotton, grain sorghums, and small grain, but more than half the acreage is now in pastures. Native vegetation within the series is predominately prairie grasses such as bluestems, indiangrass, switchgrass, and gramas, with scattered elm, hackberry, and mesquite trees.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Gladewater

The Gladewater series consists of very deep, somewhat poorly drained, very slowly permeable soils on floodplains formed in clayey alluvium in floodplains. Slope ranges from 0 to 1 percent. The mean annual precipitation ranges from 38 to 46 inches and mean air temperature ranges from 64 to 68 degrees F. Frost-free days range from 235 to 275 days and elevation is 200 to 400 feet above msl. Thornthwaite P-E index ranges from about 62 to 74. Depressional areas are very poorly drained. Most of the acreage is in pasture or forest. Some areas are in native pasture or range. Pasture areas are introduced grasses such as dallisgrass and fescue. Forested areas are in mixed hardwoods including water oak, willow oak, cedar elm and black willow.

Kaufman

The Kaufman series consists of very deep, moderately well-drained, very slowly permeable soils on floodplains formed in clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 2 percent. Mean annual precipitation ranges from 35 to 50 inches, and mean annual temperature ranges from 62 to 70 degrees F. Frost-free days range from 230 to 280 days and elevation ranges from 100 to 550 feet above msl. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in pasture of dallisgrass, bermudagrass, and fescues. A few areas are used for producing cotton, corn, sorghums, and soybeans. Native vegetation is hardwoods such as elm, hackberry, oak, ash, and grasses which includes species of andropogon, paspalum, panicum, and tripsacum.

Nahatche

The Nahatche series consists of very deep, somewhat poorly drained, moderately permeable soils on floodplains, formed in stratified loamy alluvium. Slopes range from 0 to 1 percent. Nahatche soils are on floodplains of streams draining soils of the Southern Coastal Plain. These soils are flooded from one to several times each year for a duration of a few days to about one month in most areas, unless protected. Some areas are rarely flooded or occasionally flooded. They formed in loamy alluvial sediments. Mean annual temperature ranges from 65 to 70 degrees F. and the mean annual precipitation ranges from 40 to 52 inches. Frost-free days range from 235 to 270 days and elevation ranges from 100 to 400 feet. The Thornthwaite P-E indices range from 62 to 82. Most of the soil is used for woodland or pasture. The native vegetation is loblolly pine, shortleaf pine, cypress, American sycamore, water oak, willow oak, cottonwood, sweetgum, southern sweetbay, pecan, and green ash. Herbaceous plants include Virginia wildrye, rusty seed paspalum, beaked panicum, and low panicum. Improved pasture grasses include coastal bermudagrass, and bahiagrass.

Texark

The Texark series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in clayey alluvium floodplains that drain mainly from the Blackland Prairies. Slopes are 0 to 1 percent. Average annual precipitation ranges from 40 to 55 inches, average annual temperature is 62 degrees to 70 degrees F. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in forest, pasture, and wildlife habitat. Native vegetation conaiata of hardwood trees such as green ash, hackberry, water oak, willow oak, elm, and sweetgum. Understory vegetation consists of hawthorns, sedges, grasses, and annual weeds.

Woodtell

The Woodtell series consists of soils that are deep to stratified shale and loamy materials on gently sloping stream divides. They are well-drained and very slowly permeable. The slope ranges from 1 to 20 percent. Woodtell soils are strongly to moderately steep side slopes of uplands. Slope gradients are mainly 2 to 12 percent but range from 1 to 20 percent. The soils formed in materials weathered from unconsolidated, stratified loamy, clayey, and shaly materials of Eocene age mainly in the Wilcox and Cook Mountian formations. The average annual rainfall ranges from 40 to 46 inches. The mean annual temperature is about 62 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 78. Frost-free days range from 230 to 270 and elevation ranges from 300 to 650 feet above msl. These soils are used mainly for pasture. Native vegetation is mainly post oak, blackjack oak, elm and red oak in a fairly dense savannah. In open areas tall and mid grasses such as bluestems, tridens and panicums are common with longleaf uniola under the tree canopy. American beautyberry and hawthorn species are also a part of the understory. The main pasture plants are bermudagrass and bahiagrass with crimson and arrowleaf clovers. There are scattered shortleaf and loblolly pine with small plantations and a some dense pine areas on the eastern side of the series province. Some areas are planted to small grain for winter grazing.

5.6.2.2 Hydrological Elements

5.6.2.2.1 Surface Water

The potential reservoir is located on the Sabine River. This portion of the Sabine River is included in the Texas Natural Resource Conservation Commission (TNRCC) - *The state of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0506 (Sabine River below Lake Tawakoni). This 118-mile segment originates from a point 110 yards downstream of US 271 in Gregg County to Iron Bridge Dam in Rains County. This segment is classified as "effluent limited" and designated uses re for contact recreation, high aquatic life, and public water supply. Elevated levels of orthophosphorus are a concern in the lower 25 miles of the segment.[7]

5.6.2.2.2 Ground Water

The Sabine River is located within the Carrizo-Wilcox Aquifer. The potential reservoir is located in Harrison and Marion counties in the outcrop region of the Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeasterm part of the aquifer.

Extremely large water-level declines have occurred in northeast Texas around Tyloer and the Lufkin-Nacogdoches area. Much of the pumpages has been for municipal supply, but industrial pumpage is also significant.[8]

5.6.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Carl L. Estes reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Carl Estes reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.6.2.4 Biological Elements

5.6.2.4.1 Vegetation

The potential Carl Estes reservoir is centrally located within the Texan province[9] and is within the Post Oak Savannah Region.[10] The Post Oak Savannah vegetation area typically has a gently rolling to hilly topography, with moderately dissected wooded plain. The soil composition for this community consists of gray, slightly acidic sandy loams, and reddish brown to dark gray, slightly acidic to calcareous, loamy to clayey alluvial. The Post Oak Savannah soils support short oak trees and tallgrasses. Trees in the region consist of post oak and blackjack oak, elms, junipers, hackberries, and hickories. Yaupon, American beautyberry, coralberry, greenbriar, and grapes are shrubs and vines that are characteristic to the area. Grasses in the area includes little bluestem, indiangrass, switchgrass, silver bluestem, Texas wintergrass, purpletop, narrowleaf wildoats, beaked panicum, brownseed paspalum, threeawn, broomsedge bluestem, splitbeard bluestem, rosette grasses, and lovegrasses. Forbs in the region consist of wild indigo, indigobrush, sennas, tickclover, lespedeza, prairie-clovers, western ragweed, crotons, and sneezeweeds. There has been some vegetation introduced into the area, including bermudagrass, bahiagrass, weeping lovegrass, and clover.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Carl Estes reservoir location include Post Oak Wooded (40%); Water, Oak, Elm (54%), and Other (7%).

In accordance to *Water and Wildlife, 1990*, The potential Carl Estes reservoir contains three cover types within its proposed boundaries. The resource categories are: Mixed Bottomland Hardwood Forest (64%), Grasses (14%), and Other (22%).[11]

5.6.2.4.2 Fish and Wildlife

The result of the potential Carl Estes reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Carl Estes reservoir is located within the Prairies and Lakes Eco-region. Some of the common wildlife in this region includes the plains pocket gopher, beaver, raccoon, porcupine, Texas kangaroo rat, hispid cotton rat, ornate box turtle, green-winged teal, bobwhite quail, red-shouldered hawk, scissortail flycatcher, white-tailed deer, Brazilian freetail bat, ringtail, nine-banded armadillo, eastern hognose snake, tarantula, Texas horned lizard, golden cheeked warbler, black-capped vireo, northern mockingbird, and guadelupe bass. [12]

5.6.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the proposed project location (Table 5.6-3). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.6-3 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Rains, Smith, Van Zandt, and Wood Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Western Sand Darter	*Etheostoma clarum*		T
Mammals			
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Louisiana Pine Snake	*Pituophis melanoleucus ruthveni*	C1	T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Rough-stem aster	*Aster puniceus* ssp. *Eliotti* var. *scabricaulis*		R
Texas Trillium	*Trillium pusillum* var. *texanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status

(Texas Department of Transportation, Annotated County Lists of Rare Species for Rains, Smith, Van Zandt, and Wood Counties, 1999.)

5.6.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Carl Estes reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.6.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows four hydric soil associations are within the potential Carl L. Estes reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.6.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There is a proposed wetland mitigation bank project that is located near or will be adversely affected by the potential Carl Estes reservoir. The proposed mitigation bank is called Tawokoni and consists of 1146 acres *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.6.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Carl Estes reservoir is located within the Sabine River basin, which represents approximately 22% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-County study area. The potential Carl Estes reservoir is within and adjacent to the Sulphur River Bottom West site and is listed as Priority 2.[13] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.6.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within the footprint of the potential Carl Estes reservoir.

5.6.2.10 Social and Economic Conditions

The potential reservoir is located in Rains and Van Zandt counties. The population of these counties according to the 1990 Census is 6,715 and 37,944. The Texas State Data Center has estimated the 2020 population to be approximately 10,550 and 56,389. The median household income for Rains and Van Zandt counties in 1989 is $21,741 and 21,072, respectively.[14]

5.6.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Carl Estes reservoir will affect portions of Rains, Smith, Van Zandt, and Wood counties.

Historical and Archeological Resources for the four county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.6-4.[19]

Table 5.6-4 Historical and Archeological Resources for Carl Estes.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Rains	5	1	1	NA	3	NA
Smith	98	NA	85	NA	9	4
Van Zandt	16	1	13	NA	NA	2
Wood	139	1	88	42	7	1

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.6-5) details the results of previous cultural studies that have been performed on the area since 1879. Some counties, such as Wood county, have been investigated more thoroughly than other counties with regards to cultural resources due to federal cultural mandates or the construction of reservoirs. This is important to note because there is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Rains, Smith, and Van Zandt counties. Although Wood County has been studied more intensely than others due to federal cultural mandates, there is still the potential for the discovery of archeological sites.[15]

Table 5.6-5 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Rains	16	38	10	5	69
Smith	9	78	36	17	140
Van Zandt	13	46	16	2	77
Wood***	42	101	21	20	184
Sub-total	80	263	83	44	470

* Significance refers to National Register criteria.
** County tabulations are incomplete.
Source: THC, 1993.

5.6.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the Northeast Texas region has been determined and is presented in Table 5.6-6.

Table 5.6-6 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.6-7 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.6-7 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Rains			1	6	
Smith				16	13
Van Zandt		1	1	5	1
Wood			1	7	21

Source: THC, 1993, and Perttula T. K., 1999.[16]

5.6.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.6.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.6-8 depicts the percent coverage by major land uses within the reservoir study area.[17]

Table 5.6-8. Land Use for the Potential Carl Estes Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	56%
Deciduous Forest Land	42%
Mixed Forest Land	2%
Other	1%

5.6.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites and municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are two municipal solid waste landfill sites and no Superfund sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[18]

5.6.2.14 Potential Environmental Impact Summary

Table 5.6-9. Potential Environmental Impact Summary for Carl Estes.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
Proposed Wetland Mitigation Bank Conflict	Substantial
USFWS Priority Bottomland Hardwood area	Moderate
2-Municipal Solid Waste Landfills	Moderate

---

[1] U.S. Army Corps of Engineers, Fort Worth District (USACE). Carl L. Estes Dam and Lake, Design Memorandum No. 2, General - Phase 1, Plan Formulation. April 1976.

[2] U.S. Army Corps of Engineers, Fort Worth District (USACE). Carl L. Estes Lake, Design Memorandum No. 1 – Hydrology. February 1975.

[3] Texas Water Development Board. Water For Texas. August 1997.

[4] Freese and Nichols, Comprehensive Sabine Watershed Management Plan, December, 1999.

[5]Hatch, Stephan L. , Kancheepuram M. Gandi, and Larry E. Brown. July 1990. *Checklist of the Vascular Plants of Texas.* College Station, Texas: Texas Agricultural Exper. Station.

[6] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[7] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96.* Austin, Texas. TNRCC.

[8] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan.* Austin, Texas. TWDB

[9] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[10] Gould, F. W. 1975. Texas Plants: Aa Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[11] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[12] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[13] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[14] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[15] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[16] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[17] www.tnris.state.tx.us

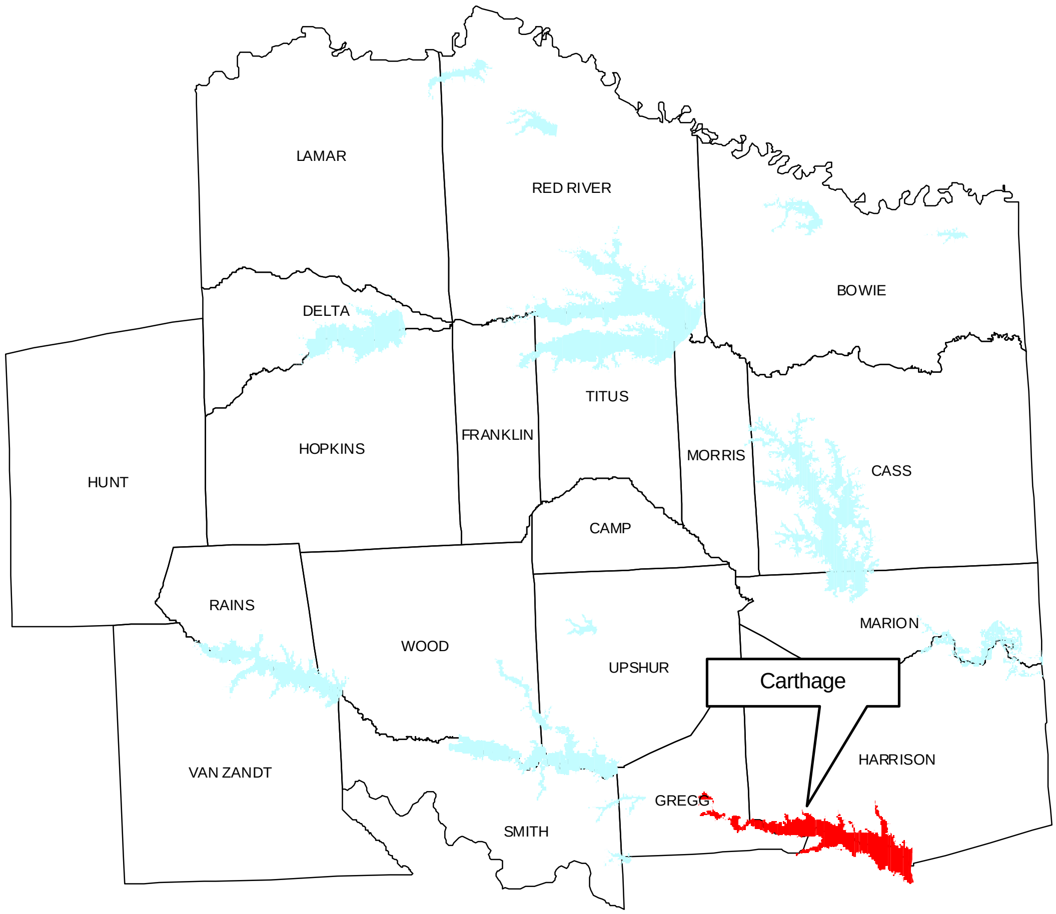
[18] www.tnris.state.tx.us

5.7 CARTHAGE

5.7.1 Summary of Prior Studies

5.7.1.1 Location

Figure 5.7-1. Location of Carthage within the Region D Planning Region



The Carthage Reservoir Dam is located immediately upstream of the US Highway 59 crossing and downstream of Longview, Texas. This is part of the Sabine River Basin above the Toledo Bend Reservoir and within Panola, Harrison, Rusk and Gregg counties *(See Appendix, Exhibit A, Vicinity Map)*.

5.7.1.2 Impoundment Size and Volume

With a conservation pool Elevation of 244 ft msl, the reservoir will have a storage of 651,914 acre-ft, a surface area of 41,200 acres and a supply yield of 537,000 ac-ft/yr.[1]

5.7.1.3 Site Geology and Topography

Basin soils consist of the Blackland Prairie, East Texas Timberland, and Coastal Prairie types. Higher erosion susceptibility due to their sloping nature and clay texture has caused greater sediment production rates, a matter to be taken into consideration for reservoir operation analyses.[1]

Tertiary deposits of poorly consolidated sandstone, clay, and shale are the majority of the soils located within the study area. The two major groups are the Claiborne and Wilcox. The rocks forming the Wilcox Group were deposited about 52 million years ago and have two main formations which contain sandstone, shale and lignite. The rocks of the younger Clairborne Group were deposited from about 48 to 43 million years ago. Eight formations make up the Clairborne Group, two of which, the Carrizo and Queen City, are important aquifers for the region. The Carrizo-Wilcox aquifer is by far the best supply of good quality water.[2]

5.7.1.4 Dam Type and Size

No information on the dam type and size was available from other studies.

5.7.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the Carthage damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

Streamflows, evaporation, adjusted area-capacity relationship which reflect sedimentation and water rights information for streamflow maintenance are the major factors into the reservoir operation study for firm yield determination. A computer program, SIMYLD-II, developed by the Texas Water Development Board was used for reservoir studies within the Sabine River Basin. It was used for its effectiveness in analyzing water data in multi-basin systems.[3] The total contributing area to the reservoir is 3,740 square miles.[4] Input used in the reservoir operation study for Carthage Reservoir included the following:

- reservoir inflows
- lake evaporation
- sediment volume
- area-capacity curve data

5.7.1.5.1 Reservoir Inflows

A period of record from January 1941 through December 1979 from USGS recording gauges throughout the study area was used to estimate reservoir inflows on a monthly basis. Adjustments for depletions of flow were made for known historic reservoir operation studies in which only reservoirs with a capacity of 5,000 ac-ft or greater were considered.[5] Adjustments for land treatment measures, farm ponds and minor reservoirs, floodwater-retarding structures and urbanization when determining natural runoff estimates.

The Carthage Reservoir encompasses a drainage area of 3,740 square miles.[4] Data for the hydrologic studies of the reservoir inflows was obtained from the USGS Water Data Storage and Retrieval System (WATSTORE) in Reston, Virginia. Monthly streamflow records from the existing gauges within the Sabine Watershed were used to estimate natural inflows. Naturalized streamflows represent streamflow conditions without man-made effects. The computer simulation model accounted for the effects of upstream reservoirs and water demands.[3]

5.7.1.5.2 Lake Evaporation

A period of record from January 1941 through December 1979 for the area of interest from the National Weather Service precipitation/evaporation stations throughout the study area are used to estimate net lake evaporation. Adjustments are made using contour maps broken into quadrangles.[6]

5.7.1.5.3 Sediment Volume

Data for suspended sediment load of Texas streambed are obtained from TDWR and USGS. Suspended-sediment rating curves and flow-duration curves are used to estimate sediment volume where an assumed unit weight for particle size, generally around 70 pcf, is used[5]

5.7.1.5.4 Area Capacity Data

The elevation-area-capacity relationship (also referred to as area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. The relationship is based upon existing conditions taken from USGS quad map topography of the land to be inundated by the reservoir[5]

5.7.1.5.5 Pass-Through Flows for Downstream Maintenance

Minimum discharge is important to protect downstream environmental requirements. Minimum streamflows will need to be determined to sustain aquatic habitat as specified by the environmental mitigation plan. Higher flows will be released for short periods during historic low flow periods.[2]

5.7.1.6 Water Quality

Water from the Carrizo-Wilcox aquifer is generally good; however, corrosive water with high iron content can occur within the northeastern part of the aquifer.[7]

Potential for mineral development to impact water quality does exist for the Sabine River Basin. Dissolved metals such as selenium, aluminum, silver and mercury have been detected in the past near mining operations.[1] Historical water data in the Sabine basin shows instances of exceedence with chloride, sulfate, fecal coliform, pH and dissolved oxygen. However, standards are not necessarily violated if the levels return to below limits, or above the limit in the case of dissolved oxygen, within a pre-determined amount of time[8].

5.7.1.7 Project Yield for Water Supply

The project firm yield is 537,000 ac-ft/yr.

5.7.1.7.1 Water Rights

Of the Upper and Lower Sabine Basin, the majority of the existing water rights exist in the upper basin, totaling 163 just in the area between Toledo Bend reservoir and Lake Fork and Iron Bridge Dams. The total permitted water rights for the upper Sabine Basin amount to approximately 723,000 ac-ft/yr.[1] This is the area of highest demand, and even the currently unused rights in the area will not be made available as they are being saved for future use.

5.7.1.8 Other Potential Benefits

Potential benefits associated with construction of the Waters Bluff Reservoir include water supply and recreation such as swimming and fishing.

5.7.1.9 Land Acquisition and Easement Requirements

Approximately a third of the surface area, about 10,371 ac, would be inundated contain bottomland hardwoods with an undetermined amount of acreage for mitigation.[1] Of the types of terrestrial habitat that would be affected by the creation of the reservoir, the most affected would be deciduous forested wetland (DFW).[2]

With regards to easements, mitigation banks and bottomland hardwoods, of most concern for the Carthage Reservoir site is of the bottomland hardwoods. An estimation of currently unknown mitigation costs will be required.[1]

5.7.1.9.1 Potential Land Use Conflicts

Potential near surface lignite reserves as well as existing oil and gas fields may exist in the area to be indundated.[8] Refer to Table 5.7-1 for a list of the reservoir conflicts.

Table 5.7-1 Reservoir Conflicts Table

No.	***Conflict***	***Cost***
1	Main Highways	$49,208,000
2	Light-Duty Roads	$16,370,000
3	Pipelines	$9,637,500
4	Power Lines	$15,351,000
5	Railroads	$1,700,000
6	Oil Wells	$1,181,320
7	Gas Wells	$843,800
8	Dwellings	$450,000
9	Cemeteries	$750,000
10	Fish Farm	$300,000
11	Power Plant	$2,000,000
	Total:	**$97,791,620**

5.7.1.9.2 Local, State and Federal Permitting Requirements

Among the permitting requirements for water resource projects are environmental rules. The Carthage site is on a navigable waterway and Congressional is required to obtain approval to construct the dam per the Rivers and Harbors Act of 1899.[1] This rule and others that may apply are listed in the following Table 5.7-2.

This Space Intentionally Left Blank

Table 5.7-2 Major Permitting Requirements

Permit	***Issuing Agency***	***Summary of Requirements***
Section 404 Permit, Clean Water Act of 1972	U.S. Army Corps of Engineers (COE)	Applicable to all new dams in the United States because they add new dredge or fill material to U.S. waters.
Section 10 Permit, Rivers & Harbors Act of 1899	U.S. Army Corps of Engineers	Usually applied for in conjunction with Section 404. Congressional approval required for construction of obstructions on navigable waters.
Section 7 Consultation & Section 10 Permit	U.S. Department of the Interior, Fish & Wildlife Service (USFWS)	Required for the incidental taking of endangered or threatened species. Mitigation is also generally a requirement as a condition of the permit.
Water Rights Permit	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone wanting to divert, use or store surface waters, or transfer surface water between basins. Includes environmental, hydrologic and conservation assessments.
Section 401 Certification, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Certification that projects obtaining a 404 permit will not degrade water quality below state standards.
TPDEX Discharge Permit, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone who discharges wastewater into the Sabine Basin.
Grant of Easement	Texas General Land Office	Requirement for projects that cross or impact state owned waterways.

5.7.1.10 Updated Project Costs

Opinions of probable project cost for the Carthage Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1998.1 The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of

opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher capital cost estimate than the initial analysis. Please refer to

Table 5.7-3 for the Updated Project Cost and Table 5.7-4 for the Construction Cost.

5.7.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in

Table 5.7-3. The assumed average developed cost per acre of land for the reservoir was $2,300/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 41,200 acres plus the additional surface area attained above the conservation pool elevation, which together is approximately 51,500 ac.

5.7.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in

Table 5.7-3.

5.7.1.10.3 Construction Costs

As shown in Table 5.7-4, direct construction cost estimates was based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

Table 5.7-3 Updated Project Cost

Description	*Quantity*	*Unit*	*Unit Price ($)*	*Cost ($)*	*Total Cost ($)*
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$42,309,400
Relocations (conflict resolution)		L.S.			$97,791,620
Construction Capital Costs (CCC) Subtotal:					**$140,101,100**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$49,035,400
Land Cost	51,500	Ac.	$2,300.00		$118,450,000
Studies, Mitigation, Permitting					$144,305,200
Mitigation (equal to land cost)				$118,450,000	
Permitting and Studies					
High classification (10% of Capital + Land)				$25,855,200	
Interest During Construction (4 yrs.)					$6,840,000
Other Project Costs Subtotal:					**$318,630,600**
	December 1998 Subtotal:				$458,731,700
20-City Average Escalation Factor	0.8%				$3,669,860
OPINION OF PROBABLE PROJECT COST					**$462,402,000**

Notes:
1. Original cost estimates were taken from F&N, 1999.[1]
2. Interest during construction was included.
3. The engineering and other fees were increased to 35%.

Table 5.7-4 Construction Cost

Item #	***Description***	***Quantity***	***Unit***	***Unit Price ($)***	***Cost ($)***
	Dam Embankment				
1	Diversion and Care of Water		L.S.		$ 720,000
2	Clearing and Grubbing	420	Ac.	$864.00	$ 362,880
3	Excavation	1,483,258	C.Y.	$2.88	$ 4,271,783
4	Compacted Fill	2,863,406	C.Y.	$2.88	$ 8,246,609
5	Riprap Bedding	30,951	C.Y.	$21.60	$ 668,542
6	Riprap	103,172	Ton	$43.20	$ 4,457,030
7	Slurry Trench	91,600	S.F.	$5.76	$ 527,616
8	Soil Cement	82,300	C.Y.	$28.80	$ 2,370,240
9	Embankment Drainage and Instrumentation		L.S.		$ 700,000
10	Topsoil	50,194	C.Y.	$14.40	$ 722,794
11	Hydromulch	2,710,480	S.F.	$0.10	$ 271,048
12	Roadway	366,400	S.F.	$4.50	$ 1,648,800
	Spillway				
13	Clearing and Grubbing	11	Ac.	$864.00	$ 9,504
14	Excavation	53,600	C.Y.	$2.88	$ 154,368
15	Piles	650	Ea.	$864.00	$ 561,600
16	Concrete Weir	1,680	C.Y.	$300.00	$ 504,000
17	Concrete Slab	1,230	C.Y.	$250.00	$ 307,500
18	Concrete Walls	2,040	C.Y.	$325.00	$ 663,000
19	Concrete Stilling Basin	5,500	C.Y.	$250.00	$ 1,375,000
20	Tainter Gates (40' X 20')	10	Ea.	$528,000.00	$ 5,280,000
21	Superstructure and Hoists		L.S.		$ 800,000
22	Drainage System		L.S.		$ 130,000
23	Riprap Bedding	1,250	C.Y.	$21.60	$ 27,000
24	Riprap	5,400	Ton	$43.20	$ 233,280
25	Hydromulch	1,800	S.F.	$0.10	$ 180
26	Fencing	1,200	L.F.	$21.60	$ 25,920
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$ 35,038,694**
	Mobilization (5% of BCS)				$1,751,940
			Subtotal:		$ 36,790,700
	OH & P (15% of Subtotal)				$ 5,518,610
	Construction Capital Cost Subtotal (CCC)				**$ 42,309,400**

5.7.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 537,000 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $462,402,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Carthage Reservoir, the O&M is $2,101,520 and the annualized debt service is $32,739,400. The firm yield is then divided into the total annualized cost of $34,840,920 to yield a unit cost of $64.89 per acre-foot ($0.20/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 contained in the executive summary.

5.7.2 Environmental Overview –Affected Environment and Environmental Consequences

5.7.2.1 Geological Elements

5.7.2.1.1 Physiography

The potential Carthage reservoir is located within the Pineywoods vegetative region of Texas. The Pineywoods area is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods vegetative region lies entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods vegetative region. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dallisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

5.7.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[9]

5.7.2.1.3 Soils

The area of the potential reservoir contains four major soil groups.[9] These groups are Bernaldo-Elrose-Erno, Bowie-Cuthbert-Kirvin, Estes-Mantachie-Bienville, and Iuka-Guyton-Mantachie. Approximately one percent of the area is Bernaldo-Elrose-Erno, 8.7 percent Bowie-Cuthbert-Kirvin, 49.9 percent Estes-Mantachie-Bienville, and 15.6 percent Bowie-Cuthbert-Kirvin. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Bernaldo

The Bernaldo series consists of very deep, well-drained, moderately permeable soils that formed in loamy alluvial deposits. The soils are on nearly level to moderately sloping stream terraces. Slopes are dominantly less than 5 percent but range from 0 to 8 percent. Bernaldo soils are on nearly level to moderately sloping areas about 10 to 130 feet above present streams. The average annual precipitation ranges from 40 to 48 inches and the mean annual temperature ranges from 64 to 68 degrees F. Frost-free days range from 240 to 260 and elevation ranges from 200 to 550 feet above msl. Thornthwaite annual P-E indexes range from 64 to 84. Most acreage is in woodland with dominant pine species of loblolly and shortleaf and many oak species and other southern hardwoods. Some areas are in pasture. Pastures are mainly in improved or common bermudagrass, bahiagrass, overseeded with legumes of crimson and arrowleaf clovers, vetch or singletary peas. Small areas are farmed to corn, small grains for grazing, sorghum for grazing and hay, and truck crops.

Bienville

The Bienville series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils, formed in sandy coastal plain sediments on nearly level or gently sloping stream terraces. The typical slope is dominantly 1 to 3 percent, but ranges from 0 to 5 percent. Bienville soils are on stream terraces in the Gulf Coastal Plains. A water table is at depths of 4 to 6 feet in late winter and early spring. These soils formed in sandy alluvium mainly from sandy coastal plain sediments. The climate is warm and humid. Mean annual precipitation ranges from 45 to 62 inches and mean annual temperature ranges from 60 to 70 degrees F. Most acreage is in woodland, dominantly mixed hardwood and pine. This soil series is typically used for cotton, corn, and truck crops within cleared areas.

Bowie

The Bowie series consists of very deep, well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain deposits. These soils are on broad very gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The climate is humid; mean annual precipitation ranges from 40 to 50 inches; and mean annual temperature from 64 to 69 degrees F. The Thornthwaite annual P.E. index exceeds 64. The frost-free days range from 220 to 250. Elevation ranges from 150 to 600 feet above msl. Runoff is low on 1 to 3 percent slopes, medium on 3 to 5 percent slopes, and high on 5 to 8 percent slopes. A perched water table is at a depth of 3.5 to 5 feet during winter and early spring in most years. The principal use is for pasture and forest. Some areas are used for growing corn, peanuts, sweet potatoes, peaches, watermelons and other vegetables or fruit crops. Pasture is mainly bermudagrass or bahiagrass. Forests consists of loblolly and shortleaf pines, sweetgum, red oak, and hickory trees with tall and midgrasses.

Cuthbert

The Cuthbert series consists of soils that are moderately deep to weakly consolidated sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on strongly sloping to steep uplands. Slopes are dominantly 8 to 25 percent, but range from 5 to 40 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 56 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 750 feet above msl. Mean annual temperature ranges from 63 to 67 degrees F, and Thornthwaite annual P-E indexes exceed 64. Runoff is medium for slopes of 5 to 20 percent and high for slopes greater than 20 percent. Cuthbert soils are used mainly for woodland and pastureland. The principal trees are shortleaf and loblolly pine, red oak, sweetgum, and other hardwoods. Pastures include common and improved bermudagrass, bahiagrass, and weeping lovegrass.

Elrose

The Elrose series consists of very deep, well drained, moderately permeable soils on uplands, formed in marine sediments high in glauconite. Slopes range from 1 to 12 percent. Elrose soils occur on gently sloping to strongly sloping uplands in the western part of the Southern Coastal Plain. The soils developed in stratified sediments of marine origin that contain a high content of glauconite mainly from the Weches Geologic Formation. Average annual temperature ranges from 64 to 67 degrees F. Frost-free days range from 235 to 270. Elevation ranges from 350 to 750 feet above msl. The annual average rainfall ranges from 39 to 48 inches and the Thornthwaite P-E index is about 68. Most of the Elrose soils are used for pastureland or woodland. A few areas are cropped to corn, oats, peanuts, peas, and hay. Native vegetation is mixed pine and oak forests consisting of shortleaf pine, Southern red oaks, and sweetgum.

Erno

The Erno series consists of very deep, well drained, slowly permeable soils on stream terraces and terrace remnants, formed mainly in loamy sediments. Slopes range from 0 to 3 percent. Erno soils are on nearly level to very gently sloping stream terraces and terrace remnants about 10 to 100 feet above the present streams. It occurs in an intermounded area in association with convex oval mounds. The sediments are mainly of the Pleistocene to Montgomery aged terraces. The soil formed in loamy alluvial sediments which have been reworked by wind and water. The mean annual temperature ranges from about 64 to 68 degrees F., average annual precipitation ranges from 44 to 50 inches. The Thornthwaite P-E index ranges from 68 to 80. The frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 230 to 240. A perched water table generally occurs above the fragipan at a depth of 2.5 to 4 feet during the winter and spring months. Most of the Erno soils are used for timber production and for pasture. A few areas are used for hayland and cropland. Native vegetations includes loblolly pine, shortleaf pine, southern red oak, sweetgum and hickory with mid and tall grasses such as pinehill bluestem, indiangrass, longleaf uniola, and panicums. American beautyberry, sumac, greenbriar, and hawthorn species are part of the understory. Improved pastures consist mainly of bermuda and bahiagrass commonly overseeded with crimson or arrowleaf clovers.

Estes

The Estes series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in acid clayey and loamy alluvium in the Coastal Plains. These flood plain soils have slopes ranging from 0 to 1 percent. Estes soils are on broad, slightly concave to smooth, nearly level bottomlands. They formed in acid clayey and loamy alluvium mainly in the Sabine River system. Mean annual precipitation is 45 to 55 inches. Frost-free days range from 235 to 250. The elevation ranges from 200 to 450 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E index exceeds 64. This soil is used mainly for woodland or wildlife land. A few areas are used for improved pastures of bahiagrass, fescue or dallisgrass. The native vegetation is a mixed hardwood forest. The major commercial trees are water oak, willow oak and sweetgum. There are a few scattered green ash, elm, hackberry, mulberry, hickory, pecan and widely scattered native pine with an understory of grasses and shrubs.

Guyton

The Guyton series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in thick loamy sediments. These soils are on Coastal Plain local stream floodplains and in depressional areas on late Pleistocene age terraces. Slopes range from 0 to 1 percent. The climate is warm and humid. Mean annual temperature ranges from 60 to 70 degrees F. Average annual rainfall ranges from 42 to 62 inches. Where runoff is ponded, drainage is very poor. Runoff is slow to ponded. A seasonal high water table is at 0 to 1.5 feet below the surface from December through May, except where ponded. Where ponded, it is from 1 foot above the surface to 0.5 foot below the surface most of the time. In places, the soils are subject to rare, occasional, or frequent flooding. Most areas are in woodland. Water oak, bald cypress, water tupelo, loblolly pine, and shortleaf pine are dominant in the drainageways. On broad terraces, bald cypress and water tupelo generally are absent and sweetgum dominates. Some areas are used as pastureland or cropland.

Iuka

The Iuka series consists of deep, moderately well-drained, moderately permeable soils that formed in stratified loamy and sandy alluvial sediments. These soils are on nearly level floodplains. They are saturated with water at depths of 1 foot to 3 feet below the surface during wet seasons and are subject to flooding. Slopes range from 0 to 2 percent. The climate is warm and humid. Near the type location the average daily temperature for January is 42 degrees F., the average daily temperature for July is 79 degrees F., the mean annual temperature is about 61 degrees F., and the mean annual precipitation is about 54 inches. Iuka soils are rarely to commonly flooded. A water table is at depths of 12 or more inches, and the soil is commonly saturated with water between 12 and 40 inches during some season of most years. Much of the soil has been cleared and cultivated. It is cropped to corn, soybeans, small grains, truck crops, and hay or is in pasture. Native vegetation is forest of water oak, willow, beech, sweetgum, hickory, maple, ironwood, eastern cottonwood, alder, white oak, and in some places, pine.

Kirvin

The Kirvin series consists of soils that are deep to stratified sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on gently sloping to moderately steep convex uplands. Slope is dominantly 2 to 8 percent, but ranges from 1 to 15 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 48 inches, with frost-free rainfall of 25 to 30 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 650 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. Runoff is very low on 1 to 3 percent slopes, low on 3 to 5 percent slopes, and medium on 5 to 15 percent slopes. Principal use is for pastureland and woodland. Bermudagrass is the main pasture grass. Forests are of shortleaf, slash, and loblolly pine, red oak, sweetgum, and other hardwood trees. A few areas are used for growing truck crops, cotton, corn, and oats.

Mantachie

The Mantachie series consists of somewhat poorly drained, moderately permeable soils. They formed in loamy alluvium. These soils are on floodplains. They usually flood late in winter and early in spring. The seasonal high water table is at a depth of 1.0 to 1.5 feet. Slope is dominantly less than 1 percent but ranges to 3 percent. Near the type location the mean annual temperature is about 63 degrees F., and the mean annual precipitation is about 53 inches. These soils are subject to rare, occasional, or frequent flooding for brief to long duration, unless protected. The water table is within 1.0 to 1.5 feet of the surface during periods of high rainfall. Most areas of these soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture, and hay. Some areas are in bottomland hardwoods. Common trees are green ash, eastern cottonwood, cherrybark oak, loblolly pine, sweetgum, and yellow-poplar.

5.7.2.2 Hydrological Elements

5.7.2.2.1 Surface Water

The potential reservoir is located within the Sabine River Basin on the Sabine River. This portion of the Sabine River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program* as stream segment 0504 (Toledo Bend Reservoir). This 122-mile segment is located from Toledo Bend Dam in Newton County, up to normal pool elevation of 172 feet (impounds Sabine River). This segment is classified as “water quality limited" and designated uses are for contact recreation, high aquatic life, and public water supply. Elevated levels of lead in sediment are a concern in the middle third of the reservoir, and elevated levels of manganese are a concern in the entire reservoir.[10]

5.7.2.2.2 Ground Water

The potential reservoir is located in Harrison County within both the Carrizo-Wilcox Aquifer and the Queen City Aquifer. The potential reservoir is located in the outcrop region of the Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeasterm part of the aquifer.

This aquifer extends in a band across most of the state from the Frio River in South Texas northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson County. Total pumpage for all uses in 1994 was 16,319 ac-ft.

The potential reservoir is also within the Queen City Aquifer. Sand, loosely cemented sandstone, and interbeded clay units of the Queen City Formation of the Tertiary Claiborne Group make up the aquifer as delineated within Texas. These rocks dip gently to the south and southeast toward the Gulf Coast. Although total aquifer thickness is usually less than 500 feet, it can approach 700 feet in some areas of northeast Texas. In the outcrop area, water occurs under water-table conditions while in the downdip subsurface, where the Queen City is covered by younger, non water-bearing rocks, the water is under artesian conditions. Usable quality water is generally found within the outcrop and for a few miles downdip, but in some areas it may occur down to depths of approximately 2,000 feet. Yields of individual wells are commonly low, but exceed 400 gal/min.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent however, quality deteriorates with depth in the downdip direction. The water may have high acidity (low pH) in much of northeast Texas and relatively high iron concentrations in localized areas. Hydrogen sulfide gas is sometimes present. Fortunately, each of these naturally occurring conditions may be treated relatively easily and economically.

While large amounts of usable quality groundwater are contained within the rocks of the Queen City, yields are low. Estimates of the availability of water from the Queen City Aquifer are based on recharge to the aquifer. Because of differences in topography, vegetative cover, and other factors, only two percent of the annual rainfall is estimated recharge in the Trinity, Colorado, Guadelupe, San Antonio and Neches

River basins. Approximately five percent is estimated recharge in the Neches, Sulphur, Sabine, and Cypress Creek Basins. Total annual effective recharge to the aquifer is estimated to be 682,100 ac-ft.[10]

5.7.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Carthage reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with river and stream.

The development of the potential Carthage reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.7.2.4 Biological Elements

5.7.2.4.1 Vegetation

The potential Carthage reservoir is centrally located within the Austroriparian province[11] and is within the Pineywoods region.[12] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Carthage reservoir location include Pine Hardwood (14%); Willow Oak Water (74%), and Other (12%).

5.7.2.4.2 Fish and Wildlife

The result of the potential Carthage reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Carthage reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter. [13]

5.7.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.7-5). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.7-5 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Gregg and Harrison Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Bluehead Shiner	*Notropis hubbsi*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*		T
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Louisiana Pine Snake	*Pituophis melanoleucus ruthveni*	C1	T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Neches River rose-mallow	*Hibiscus dasycalyx*	C1	
Southern Lady's-Slipper	*Cypripedium kentuckiense*		R
Texas Trillium	*Trillium pusillum var. texanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status

** Migratory Species Common to many or all counties in Texas. May occur as migrants in Project Area.

LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)

LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)

C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened

E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance

DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Gregg and Harrison Counties, 1999.)

5.7.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Carthage reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.7.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows four hydric soil associations are within the potential Carthage reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.7.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There is one existing wetland mitigation bank that is located near or adversely affected by the potential Carthage reservoir. It is an NRCS mitigation bank consisting of 175 acres *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.7.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Carthage reservoir is located within the Sabine River basin, which represents approximately 22% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;

- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-County study area. The potential Carthage reservoir is within and adjacent to the Lower Sabine River Bottom West site listed as priority one.[14] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.7.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within the footprint of the potential Carthage reservoir.

5.7.2.10 Social and Economic Conditions

The potential reservoir is located in Harrison County. The population of this county according to the 1990 Census is 57,483. The Texas State Data Center has estimated the 2020 population to be approximately 72,814. This corresponds to a 27 percent increase in Harrison County.[15] The median household income for Harrison County in 1989 was 22,625.[16]

5.7.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Carthage reservoir will affect portions of Gregg and Harrison counties.

Historical and Archeological Resources for the two county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.7-6.[19]

Table 5.7-6 Historical and Archeological Resources for Carthage.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Gregg	175	1	87	78	4	5
Harrison	239	1	115	100	17	6

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.7-7) details the results of previous cultural studies that have been performed on the area since 1879. Although Harrison County has been investigated more thoroughly than the other counties for cultural resources due to federal mandated cultural surveys, there is the potential to discover additional archeological resources due to the construction of the potential reservoir. There is an even greater potential for archeological sites being discovered in counties that have not been excessively studied, such as Gregg County.[17]

Table 5.7-7 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Gregg	4	19	13	4	40
Harrison**	84	59	23	5	171
Sub-total	88	78	36	9	211

* Significance refers to National Register criteria.
** County tabulations are incomplete.
Source: THC, 1993.

5.7.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the Northeast Texas region has been determined and is presented in Table 5.7-8.

Table 5.7-8 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.7-9 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.7-9 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Gregg			1	4	7
Harrison			2	6	13

Source: THC, 1993, and Perttula T. K., 1999.[18]

5.7.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.7.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a 3-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.7-10 depicts the percent coverage by major land uses within the reservoir study area.[19]

Table 5.7-10 Land Use for the Potential Carthage Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	18%
Deciduous Forest Land	23%
Mixed Forest Land	48%
Evergreen Forest Land	2%
Forested Wetland	1%
Industrial	1%
Mixed Rangeland	1%
Reservoirs	2%
Residential	1%
Shrubs and Brush Rangeland	2%
Strip Mines	1%
Transportation Areas	1%
Other	1%

5.7.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites, municipal solid waste landfill sites, within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are four municipal solid waste landfills sites, one Superfund site (Garland Creosoting), and two permitted industrial and hazardous waste sites located within reservoir study area. There are no air quality monitoring stations within the subject area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[20]

5.7.2.14 Potential Environmental Impact Summary

Table 5.7-11 Potential Environmental Impact Summary for Carthage.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown

Wetland Mitigaiton Bank Conflict	Substantial
4-Municipal Solid Waste Landfills	Moderate
1- Superfund Site	Substantial
2- Permitted Industrial and Hazardous Waste Sites	Substantial

[1] Freese and Nichols, Inc. Comprehensive Sabine Watershed Management Plan. December, 1999.

[2] U.S. Army Corps of Engineers, Fort Worth District, Executive Summary Report on Texas Big Sandy Study, Texas, April, 1991.

[3] U.S. Army Corps of Engineers, Fort Worth District, Big Sandy Lake General Design Information, 1980-1985.

[4] Freese and Nichols, Comprehensive Sabine Watershed Management Plan, Technical Memorandum Task 17 – Surface Water Projects Issues, Preliminary Screening of Previously Proposed Projects, February, 1999.

[5] U.S. Department of the Interior, Bureau of Reclamation. July 1990. Texas Big Sandy Study Supporting Materials, Volume E – Hydrology.

[6] Espey, Huston & Associates, Inc. and Tudor Engineering Company. Update of the Master Plan for the Sabine River and Tributaries in Texas. Hydrology Appendix. March, 1985.

[7] U.S. Army Corps of Engineers, Fort Worth District, Big Sandy Lake Stage 2 Documentation Report, February, 1981.

[8] Espey, Huston & Associates, Inc. and Tudor Engineering Company. Update of the Master Plan for the Sabine River and Tributaries in Texas. Report. March, 1985.

[9] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[10] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan*. Austin, Texas. TWDB.

[11] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science,* 2:93-117.

[12] Gould, F. W. 1975. Texas Plants: Aa Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[13] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[14] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[15] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[16] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[17] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[18] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[19] www.tnris.state.tx.us

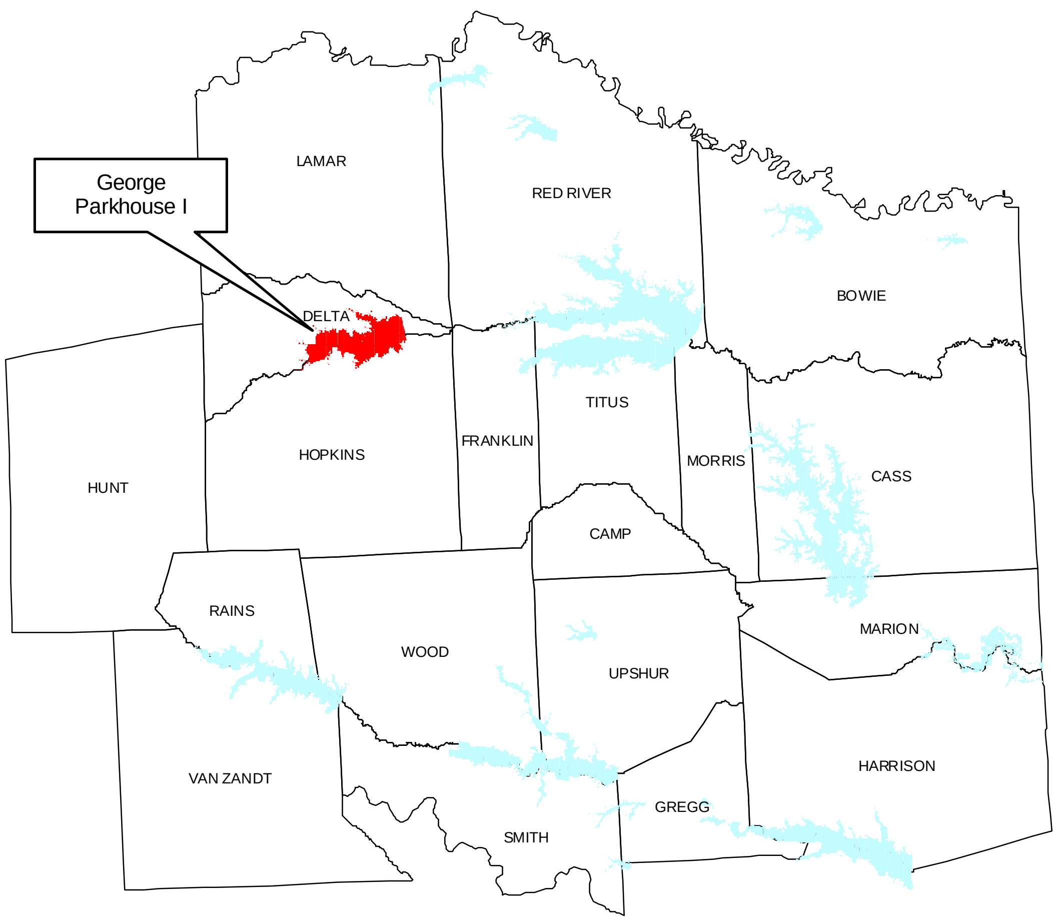
[20] WWW.TNRIS.STATE.TX.US

5.8 GEORGE PARKHOUSE I

5.8.1 Summary of Prior Studies

5.8.1.1 Location

Figure 5.8-1 Location of George Parkhouse I within the Region D Planning Region



The George Parkhouse I site is located 110 miles east of Fort Worth on the South Fork of the Sulphur River downstream from Cooper Reservoir. The potential site would be located at river mile 3.0 which borders Lamar County and Delta County. The South Sulphur River is a tributary that joins the North Sulphur River at the borders of Red River and Franklin counties upstream of the potential Marvin Nichols I and II reservoirs. Existing major water supply reservoirs in the area are Lake Sulphur Springs, Lake Wright Patman and Lake Cooper *(See Appendix, Exhibit A, Vicinity Map).*

5.8.1.2 Impoundment Size and Volume

At the conservation pool elevation of 401.0 feet msl, the storage capacity and surface area of George Parkhouse I is 685,706 acre-feet and 29,740 acres respectively.[6] At the probable maximum flood (PMF) elevation of 414.2 feet msl, the reservoir surface area is 36,120 acres.[1] During the 100-year flood event, a surface area of 31,240 acres will be inundated to an elevation of 404.0 ft msl.[1] Reservoir area and capacity relationships shown below are taken from previous reports[2] and are based on planimeter and digitizer measurements of surface areas and corresponding elevations from U.S. Geological Survey 1:24,000 contour maps.

5.8.1.3 Site Geology and Topography

The George Parkhouse I damsite is in the Sulphur River Basin in the Coastal Plain physiographic province. It is characterized by low elevations and relief, with wide and extremely flat floodplains.

Two notable structural features are in the vicinity but south of the damsite: the East Texas Syncline, and the Mexia-Talco Fault System. The East Texas Syncline trends northeast-southwest and has affected the regional dip of the strata. The Mexia-Talco Fault System is composed of a series of en echelon grabens; individual faults in this system have steep dips and near-surface displacements of several hundred feet.

The sediments of interest underlying the site are of Quaternary and Cretaceous ages. Bedrock is covered by deposits of alluvial terraces and recent alluvial deposits in the valley bottom.

Alluvial terrace material is widespread in the area of the potential dam. It consists of an upper zone of stiff hard clays and sandy clays, overlying but gradational with a zone of clayey, silty sands with pockets or layers of coarse sand and/or gravel. This lower sandy zone may terminate somewhere beneath the left abutment.

The recent alluvial deposits in the river valley are reported to consist of medium to hard clays that become sandier with depth. The lower part of the alluvium consists predominantly of sandy clays or clayey silts. A lower zone of silty sand or fine sand is not present to the extent that it is typically present at other locations in the Sulphur River Basin.[3] Gravel, concretions, and shell fragments appeared in borings marking the contact with the underlying bedrock.

Bedrock consists of either the Marlbrook formation of the Taylor Group or the undifferentiated Navarro Group deposits. A 1967 report by the USACE discusses the materials using soils terminology, although others[4] describe the materials as bedrock. Boring log descriptions indicate that the materials are fissile shales. Degree of fissility and plasticity could not be evaluated from the available information.

5.8.1.3.1 Geotechnical Conditions and Limitations

The recent alluvium and terrace deposits should be treated as sources for potential modes of failure with regard to embankment settlement, differential settlement, and slope stability. Adequate investigation is required to evaluate these materials for dam design. Loading upon the underlying bedrock and potential development of positive pore pressures therein should be considered to preclude potential slope stability issues.

The USACE report states that settlement has been evaluated by others based on a few consolidation tests. The study reports that settlement would not be uniform and that the maximum amount of settlement expected (80 in, or 6.7 feet, occurring over the alluvial deposits and including both embankment and foundation settlement) would not be excessive.

The USACE reports states that the terrace deposits may provide a significant path for seepage, particularly the terrace on the right abutment, between the North and South Sulphur Rivers. The recent alluvial deposits are not expected to provide a significant path for seepage based on the thick impervious upper zone and the limited quantity of relatively permeable materials underneath. Should they be required, seepage countermeasures could include cutoff walls.

The project is in seismic zone 1, a zone of minor seismic hazard. It lies north of the Mexia-Talco Fault System that has reportedly been inactive during Recent times, and is not considered to be an issue for a well-designed and constructed dam.[3] The site should be evaluated using modern seismic analyses methods to study dam performance under design earthquake loading.

5.8.1.3.2 Construction Materials

No borrow materials investigation is known to have been conducted for the project. Available boring logs do not indicate the presence of significant sources of clean sands, sands that could easily be produced on-site, or gravels, materials that would be needed for construction of filters, drains, and concrete. The materials would be available from commercial producers along the Red River and Texarkana areas, at haul distances estimated at 40 to 60 miles. Stone suitable for rip-rap is reportedly not available in the area (1990) but would be available from commercial producers in southern Oklahoma at haul distances estimated at 40 to 60 miles.

It is anticipated that dam core and shell construction materials could be produced from alluvial and terrace deposits within the reservoir.

5.8.1.4 Dam Type and Size

George Parkhouse I will consist of a 20,000 ft-long earthen embankment constructed across the South Sulphur River with an additional ½-mile-long earthen dike built across the low stream divide between the North Sulphur River and the South Sulphur River. The embankment crest widths are 24 feet at elevation 412.0 ft msl.[5] If George Parkhouse I is built as a Stage 2 to George Parkhouse II, the earthen dike is not required. A more recent study sets the elevation of the top of dam at 420 ft msl, requiring an increase in the crest length and subsequently an increase in the saddle dam lengt.[1] The same study shows soil cement protection of the dam face, 3.5H:1V side slopes, a 22-foot wide roadway, and a slurry trench cutoff wall.

The potential spillway appears to be a gated ogee shaped spillway with the crest elevation at 390.0 ft msl. During the probable maximum flood, the potential spillway will convey the peak discharge through four 40 ft gated bays with approximately 5 ft of freeboard from the maximum water surface elevation to the top of dam elevation.[1]

5.8.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the potential George Parkhouse I damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.8.1.5.1 Reservoir Inflows

Daily reservoir inflows are developed from U.S. Geological Survey (USGS) historical flows originating below major reservoirs upstream of the potential George Parkhouse I site. To derive the naturalized flows from the historical flows, daily flows are converted to monthly flows, and adjustments are made to these to account for diversions for upstream water rights and monthly spills from upstream major reservoirs. The adjusted monthly inflows are converted back to daily values using the historical pattern of flow from nearby USGS gauges.[6]

For George Parkhouse I, the reservoir inflow equations assume no other new reservoirs are constructed. Inflow equations are based on drainage area ratios which vary depending on the location and size of the potential reservoir and the corresponding location and size of the nearby U.S. Geological Survey (USGS) gaging station. Reservoir inflow values are similar to previously reported values from the 1990 Freese and Nichols study that are updated to include:

- A longer period of record (extended from 1986 through 1990).
- Changes to water rights since the previous studies were completed.
- The impact on yield of the draft Environmental Water Needs Criteria being considered by the Texas Water Development Board, the Texas Department of Parks and Wildlife, and the Texas Natural Resource Conservation Commission.

5.8.1.5.2 Firm Yield

The Texas Water Development Board 31 TAC 357.7(a)(3) requires "an evaluation of adequacy of current water supplies available to the regional water planning area for use during drought of record. This evaluation shall consider surface water and groundwater data from the State Water Plan, existing water rights, contracts and option agreements, other planning and water supply studies, and analysis of water supplies currently available to the regional water planning area. Analysis of surface water available during drought of record from reservoirs shall be based on firm yield analysis of reservoirs".[7]

Firm yield studies are summarized for George Parkhouse I in the section 5.8.1.7 entitled, "Project Yield for Water Supply."

5.8.1.5.3 Reservoir Evaporation

Reservoir evaporation data was estimated by Freese & Nichols in the 1990 Regional Water Supply Plan using guidelines published by the Texas Water Development Board. The net evaporation used in the reservoir operation studies have been calculated as the difference between gross reservoir evaporation and precipitation, with positive values representing conditions when evaporation exceeds precipitation. Daily evaporation values are assumed to be constant within each month.

5.8.1.5.4 Area Capacity Data

The elevation-area-capacity relationship (also referred to as an area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. The relationship is based on the topographic characteristics of the land to be inundated by the reservoir. Reservoir area and capacity relationships shown below are summarized from previous reports[2] and are based on planimeter and digitizer measurements of area and elevation from U.S. Geological Survey 1:24,000 contour maps. During the life of the reservoir, sediment deposition within the reservoir typically alters that relationship and reduces the capacity of the reservoir. Sediment deposition is distributed in various zones of a reservoir at differing rates, depending on the shape of the reservoir and other factors such as the type of sediment from the tributary basin.

5.8.1.6 Water Quality

The examination of water quality is based upon existing water quality and streamflow data provided by the U.S. Geological Survey (USGS) and the Texas Water Commission (TWC). Water quality data for for physical and chemical data for George Parkhouse I was recorded at a single location in the Sorth Sulphur River near Cooper, Texas from 12/79 to 07/87. Data for heavy metals data was recorded from 1/80 to 7/87. The water quality analyses include an evaluation of inorganic parameters and biological contaminants, if available. The water quality standards considered are taken from the following agencies:

EPA National Primary Drinking Water Regulations, EPA Secondary Drinking Water Regulations, 1986 EPA Quality Criteria for Water, Texas Department of Health Primary and Secondary Drinking Water Regulations, and 1988 Texas Surface Water Quality Standards (TSWQS). The comparison provides an indication of the degree of treatment required for the George Parkhouse I water source. Table 4.1-1 provides a comparison of historical water quality data with Texas Water Quality Standards necessary to reservoir development.

This Space Intentionally Left Blank

Table 5.8-1 Water Quality Data

Parameter	*Unit*	*1988 Texas Surface Water Quality Standards*	*Historical Physical and Chemical Water Quality Data*	
			Flow Weighted Average	*Range of Data*
Arsenic	(µg/l)	360/190	4.72	1-31
Barium	(µg/l)	–	51.4	40-110
Cadmium	(µg/l)	32.9/1.12	0.78	0.5-11
Calcium	(mg/l as	–	53.2	35-212
Chloride	(mg/l)[c]	190	5.5	3.6-58
Chromium	(µg/l)	1,708/203	4.3	4-10
Copper	(µg/l)	18.8/12.6	4.7	0.5-7
Dissolved Oxygen	(mg/l)[a]	5.0	6.9	3.4-13.0
Fecal Coliform	(# / 100 ml)[b]	200	–	–
Fluoride	(mg/l)	–	0.18	0.1-0.5
Iron	(mg/l)	–	127.3	5-160
Langelier Index[f]		–	–	Moderate
Lead	(µg/l)	79.6/3.1	1.1	0.5-6
Magnesium	(mg/l)	–	2.3	1.5-10
Manganese	(mg/l)	–	5.4	4-90
Mercury	(µg/l)	2.4/0.012	0.05	0.1-0.7
Nickel	(µg/l)	1,394/155	–	–
Nitrate	(mg/l)	–	1.5	0.02-4.9
pH		6-8.5	--	7-8.4
Selenium	(µg/l)	260/35	0.45	0.4-1.0
Silver	(µg/l)	3.92/0.49	0.5	–
Sodium	(mg/l)	–	8.5	4.5-93
Sulfate	(mg/l)[c]	475	15.2	5-95
Total Alkalinity	(mg/l as $CaCO_3$)	–	61	31-251
Total Dissolved Solids	(mg/l)[c]	1320	105	69-470
Total Hardness	(mg/l as $CaCO_3$)	–	63	42-250
Turbidity	(NTU)	–	83	4.5-1,000
Zinc	(µg/l)	115/104	13.9	1.5-38

Notes:

(a) No measurements should fall below this value.
(b) Thirty-day geometric mean not to exceed this value.
(c) Annual average not to exceed this value.
(d) Standards for arsenic and subsequent parameters are expressed as acute limit/chronic limit.
(e) Indicates the tendency of the raw water to become corrosive during cold weather.
(f) mg/l = ppm (parts per million)
(g) µg/l = ppb (parts per billion)
(h) Data in this report is based on analyses done at the time the reservoir was initially evaluated and the water quality evaluations were based on a comparison with standards that may have since changed.

Water quality data and standards reprinted from the 1990 Regional Water Supply Plan, by Freese and Nichols, Inc. and Alan Plummer and Associates, Inc. show that the contaminants of greatest concern include Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel, Selenium, Silver and Zinc. On occasions, the standards for some physical and inorganic parameters are violated for pH, chloride, sulfate, TDS, fecal coliform bacteria and dissolved oxygen, but those of greatest concern remain acceptable. The flow-weighted averages indicate that all parameters except turbidity would be acceptable for reservoir development to meet probable long-range receiving water and water supply criteria.

5.8.1.7 Project Yield for Water Supply

Firm yield as described in the SB1 Regional Water Plan by the State of Texas is "the maximum amount of water supply, based upon simulation, that a reservoir could have produced each year if it had been in place during the drought of record. Firm yield analyses reported in the 1997 Water for Texas and any other equivalent existing analyses are acceptable. All water availability based on firm yield must satisfy full utilization of senior water rights. Where special conditions exist, such as the Rio Grande Project, water available based on operating procedures during the drought of record conditions will be used in place of reservoir firm yield analysis. In performing a simulation for firm yield determination for a new site, the following criteria must be met".[6]

The basic procedures required in analyzing water availability in the river basin involve simulating on a monthly basis the ability of individual water rights to satisfy their authorized diversions or storage quantities under historical, but naturalized characteristics. By taking into account the wide range of historical naturally occurring streamflow conditions, the results provide a meaningful indication of the water available for the future. The Texas Water Development Board has criteria for determining firm yield analyses as outlined in Exhibit B of SB1 Regional Water Plan.

5.8.1.7.1 Reservoir Operation Summary

From the 1990 "Regional Water Supply Plan" developed by Freese and Nichols, Inc. & Alan Plummer and Associates, Inc.:

The yield available from the George Parkhouse I reservoir was calculated by computer operation studies using the following hydrologic data and operating assumptions:

- area and capacity characteristics
- runoff
- evaporation data
- Cooper Reservoir and Lake Sulphur Springs are operated at their full, permitted diversions. Spills from these reservoirs are available for use downstream.
- Releases are made from the reservoirs immediately upstream from Lake Wright Patman to keep the yield from that reservoir at its current level of 160,800 acre-feet per year.
- Other existing water rights are assumed to make full use of available flows to the extent of their permits.

Reservoir studies were completed using these assumptions to determine the additional yield made available. In addition, reservoir studies are the result of modeling the basin for George Parkhouse I with no other new reservoirs in place.[5]

The annual firm yield from George Parkhouse I under the operating assumptions above is 123,000 ac-ft/year (109.8 mgd). Pass-through flows to satisfy environmental requirements were not included in the initial reservoir operation analysis.

5.8.1.7.2 Modified Reservoir Operation Study

A more recent study from the 1996 "North Texas Municipal Water District" by Freese and Nichols, Inc. shows the following assumptions and yield results to include pass-through flows:

The yields for the potential project under various assumptions are determined by daily reservoir operation studies with pass-throughs of inflow as proposed in the "Draft Environmental Water Needs Criteria"[2]. The pass-through requirements as used in the reservoir operation studies are shown in the following Table 5.8-2.

Table 5.8-2 Environmental Flow Requirements

Zone	*Goal*	*Content (%)*	*Content (af)*
1	Median	>80%	>508,312
2	25%	50-80%	317,695 – 508,312
3	7Q2	<50%	<317,695

The flushing flow (1.5 year event) is 10,764 cfs.
Note: 0.1 cfs is used for the actual 7q2 value of 0.0 cfs, as in TNRCC Published values.

The amount of flow released for pass-through requirements varies by month and reservoir content level.

The modified reservoir operating assumptions studied are as follows:

- Capturing all Inflow
- Releases for Downstream Rights to Protect Wright Patman Diversions
- Releases for Downstream Rights to Protect Wright Patman Diversions and Environmental Flow Criteria
- Releases for Downstream Rights to Protect Wright Patman Elevation
- Releases for Downstream Rights to Protect Wright Patman Elevation and Environmental Flow Criteria

Table 5.8-3 lists by row and column the effects the above mentioned alternate reservoir operating assumptions have on the average annual yield. Increased downstream protection rights result in decreased reservoir yields. The estimated decreases in the annual yield due to the downstream protection right are based upon a 122,768 acre-ft per year (109.6 mgd) yield, noted in the updated 1996 Freese and Nichols, Inc. report. This is a decrease from the earlier noted annual yield of 123,000 acre-ft per year (109.8 mgd).

Table 5.8-3 Annual Yield from George Parkhouse II under the Operating Assumptions Above

Operation Study	*Yield*
Capturing all Inflow	109.6 mgd (122,768 af/y)
Releases for Downstream Rights to Protect Wright Patman Diversions	107.6 mgd (120,527 af/y)
Releases for Downstream Rights to Protect Wright Patman Diversions and Environmental Flow Criteria	106.2 mgd (118,959 af/y)
Releases for Downstream Rights to Protect Wright Patman Elevation	102.5 mgd (114,815 af/y)
Releases for Downstream Rights to Protect Wright Patman Elevation and Environmental Flow Criteria	101.3 mgd (113,470 af/y)

The updated 1996 study shows a reduction in yield from the previous 1990 study due to the inclusion of the environmental flow requirements.

5.8.1.8 Other Potential Benefits

Other potential benefits may include hydropower generation, flood control, irrigation and recreation. No studies have been conducted to evaluate additional benefits. [1]

5.8.1.9 Land Acquisition and Easement Requirements

The acquisition of land and easement requirements includes land in the conservation pool to elevation 401.0 ft msl and flood easements for land above the conservation pool to elevation 406.0 ft msl. The take area for the reservoir system for purposes of this study is approximately 32,240 ac.

5.8.1.9.1 Potential Land Use Conflicts

This section discusses the results of field reconnaissance studies made to locate potential conflicts in terms of roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. The following Table 5.8-4 shows the costs associated for the reservoir development conflicts. The costs are based on December 1989 prices. [1]

Table 5.8-4 Reservoir Conflicts Table

Roadway Conflicts	*Pipeline Conflicts*	*Cemetery Conflicts*	*Oil Field Conflicts*	*Miscellaneous Conflicts*	*Total*
$10,806,880	$2,332,080	$723,680	$0	$306,320	$14,168,960

The breakdown of the associated conflicts showing each roadway and cemetery conflicts was not available from the source data.

5.8.1.9.2 Local, State, and Federal Permitting Requirements

The 1996 study by Freese and Nichols discusses the need for the following four permits: 1) Water rights permits from the Texas Water Commission, 2) Section 404 permit from the U.S. Army Corps of Engineers, including all NEPA compliance, 3) Antiquities Permit from the Texas Antiquities Committee, and 4) Sand and Gravel Permit from the Texas Parks and Wildlife Department.

This Space Intentionally Left Blank

Table 5.8-5 Permitting Requirements

Permit	***Issuing Agency***	***Summary of Requirements***
Water Rights	Texas Water Commission	Engineering report; environmental effects report on water quality and fish and wildlife; water conservation plan; public hearing; may include mitigation requirements.
Section 404*/Section 10	U.S. Army Corps of Engineers	Description of proposed fill activities; preparation of environmental impact statement; may require special studies by applicant, including archeological survey, water quality studies, ecological studies and NEPA compliance; may include mitigation requirements.
Antiquities Permit	Texas Antiquities Committee	Archeological survey, testing and evaluation, and mitigation of important sites.
Sand and Gravel Permit	Texas Parks and Wildlife Department	$0.20 per cubic yard of sand, gravel or marl excavated from river channel

* Includes Section 401 Certification of Water Quality from Sate Agency (TWC)

No hydroelectric facilities are proposed for George Parkhouse I, therefore a license from the Federal Energy Regulatory Commission (FERC) is not required.

5.8.1.10 Updated Project Costs

Opinions of probable project cost for the George Parkhouse I Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1989.[5] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor's Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher capital cost estimate than the initial analysis, which estimated the project cost at $224,726,000. Please refer to Table 5.8-6 for the Updated Project Cost and Table 5.8-7 for the Construction Cost.

5.8.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in Table 5.8-6. The assumed average developed cost per acre of land for the reservoir was $550/ac. and the easement cost was $412.50/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 29,700 acres plus the additional surface area attained for easement, which together is approximately 32,240 ac.

5.8.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in Table 5.8-6.

5.8.1.10.3 Construction Costs

As shown in Table 5.8-7, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for

Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

Table 5.8-6 Updated Project Costs

Description	***Quantity***	***Unit***	***Unit Price ($)***	***Cost ($)***	***Total Cost ($)***
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$60,289,900
Relocations (conflict resolution)		L.S.			$17,831,000
Construction Capital Costs (CCC) Subtotal:					**$78,120,900**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$27,342,400
Land Cost					$24,802,250
Land Purchase	29,740	Ac.	$550.00	$16,357,000	
Easements	2,500	Ac.	$412.50	$1,031,250	
Acquisition Costs (15% of land)		L.S.		$2,453,550	
Contingencies (25% of land purchase, easements & acquisition costs)		L.S.		$4,960,450	
Studies, Mitigation, Permitting					$30,363,250
Environmental Studies		L.S.		$300,000	
Archeological Studies (pmf pool)	36,100	Ac.	$10.00	$361,000	
Geotechnical Studies		L.S.		$1,042,000	
Mitigation Costs (equal to land cost)		L.S.		$24,802,250	
Permitting		L.S.		$3,858,000	
Interest During Construction					$9,747,000
Other Project Costs Subtotal:					**$92,254,900**
		Jan. 1989 Subtotal:			$170,375,800
20-City Average Escalation Factor	31.9%				$54,349,890
OPINION OF PROBABLE PROJECT COST					**$224,726,000**

Notes:

1. Original cost estimates were taken from F&N, 1989.[6]
2. The 35% engineering and other fees include the engineering design listed in the original estimate.
3. Mitigation costs were included.
4. Dam instrumentation cost was included with the construction costs.

Table 5.8-7 Construction Costs

Item #	*Description*	*Quantity*	*Unit*	*Unit Price ($)*	*Total Cost ($)*
1	Land Clearing	5,350	acre	$535.00	$2,862,250
	Excavation				
2	Approach Channel	140,200	C.Y.	$1.31	$183,662
3	Channel	123,000	C.Y.	$1.31	$161,130
4	Spillway	289,300	C.Y.	$1.20	$347,160
5	Emergency Spillway	434,300	C.Y.	$1.20	$521,160
	Fill				
6	Impervious	1,567,800	C.Y.	$1.75	$2,743,650
7	Random	7,169,400	C.Y.	$1.75	$12,546,450
8	Filter, 1 & 2 (Foundation drainage)	668,200	C.Y.	$10.00	$6,682,000
9	Bridge	190	L.F.	$720.00	$136,800
10	Roadway	63,067	S.Y.	$4.60	$290,108
11	Cutoff Slurry Trench	800,000	S.F.	$3.50	$2,800,000
12	Soil Cement	394,130	C.Y.	$16.00	$6,306,080
13	Elevator	1	ea.	$100,000.00	$100,000
14	Barrier Warning System	456	L.F.	$12.00	$5,472
	Gates				
15	Gate & Anchor (Install/Paint)	2,240	S.F.	$200.00	$448,000
16	Stop Gate & Lift Beam	160	L.F.	$1,450.00	$232,000
17	Hoist	4	ea.	$118,000.00	$472,000
18	Electrical		L.S.		$320,000
19	Power Drop		L.S.		$144,000
20	Low Flow System		L.S.		$1,000,000
21	Monorail System	190	L.F.	$640.00	$121,600
22	Embankment Internal Drainage	25,800	L.F.	$38.00	$980,400
23	Guardrail	380	L.F.	$18.00	$6,840
24	Grassing	54	acre	$3,700.00	$199,800
25	Concrete (mass)	52,000	C.Y.	$125.00	$6,500,000
26	Concrete (walls)	5,600	C.Y.	$200.00	$1,120,000
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$47,230,570**
	Clearing/Grubing, Care of Water (6% of BCS)				$2,833,840
	Mobilization (5% of BCS)				$2,361,530
				Subtotal:	$52,425,940
	OH & P (15% of Subtotal)				$7,863,900
	Construction Capital Cost Subtotal (CCC)				**$60,289,900**

5.8.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 113,500 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $224,726,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For George Parkhouse I Reservoir, the O&M is $1,171,820 and the annualized debt service is $15,911,300. The firm yield is then divided into the total annualized cost of $17,083,120 to yield a unit cost of $150.52 per acre-foot ($0.47/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 in the executive summary.

5.8.2 Environmental Overview –Affected Environment and Environmental Consequences

5.8.2.1 Geological Elements

5.8.2.1.1 Physiography

The reservoir is located within the Blackland Prairies. The Blackland Prairie covers approximately 12.6 million acres of land. It averages 30-45 inches of precipitation annually with 230 to 280 frost-free days. The topography is nearly level to rolling with an elevation of 250 to 700 feet above msl. The Blackland Prairie area intermingles with the Post oak Savannah in the southwest and has division known as the San Antonio and Fayette Prairies. This rolling and well-dissected prairie represents the southern extension of the true prairie that occurs from Texas to Canada.

The upland Blacklands are dark, calcareous shrink-swell clayey soils, changing gradually with depth to light marls or chalks. Bottomland soils are generally reddish brown to dark gray, slightly acid to calcareous, loamy to clayey and alluvial. The soils are inherently productive and fertile, but many have lost productivity through erosion and continuous cropping.

The Blackland Prairie is characterized by little relief and dark, thick, plastic clay soils. All outcropping strata are generally classified as sedimentary. The exposed bedrock is composed of nearshore and shoreline marine sediment deposited at the edge of the Gulf Coast Embayment by a shallow Cretaceous sea existing approximately 100 million years ago. Sediment deposited in this sea consists of sand, silt, and clay and formed layers that incline eastward toward the embayment at an average rate of 45 feet per mile.

5.8.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[8]

5.8.2.1.3 Soils

The area of the reservoir contains four major soil groups.[9] These groups are Annona-Freestone-Woodtell, Crockett-Wilson-Gowen, Houstonblack-Leson-Heiden, and Kaufman-Tinn-Gladewater. Approximately 17 percent of the area is Annona-Freestone-Woodtell,10 percent Crockett-Wilson-Gowen, 1 percent Houstonblack-Leson-Heiden, and 72 percent Kaufman-Tinn-Gladewater. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Annona

The Annona series consists of very deep, moderately well-drained, very slowly permeable soils. Slopes range from 0 to 8 percent. These soils are on nearly level to moderately sloping Pleistocene terraces. The soils formed in clayey alluvial terrace sediments. Mean annual temperature ranges from 64 to 68 degrees F., mean annual precipitation ranges from 40 to 48 inches, and the summer rainfall is about 25 to 30 inches. Frost-free days range from 230 to 280. The elevation ranges from 200 to 500 feet above msl. Thornthwaite annual P-E index ranges from 64 to 78. Runoff is low for 0 to 1 percent slopes, medium on 1 to 3 percent slopes, high on 3 to 5 percent slopes, and very high on 5 to 8 percent slopes. A saturated zone is perched above the Bt horizon for short periods following heavy rains. Almost all of this soil is in pasture and woodland. Forests are mixed hardwood and pine. Major hardwood species are red oak, post oak, sweetgum, and hickory. Needleleaf trees are shortleaf and loblolly pine. Pastures include improved bermudagrass, common bermudagrass, bahiagrass, with arrowleaf dover, crimson clover, and vetch overseeded. Some areas are used for growing corn, soybeans, grain sorghum, wheat, or hay crops.

Crockett

The Crockett series consists of nearly level to moderately sloping soils that are deep to weathered shale. They are moderately well-drained, and very slowly permeable, on uplands. Slopes are dominantly 1 to 5 percent, but range from 0 to 10 percent. Mean annual temperatures ranges from 64 to 70 degrees F., and mean annual precipitation ranges from 32 to 45 inches. Frost-free days range from 230 to 275 days, and elevation ranges from 200 to 800 feet. Thornthwaite P- E indexes range from 50 to 75. The soil is mainly used for growing cotton, grain sorghums, and small grain, but more than half the acreage is now in pastures. Native vegetation within the series is predominately prairie grasses such as bluestems, indiangrass, switchgrass, and gramas, with scattered elm, hackberry, and mesquite trees.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Gladewater

The Gladewater series consists of very deep, somewhat poorly drained, very slowly permeable soils on floodplains formed in clayey alluvium in floodplains. Slope ranges from 0 to 1 percent. The mean annual precipitation ranges from 38 to 46 inches and mean air temperature ranges from 64 to 68 degrees F. Frost-free days range from 235 to 275 days and elevation is 200 to 400 feet above msl. Thornthwaite P-E index ranges from about 62 to 74. Depressional areas are very poorly drained. Most of the acreage is in pasture or forest. Some areas are in native pasture or range. Pasture areas are introduced grasses such as dallisgrass and fescue. Forested areas are in mixed hardwoods including water oak, willow oak, cedar elm and black willow.

Gowen

The Gowen series consists of very deep, well-drained, moderately permeable soils that formed in loamy alluvium, on nearly level floodplains. Slopes are dominantly less than 1 percent, but range up to 2 percent. Flooding occurs at intervals ranging from one or more times a year to once in about every five years unless protected. Mean annual temperature ranges from 64 to 70 degrees F., and mean annual precipitation ranges from 28 to 40 inches. Frost-free days range from 230 to 270 days and elevation ranges from 200 to 950 feet. The Thornthwaite indexes range from 30 to about 60. Runoff is negligible. In some areas during the winter months a water table is at a depth of 4 to 7 feet. Most of the soil is farmed to peanuts, sorghums, cotton, and pecan orchards. Areas that flood frequently are used mainly for bermudagrass pastures and pecan orchards. Scattered hackberry, elm, and pecan trees occur in most areas.

Heiden

The Heiden series consists of soils that are well-drained and very slowly permeable .They are deep to weathered shale, on nearly level to moderately steep uplands. Slopes are mainly 3 to 8 percent but range from 0.5 to 20 percent. Surfaces are dominantly convex but plane surfaces occur in some areas of low gradients. Most untilled areas have a microrelief of microvalleys 4 to 12 feet wide and 3 to about 12 inches deep, and microridges about 4 to 12 feet wide that extend up and down slope. The soils formed, mainly, in weakly consolidated Upper Cretaceous formations of calcareous marine sediments, high in montmorillonite clays. The climate is moist subhumid. The mean annual precipitation ranges from 28 to 42 inches and the mean annual temperature ranges from 64 to 70 degrees F. Frost-free days range from 225 to 275 days and elevation ranges form 400 to 1000 feet. Thornthwaite annual P-E indexes range from 44 to 66. Runoff is low on 0 to 1 percent slopes, medium on 1 to 3 percent slopes, high on 3 to 5 percent slopes and very high on 5 to 20 percent slopes. Infiltration is rapid when the soil is dry and cracked, but very slow when the soil is wet. This soil series is used mainly for pasture and hay. Many areas have been cultivated but are now in grass. Some areas are used for growing grain sorghum and cotton. Grasses are mainly bluestem, buffalograss, and threeawn grass. Scattered mesquite trees occur throughout the series.

Houston Black

The Houston Black series consists of very deep, moderately well-drained, very slowly permeable soils that formed from weakly consolidated calcareous clays and marls of Cretaceous Age, on nearly level to moderately sloping uplands. Slopes are mainly 1 to 3 percent, but range from 0 to 8 percent. In places, the substrata are chalks or shales. The climate is warm and subhumid. The mean annual precipitation ranges from 28 to 42 inches and the mean annual temperature ranges from 63 to 70 degrees F. Frost-free days range from 220 to 250 days and elevation ranges from 400 to 1000 feet. Thornthwaite annual P-E indexes range from 44 to 66. Water enters the soil rapidly when it is dry and cracked, and very slowly when it is moist. Nearly all is cultivated and used for growing cotton, sorghums, and corn. Cotton root rot is prevalent on most areas and limits cotton yields and the use of some legumes in rotations. Native vegetation consists of tall and mid grass prairies of little bluestem, big bluestem, indiangrass, switchgrass, and sideoats grama, with scattered elm, mesquite, and hackberry trees.

Kaufman

The Kaufman series consists of very deep, moderately well-drained, very slowly permeable soils on floodplains formed in clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 2 percent. Mean annual precipitation ranges from 35 to 50 inches, and mean annual temperature ranges from 62 to 70 degrees F. Frost-free days range from 230 to 280 days and elevation ranges from 100 to 550 feet above msl. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in pasture of dallisgrass, bermudagrass, and fescues. A few areas are used for producing cotton, corn, sorghums, and soybeans. Native vegetation is hardwoods such as elm, hackberry, oak, ash, and grasses which includes species of andropogon, paspalum, panicum, and tripsacum.

Leson

The Leson series consists of very deep, moderately well-drained, very slowly permeable soils that formed in alkaline shales and clays, on nearly level or gently sloping uplands. Slopes range from 0 to 5 percent. Leson soils are on nearly level to gently sloping uplands. The climate is warm and subhumid. The mean annual precipitation ranges from 34 to 44 inches and mean annual average temperature ranges from 63 to 70 degrees F. Frost-free days range from 230 to 260 days and elevation ranges from 350 to 750 feet. Thornthwaite annual P-E indexes are 44 to 72. Water enters the soil rapidly when it is dry and cracked, and very slowly when it is moist. Mainly cultivated and used for crops such as cotton, grain sorghums, and corn. Native grasses are mainly bluestem, indiangrass, and gramas. Improved pastures are planted to bermudagrass and lovegrass. Scattered trees include bois d'arc, hackberry, elm, post oak, and locust.

Tinn

The Tinn series consists of very deep, moderately well-drained, very slowly permeable soils that formed in calcareous clayey alluvium, on floodplains of streams that drain the Blackland Prairies. Slopes are dominantly less than 1 percent but range from 0 to 2 percent. Tinn soils are on nearly level floodplains. Mean annual precipitation ranges from 32 to 42 inches, and mean annual temperature ranges from 64 to 68 degrees F. Frost-free days range 230 to 270 days and elevation ranges from 250 to 550 feet. Thornthwaite P-E indexes exceed 44. Flooding is common except where the soil is protected. Duration of flooding is very brief or brief. Most areas are in pasture or cultivated to crops such as cotton, corn, sorghums, or small grains. Native vegetation is elm, hackberry, oak, and ash, with an understory of grasses such as species of paspalums and panicums.

Wilson

The Wilson series consists of very deep, moderately well-drained, very slowly permeable soils that formed in alkaline clayey sediments, on nearly level to gently sloping stream terraces or terrace remnants on uplands. Slopes are mainly less than 1 percent but range from 0 to 5 percent. Mean annual temperature ranges from 64 to 70 degrees F., and mean annual precipitation ranges from 32 to 45 inches. Frost-free days range from 220 to 270 days and elevation ranges from 250 to 700 feet. Thornthwaite P-E indexes from 50 to 70. Very slow internal drainage. The soil is seasonally wet and is saturated in the surface layer and upper part of the Bt horizon during the winter and spring seasons for periods of 10 to 30 days. Wilson soils are cropped to cotton, sorghums, small grain, and corn. Many areas are now idle or are used for unimproved pasture. Original vegetation was tall prairie grasses, mainly andropogon species, and widely spaced motts of elm and oak trees. Most areas that are not cropped have few to many mesquite trees.

Woodtell

The Woodtell series consists of soils that are deep to stratified shale and loamy materials on gently sloping stream divides. They are well-drained and very slowly permeable. The slope ranges from 1 to 20 percent. Woodtell soils are strongly to moderately steep side slopes of uplands. Slope gradients are mainly 2 to 12 percent but range from 1 to 20 percent. The soils formed in materials weathered from unconsolidated, stratified loamy, clayey, and shaly materials of Eocene age mainly in the Wilcox and Cook Mountian formations. The average annual rainfall ranges from 40 to 46 inches. The mean annual temperature is about 62 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 78. Frost-free days range from 230 to 270 and elevation ranges from 300 to 650 feet above msl. These soils are used mainly for pasture. Native vegetation is mainly post oak, blackjack oak, elm and red oak in a fairly dense savannah. In open areas tall and mid grasses such as bluestems, tridens and panicums are common with longleaf uniola under the tree canopy. American beautyberry and hawthorn species are also a part of the understory. The main pasture plants are bermudagrass and bahiagrass with crimson and arrowleaf clovers. There are scattered shortleaf and loblolly pine with small plantations and a some dense pine areas on the eastern side of the series province. Some areas are planted to small grain for winter grazing.

5.8.2.2 Hydrological Elements

5.8.2.2.1 Surface Water

The potential George Parkhouse I reservoir is located within the Sulphur River Basin. The potential reservoir would cover approximately 11,018 acres with a normal pool elevation of 401 MSL. This portion of the Sulphur River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0305 (North Sulphur River). This 48-mile stream segment originates at the confluence with the South Sulphur River in Lamar County and continues to a point 4.2 miles upstream of FM 68 in Fannin County. This segment is classified as "water quality limited" and designated uses are for contact recreation and high aquatic life. Due to elevated levels of fecal coliform, the lower 25 miles of this segment does not meet the contact recreation use.[9]

5.8.2.2.2 Ground Water

The reservoir is located within the Trinity Aquifer, Carrizo-Wilcox Aquifer and the Nacatoch Aquifer.

The Trinity Aquifer consists of early Cretaceous age rocks of the Trinity Group formations which occur in a band from the Red River in north Texas to the Hill Country of south-central Texas and provides water in all or part of 55 counties. Usable quality water (containing less than 3,000 mg/l dissolved solids) occurs to depths of up to about 3,500 feet.

Water quality from the Trinity Aquifer is acceptable for most municipal and industrial purposes, however excess concentrations of certain constituents in many places exceed drinking-water standards for municipal supplies. Heavy pumpage and water-level declines in the north-central Texas region have contributed to deteriorating water quality in the aquifer. Water quality naturally deteriorates in the downdip direction of all the Trinity water-bearing units.

The potential reservoir is located in the outcrop region of the Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeastern part of the aquifer.

This aquifer extends in a band across most of the state from the Frio River in South Texas northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson County. Total pumpage for all uses in 1994 was 16,319 ac-ft.

The Nacotoch Aquifer occurs in a narrow band in northeast Texas and extends eastward into Arkansas and Louisiana. Pumpagefrom the aquifer totaled 3,484 acre-feet in 1994, 74 percent which was used for municipal purposes.

The Nacatoch Formation, composed of one to three sequences of sands separated by impermeable layers of mudstone or clay, was deposited in the East Texas basin during the Cretaceous Period. The aquifer also includes a hydrologically connected mantle of alluvium up to 80 feet thick where is covers the Nacatoch along major drainage ways. The south and east basinward dip of the formation is interrupted by the Mexia-Talco fault zone, which alters the normal flow direction and adversely affects the chemical quality of the groundwater. Groundwater in this aquifer is usually under artesian conditions except in shallow wells on the outcrop where water-table conditions exist.

The quality of groundwater in the aquifer is generally alkaline, high in sodium bicarbonate, and soft. Dissolved-solids concentrations increase in the downdip portion of the aquifer and are significantly higher downdip of faults. In areas where the Nacatoch occurs as multiple sand layers, the upper layer contains the best-quality water. The water quality is generally acceptable for most uses, however, the high degree of mineralization precludes its use for irrigation in some areas.

Annual availability, equivalent to annual effective recharge, for the Nacatoch Aquifer ie estimated to be 3,030 acre-feet. Recharge to the aquifer occurs mainly from precipitation on the outcrop. Aquifer water levels have been significantly lowered in some areas as a result of pumpage exceeding the effective recharge.[10]

5.8.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential George Parkhouse I reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential George Parkhouse I reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.8.2.4 Biological Elements

5.8.2.4.1 Vegetation

The potential George Parkhouse I reservoir is centrally located within the Texan province[11] and is within the Blackland Prairie region.[12] The Blackland Prairie vegetation area typically has a gently rolling to nearly level topography, which is well dissected and marked by the rapid surface drainage. The soil composition for this community is very fertile consisting of dark-colored alkaline clays mixed with gray acidic sandy loams. Blackland Prairie soils support a tall-grass prairie dominated by little bluestem. Other important grasses are big bluestem, Indiangrass, switchgrass, sideoats grama, hairy grama, tall dropseed, silver bluestem, and Texas winter grass. Under heavy grazing, Texas winter grass, buffalo grass, Texas grama, and many annuals increase or invade the land. Various post oak wooded areas dot the landscape as well as areas of pecan, cedar elm, soapberry, honey locust, sugar hackberry, and Osage orange. Invasive mesquite is common in disturbed areas. Most of the Blackland Prairie has been lost to other land uses. Only a few remnants are protected as hay meadows or conservancy land.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential George Parkhouse I reservoir location include Post Oak Wooded (23%); Water Oak, Elm (36%), crops (7%), and other (35%).

In accordance to *Water and Wildlife, 1990*, The potential George Parkhouse I reservoir contains four cover types within its proposed boundaries. The resource categories are: Mixed Bottomland Hardwood Forest (38%), Grasses (29%), Mixed Post Oak Forest (17%), and Other (16%).[13]

5.8.2.4.2 Fish and Wildlife

The result of the potential George Parkhouse I reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential George Parkhouse I reservoir is located within the Prairies and Lakes Eco-region. Some of the common wildlife in this region includes the plains pocket gopher, beaver, raccoon, porcupine, Texas kangaroo rat, hispid cotton rat, ornate box turtle, green-winged teal, bobwhite quail, red-shouldered hawk, scissortail flycatcher, white-tailed deer, Brazilian freetail bat, ringtail, nine-banded armadillo, eastern hognose snake, tarantula, Texas horned lizard, golden cheeked warbler, black-capped vireo, northern mockingbird, and guadelupe bass. [14]

5.8.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.8-8). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Table 5.8-8 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Delta and Hopkins counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Rough-stem aster	*Aster puniceus* ssp. *Eliotti* var. *scabricaulis*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Delta and Hopkins Counties, 1999.)

5.8.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential George Parkhouse I reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.8.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows two hydric soil associations are within the potential George Parkhouse I reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.8.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential George Parkhouse I reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.8.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential George Parkhouse I reservoir is located within the Sulphur River basin, which represents approximately 15% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-County study area. There are no USFWS designated priority bottomland hardwoods located within or adjacent to the potential George Parkhouse I reservoir.[15] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.8.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no consevation easements located within the footprint of the potential George Parkhouse I reservoir.

5.8.2.10 Social and Economic Conditions

The potential reservoir is located in Delta and Hopkins counties. The population of Delta County according to the 1990 Census is 4,857 and 28,833 for Hopkins County. The Texas State Data Center has estimated the 2020 population to be 4,564 for Delta County and 31,612 for Hopkins County.[16] The median household income for Delta County in 1989 was $20,208 and $20,771 for Hopkins County.[17]

5.8.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential George Parkhouse I reservoir will affect portions of Delta and Hopkins counties.

Historical and Archeological Resources for the two county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.8-9.[19]

Table 5.8-9 Historical and Archeological Resources for George Parkhouse I.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Delta	32	1	5	25	NA	1
Hopkins	16	1	12	NA	1	2

Source: THC Texas Historic Atlas Site, April 2000.

Table 5.8-10) details the results of previous cultural studies that have been performed on the area since 1879. Although Delta County has been investigated more thoroughly than other counties for cultural resources due to federal mandated cultural surveys, there is the potential for additional archeological resources to be discovered due to the construction of the potential reservoir. There is an even greater potential for archeological sites to be discovered in counties that have not been excessively studied, such as Hopkins county.[18]

This Space Intentionally Left Blank

Table 5.8-10. Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Delta**	42	49	15	8	114
Hopkins**	41	62	22	9	134
Sub-total	83	113	37	17	248

* Significance refers to National Register criteria.
** Does not include all of Cooper Lake
Source : THC, 1993.

5.8.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.8-11.

Table 5.8-11 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.8-12 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.8-12 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Delta			6	9	1
Hopkins		1	10	7	3

Source: THC, 1993, and Perttula T. K., 1999.[19]

5.8.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that

have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.8.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.8-13 depicts the percent coverage by major land uses within the reservoir study area.[20]

Table 5.8-13 Land Use for the Potential George Parkhouse I Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	78%
Deciduous Forest Land	21%
Other	1%

5.8.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites, municipal solid waste landfill sites,... within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are no Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[21]

5.8.2.14 Potential Environmental Impact Summary

Table 5.8-14 Potential Environmental Impact Summary for George Parkhouse I.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown

[1] Freese and Nichols and Turner, Collie and Braden. 2000.

[2] Freese and Nichols, Inc. *Preliminary Study of Sources of Additional Water Supply, Volume 1 – Report, Volume 2 – Apendices*. North Texas Municipal Water District. 1996.

[3] R.T.Saucier, U.S. Army Engineer Waterways Experiment Station, Corps of Engineers, Geological Reconnaissance of the Sulphur River and Cypress Creek Basins, Texas, November, 1967.

[4] United States Department of the Interior, Bureau of Reclamation, Texas Big Sandy Study, Supporting Material, Volume A, Engineering and Geology, July, 1990.

[5] U.S. Army Corps of Engineers (USACE). Geological Reconnaissance of the Sulphur River and Cypress Creek Basins, Texas. November 1967.

---

[6] Freese and Nichols, Inc., and Alan Plummer and Associates, Inc. Regional Water Supply Plan. Volume One – Report, and Volume Two – Appendices, Tarrant County Water Control and Improvement District Number One. 1990.

[7] Texas Water Development Board. Water for Texas. August 1997.

[8] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[9]. Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96*. Austin, Texas. TNRCC.

[10] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan*. Austin, Texas. TWDB.

[11] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[12] Gould, F. W. 1975. Texas Plants: Aa Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[13] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[14] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[15] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[16] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[17] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[18] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[19] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[20] www.tnris.state.tx.us

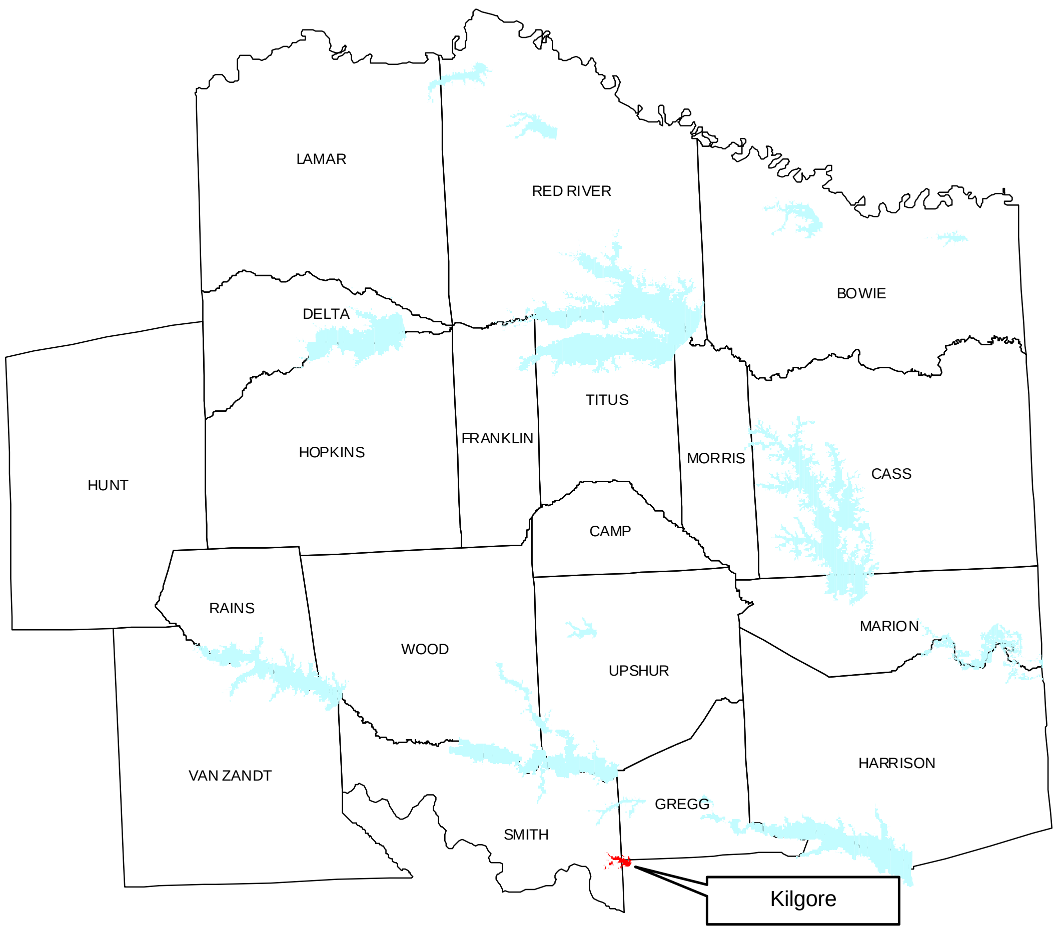
[21] www.tnris.state.tx.us

5.9 KILGORE

5.9.1 Summary of Prior Studies

5.9.1.1 Location

Figure 5.9-1 Location of Kilgore within the Region D Planning Region



The Kilgore Reservoir Dam is located on the upper Wilds Creek near Kilgore, Texas. This is part of the Sabine River Basin above the Toledo Bend Reservoir and within Rusk, Gregg and Smith Counties *(See Appendix, Exhibit A, Vicinity Map).*

5.9.1.2 Impoundment Size and Volume

With a conservation pool Elevation of 398 ft msl, the reservoir will have a storage of 16,270 acre-ft, a surface area of 817 acres and a supply yield of 5,500 ac-ft/yr.[1]

5.9.1.3 Site Geology and Topography

Basin soils consist of the Black land Prairie, East Texas Timberland, and Coastal Prairie types. Higher erosion susceptibility due to their sloping nature and clay texture has caused greater sediment production rates, a matter to be taken into consideration for reservoir operation analyses.[2]

Tertiary deposits of poorly consolidated sandstone, clay, and shale are the majority of the soils located within the study area. The two major groups are the Claiborne and Wilcox. The rocks forming the Wilcox Group were deposited about 52 million years ago and have two main formations which contain sandstone, shale and lignite. The rocks of the younger Clairborne Group were deposited from about 48 to 43 million years ago. Eight formations make up the Clairborne Group, two of which, the Carrizo and Queen City, are important aquifers for the region.[3] The Carrizo-Wilcox aquifer is by far the best supply of good quality water.

5.9.1.4 Dam Type and Size

No information on the dam type and size available from previous studies.

5.9.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the Kilgore damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.9.1.6 Reservoir Inflows

A period of record from January 1941 through December 1979 from USGS recording gauges throughout the study area was used to estimate reservoir inflows on a monthly basis. Adjustments for depletions of flow were made for known historic reservoir operation studies in which only reservoirs with a capacity of 5,000 ac-ft or greater were considered.[4] Adjustments for land treatment measures, farm ponds and minor reservoirs, floodwater-retarding structures and urbanization when determining natural runoff estimates.

The Kilgore Reservoir encompasses a drainage area of 13 square miles. Data for the hydrologic studies of the reservoir inflows was obtained from the USGS Water Data Storage and Retrieval System (WATSTORE) in Reston, Virginia. Monthly streamflow records from the existing gaugess within the Sabine Watershed were used to estimate natural inflows. Naturalized streamflows represent streamflow conditions without man-made effects. A computer simulation model accounted for the effects of upstream reservoirs and water demands.[5]

5.9.1.6.1 Lake Evaporation

A period of record from January 1941 through December 1979 for the area of interest from the National Weather Service precipitation/evaporation stations throughout the study area are used to estimate net lake evaporation. Adjustments are made using contour maps broken into quadrangles.[6]

5.9.1.6.2 Sediment Volume

Data for suspended sediment load of Texas streambeds was obtained from TDWR and USGS. Suspended-sediment rating curves and flow-duration curves were used to estimate sediment volume where an assumed unit weight of 70 lb/cf for particle size was used.[4]

5.9.1.6.3 Area Capacity Data

The elevation-area-capacity relationship (also referred to as area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. The relationship is based upon existing conditions taken from USGS quad map topography of the land to be inundated by the reservoir. [4]

5.9.1.6.4 Pass-Through Flows for Downstream Maintenance

Minimum discharge is important to protect downstream environmental requirements. Minimum streamflows will need to be determined to sustain aquatic habitat as specified by the environmental mitigation plan.[3] Higher flows will be released for short periods during historic low flow periods.

5.9.1.7 Water Quality

Water from the Carrizo-Wilcox aquifer is generally good; however, corrosive water with high iron content can occur within the northeastern part of the aquifer. [7]

No known water quality issue specifically for the Kilgore reservoir site exist.[2] Potential for mineral development to impact water quality does exist for the Sabine River Basin. Dissolved metals such as selenium, aluminum, silver and mercury have been detected in the past near mining operations.[2] Historical water data in the basin shows instances of exceedence with chloride, sulfate, fecal coliform, pH and dissolved oxygen. However, standards are not necessarily violated if the levels return to below limits, or above the limit in the case of dissolved oxygen, within a pre-determined amount of time.[8]

5.9.1.8 Project Yield for Water Supply

The project firm yield is 5,500 ac-ft/yr.

5.9.1.8.1 Water Rights

Of the Upper and Lower Sabine Basin, the majority of the existing water rights exist in the upper basin, totaling 163 just in the area between Toledo Bend reservoir and Lake Fork and Iron Bridge Dams. The total permitted water rights for the upper Sabine Basin amount to approximately 723,000 ac-ft/yr.[2] This is the area of highest demand, and even the currently unused rights in the area will not be made available as they are being saved for future use.

5.9.1.9 Other Potential Benefits

Potential benefits associated with construction of the Kilgore Reservoir include water supply and recreation such as swimming and fishing. Hydropower to supplement growing energy needs may also be applicable.[1]

Environmental mitigation studies were never performed for the Kilgore site when it never moved beyond preliminary analyses that indicated priority bottomland hardwoods are not in the area impacted.[2]

5.9.1.10 Land Acquisition and Easement Requirements

No known active lignite mines exist in the area.[2]

5.9.1.10.1 Local, State and Federal Permitting Requirements

Among the permitting requirements for water resource projects are environmental rules. Those rules that may apply are listed in the following Table 5.9-1. [2]

Table 5.9-1 Major Permitting Requirements

Permit	*Issuing Agency*	*Summary of Requirements*
Section 404 Permit, Clean Water Act of 1972	U.S. Army Corps of Engineers (COE)	Applicable to all new dams in the United States because they add new dredge or fill material to U.S. waters.
Section 10 Permit, Rivers & Harbors Act of 1899	U.S. Army Corps of Engineers	Usually applied for in conjunction with Section 404. Congressional approval required for construction of obstructions on navigable waters.
Section 7 Consultation & Section 10 Permit	U.S. Department of the Interior, Fish & Wildlife Service (USFWS)	Required for the incidental taking of endangered or threatened species. Mitigation is also generally a requirement as a condition of the permit.
Water Rights Permit	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone wanting to divert, use or store surface waters, or transfer surface water between basins. Includes environmental, hydrologic and conservation assessments.
Section 401 Certification, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Certification that projects obtaining a 404 permit will not degrade water quality below state standards.
TPDEX Discharge Permit, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone who discharges wastewater into the Sabine Basin.
Grant of Easement	Texas General Land Office	Requirement for projects that cross or impact state owned waterways.

5.9.1.11 Updated Project Costs

Original cost estimates were not listed from which to estimate an update.

5.9.2 Environmental Overview –Affected Environment and Environmental Consequences

5.9.2.1 Geological Elements

5.9.2.1.1 Physiography

The potential reservoir is located within the Pineywoods vegetative region of Texas. The Pineywoods vegetative region is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods vegetative region lies entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods vegetative region. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dallisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

5.9.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in Northeast Texas. For the past 60 million years, the northeast Texas region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River Counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[9]

5.9.2.1.3 Soils

The area of the potential reservoir contains two major soil groups: Bowie-Cuthbert-Kirvin and Libert-Darco-Briley.[9] Approximately 76.9 percent of the area is Bowie-Cuthbert-Kirvin and 23.1 percent of the area is Libert-Darco-Briley. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Bowie

The Bowie series consists of very deep, well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain deposits. These soils are on broad very gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The climate is humid; mean annual precipitation ranges from 40 to 50 inches; and mean annual temperature from 64 to 69 degrees F. The Thornthwaite annual P.E. index exceeds 64. The frost-free days range from 220 to 250. Elevation ranges from 150 to 600 feet above msl. Runoff is low on 1 to 3 percent slopes, medium on 3 to 5 percent slopes, and high on 5 to 8 percent slopes. A perched water table is at a depth of 3.5 to 5 feet during winter and early spring in most years. The principal use is for pasture and forest. Some areas are used for growing corn, peanuts, sweet potatoes, peaches, watermelons and other vegetables or fruit crops. Pasture is mainly bermudagrass or bahiagrass. Forests consists of loblolly and shortleaf pines, sweetgum, red oak, and hickory trees with tall and midgrasses.

Briley

The Briley series consists of very deep, sandy, well-drained, moderately permeable soils that formed in sandy and loamy Coastal Plain sediments. These soils are on gently sloping to moderately steep broad interstream divides. Slopes are dominantly 2 to 5 percent, but range from 1 to 20 percent. Mean annual rainfall ranges from 40 to 48 inches and is evenly distributed throughout the year. Frost-free days range from 240 to 275 days and elevation ranges from 350 to 600 feet above msl. Mean annual temperature ranges from 64 degrees to 69 degrees F., and the Thornthwaite P-E index exceeds 64. The soil type is used mainly for woodlands of loblolly and shortleaf pine and for pastures of improved bermudagrass.

Cuthbert

The Cuthbert series consists of soils that are moderately deep to weakly consolidated sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on strongly sloping to steep uplands. Slopes are dominantly 8 to 25 percent, but range from 5 to 40 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 56 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 750 feet above msl. Mean annual temperature ranges from 63 to 67 degrees F, and Thornthwaite annual P-E indexes exceed 64. Runoff is medium for slopes of 5 to 20 percent and high for slopes greater than 20 percent. Cuthbert soils are used mainly for woodland and pastureland. The principal trees are shortleaf and loblolly pine, red oak, sweetgum, and other hardwoods. Pastures include common and improved bermudagrass, bahiagrass, and weeping lovegrass.

Darco

The Darco series consists of very deep, somewhat excessively drained, moderately permeable soils that formed in sandy and loamy deposits on uplands. It is gently sloping to steep and slopes range from 1 to 25 percent. The climate is warm and humid. The average annual rainfall ranges from 40 to 50 inches. Frost-free days range from 230 to 260. Elevation ranges from 400 to 700 feet above msl. The frost-free rainfall ranges from 25 to 30 inches. The mean annual temperature ranges from 63 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 84. Runoff is negligible on 1 to 3 percent slopes, very low on 3 to 5 percent slopes, low on 5 to 20 percent slopes, and medium on slopes greater than 20 percent. Most of the soil is used for pasture or woodland. Pastures are mainly in coastal bermudagrass or weeping lovegrass. Native trees include loblolly pine, shortleaf pine, red oak, and hickory. Watermelons, peanuts, small grain for grazing, and vegetables are grown in some areas.

Kirvin

The Kirvin series consists of soils that are deep to stratified sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on gently sloping to moderately steep convex uplands. Slope is dominantly 2 to 8 percent, but ranges from 1 to 15 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 48 inches, with frost-free rainfall of 25 to 30 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 650 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. Runoff is very low on 1 to 3 percent slopes, low on 3 to 5 percent slopes, and medium on 5 to 15 percent slopes. Principal use is for pastureland and woodland. Bermudagrass is the main pasture grass. Forests are of shortleaf, slash, and loblolly pine, red oak, sweetgum, and other hardwood trees. A few areas are used for growing truck crops, cotton, corn, and oats.

Lilbert

The Lilbert series consists of very deep, well-drained, moderately slowly permeable soils. These soils formed in sandy and loamy deposits on uplands. Water runs off the surface slowly. Slopes range from 1 to 8 percent. A perched water table may occur in late winter to early spring from 3 to 6 feet below the soil surface. Average annual temperature ranges from 64 to 69 degrees F., the mean annual precipitation ranges from 40 to 50 inches. Frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 240 to 275. Elevation ranges from 350 to 600 feet above msl. The Thornthwaite P-E index is 66 to about 80. Runoff is slow. The areas where this soil type occurs are used mainly for woodland and pasture. However, some areas are used for cropland. Native vegetation consists of loblolly pine, shortleaf pine, hickory, sweetgum, red oak, and other hardwoods.

5.9.2.2 Hydrological Elements

5.9.2.2.1 Surface Water

The potential reservoir is located on the Sabine River. . This portion of the Sabine River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0506 (Sabine River below Lake Tawakoni). This 118-mile segment originates from a point 110 yards downstream of US 271 in Gregg County to Iron Bridge Dam in Rains County. This segment is classified as "effluent limited" and designated uses are for contact recreation, high aquatic life, and public water supply. Elevated levels of orthophosphorus are a concern in the lower 25 miles of the segment.[10]

5.9.2.2.2 Ground Water

The potential reservoir is located in both Gregg and Smith Counties. This is within both the Carrizo-Wilcox Aquifer and the Queen City Aquifer. The potential reservoir is located in the outcrop region of the Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeastern part of the aquifer.

This aquifer extends in a band across most of the state from the Frio River in south Texas northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson County. Total pumpage for all uses in 1994 was 16,319 ac-ft.

The potential reservoir is also within the Queen City Aquifer. Sand, loosely cemented sandstone, and interbeded clay units of the Queen City Formation of the Tertiary Claiborne Group make up the aquifer as delineated within Texas. These rocks dip gently to the south and southeast toward the Gulf Coast. Although total aquifer thickness is usually less than 500 feet, it can approach 700 feet in some areas of northeast Texas. In the outcrop area, water occurs under water-table conditions while in the downdip subsurface, where the Queen City is covered by younger, non water-bearing rocks, the water is under artesian conditions. Usable quality water is generally found within the outcrop and for a few miles downdip, but in some areas it may occur down to depths of approximately 2,000 feet. Yields of individual wells are commonly low, but exceed 400 gal/min.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent however, quality deteriorates with depth in the downdip direction. The water may have high acidity (low pH) in much of northeast Texas and relatively high iron concentrations in localized areas. Hydrogen sulfide gas is sometimes present. Fortunately, each of these naturally occurring conditions may be treated relatively easily and economically.

While large amounts of usable quality groundwater are contained within the rocks of the Queen City, yields are low. Estimates of the availability of water from the Queen City Aquifer are based on recharge to the aquifer. Because of differences in topography, vegetative cover, and other factors, only two percent of the annual rainfall is estimated recharge in the Trinity, Colorado, Guadelupe, San Antonio and Neches River basins. Approximately five percent is estimated recharge in the Neches, Sulphur, Sabine, and Cypress Creek Basins. Total annual effective recharge to the aquifer is estimated to be 682,100 ac-ft.[11]

5.9.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Kilgore reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Kilgore reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.9.2.4 Biological Elements

5.9.2.4.1 Vegetation

The potential Kilgore reservoir is centrally located within the Austroriparian province[12] and is within the Pineywoods region.[13] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region.

Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Kilgore reservoir location include Pine Hardwood (62%) and other (38%).

5.9.2.4.2 Fish and Wildlife

The result of the potential Kilgore reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Kilgore reservoir is located in the Pineywoods Eco-region of Texas. Some of the common wildlife in this region includes southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed, deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter.[14]

5.9.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.9-2). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Table 5.9-2 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Gregg and Smith Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Western Sand Darter	*Etheostoma clarum*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*		T
Southeastern Myotis	*Myotis austroriparius*		R
Mollusks			
Ouachita rock-pocketbook mussel	*Arkansia wheeleri*	LE	E
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Louisiana Pine Snake	*Pituophis melanoleucus ruthveni*	C1	T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Rough-stem aster	*Aster puniceus* ssp. *Eliotti* var. *scabricaulis*		R
Texas Trillium	*Trillium pusillum* var. *texanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status

** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.

LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)

LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)

C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened

E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance

DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Gregg and Smith Counties, 1999.)

5.9.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.9.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows there are no hydric soil associations within the potential Kilgore reservoir footprint.

5.9.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Kilgore reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.9.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state.

The potential Kilgore reservoir is located within the Sabine River basin, which represents approximately 22% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;

- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-County study area. There are no USFWS designated priority bottomland hardwoods located within or adjacent to the potential reservoir.[15] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.9.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within the footprint of the potential Kilgore reservoir.

5.9.2.10 Social and Economic Conditions

The potential reservoir is located in both Gregg and Smith Counties. The population of these counties according to the 1990 Census is 104,948 and 151,309, respectively. The Texas State Data Center has estimated the 2020 population to be approximately 126,613 for Gregg County and 203,158 for Smith County. This corresponds to a 20.6 percent and 60.4 percent increase for Gregg and Smith Counties.[16] The medium household income in 1989 for Gregg County is $25,484 and Smith County $25,769.[17]

5.9.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Kilgore reservoir will affect portions of Gregg and Smith counties.

Historical and Archeological Resources for the two county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.9-3.[19]

Table 5.9-3 Historical and Archeological Resources for Kilgore.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Gregg	175	1	87	78	4	5
Smith	98	0	85	0	9	4

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.9-4) details the results of previous cultural studies that have been performed on the area since 1879. Some counties have been investigated more thoroughly than the other counties for cultural resources. This is important to note because there is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Gregg and Smith counties.[18]

Table 5.9-4 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Gregg	4	19	13	4	40
Smith	9	78	36	17	140
Sub-total	13	97	49	21	180

* Significance refers to National Register criteria.
Source: THC, 1993.

5.9.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.9-5.

Table 5.9-5 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.9-6 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.9-6 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Gregg			1	4	7
Smith				16	13

Source: THC, 1993, and Perttula T. K., 1999.[19]

5.9.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.9.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.9-7 depicts the percent coverage by major land uses within the reservoir study area.[20]

Table 5.9-7 Land Use for the Potential Kilgore Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	33%
Deciduous Forest Land	1%
Mixed Forest Land	63%
Evergreen Forest Land	2%
Residential	1%
Other	1%

5.9.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites and municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are no Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[21]

5.9.2.14 Potential Environmental Impact Summary

Table 5.9-8 Potential Environmental Impact Summary for Kilgore.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown

---

[1] Freese and Nichols, Inc. Comprehensive Sabine Watershed Management Plan, Technical Memorandum Task 17 – Surface Water Projects Issues, Preliminary Screening of Previously Proposed Projects. February, 1999.

[2] Freese and Nichols, Inc. Comprehensive Sabine Watershed Management Plan. December, 1999.

[3] U.S. Department of the Interior – Bureau of Reclamation. Report on the Texas Big Sandy Study, Executive Summery. April, 1991.

[4] U.S. Department of the Interior – Bureau of Reclamation. Texas Big Sandy Supporting Materials, vol. E-Hydrology. July, 1990.

[5] U.S. Army Corps of Engineers, Fort Worth District, Big Sandy Lake General Design Information, 1980-1985.

[6] Espey, Huston & Associates, Inc. and Tudor Engineering Company. Update of the Master Plan for the Sabine River and Tributaries in Texas. Hydrology Appendix. March, 1985.

[7] U.S. Army Corps of Engineers, Fort Worth District, Big Sandy Lake Stage 2 Documentation Report, Design Memorandum MO. 1, General-Phase 1, Plan Formulation. February, 1981.

[8] Espey, Huston & Associates, Inc. and Tudor Engineering Company. Update of the Master Plan for the Sabine River and Tributaries in Texas. Report. March, 1985.

[9] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[10] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96.* Austin, Texas. TNRCC.

[11] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan.* Austin, Texas. TWDB.

[12] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[13] Gould, F. W. 1975. Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[14] Bauer, Frye, and Spain. 1991. A Natural Resource Survey for Proposed Reservoir Sites and Selected Stream Segments in Texas, prepared for TWDB, August.

[15] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[16] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[17]

[18] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[19] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[20] www.tnris.state.tx.us

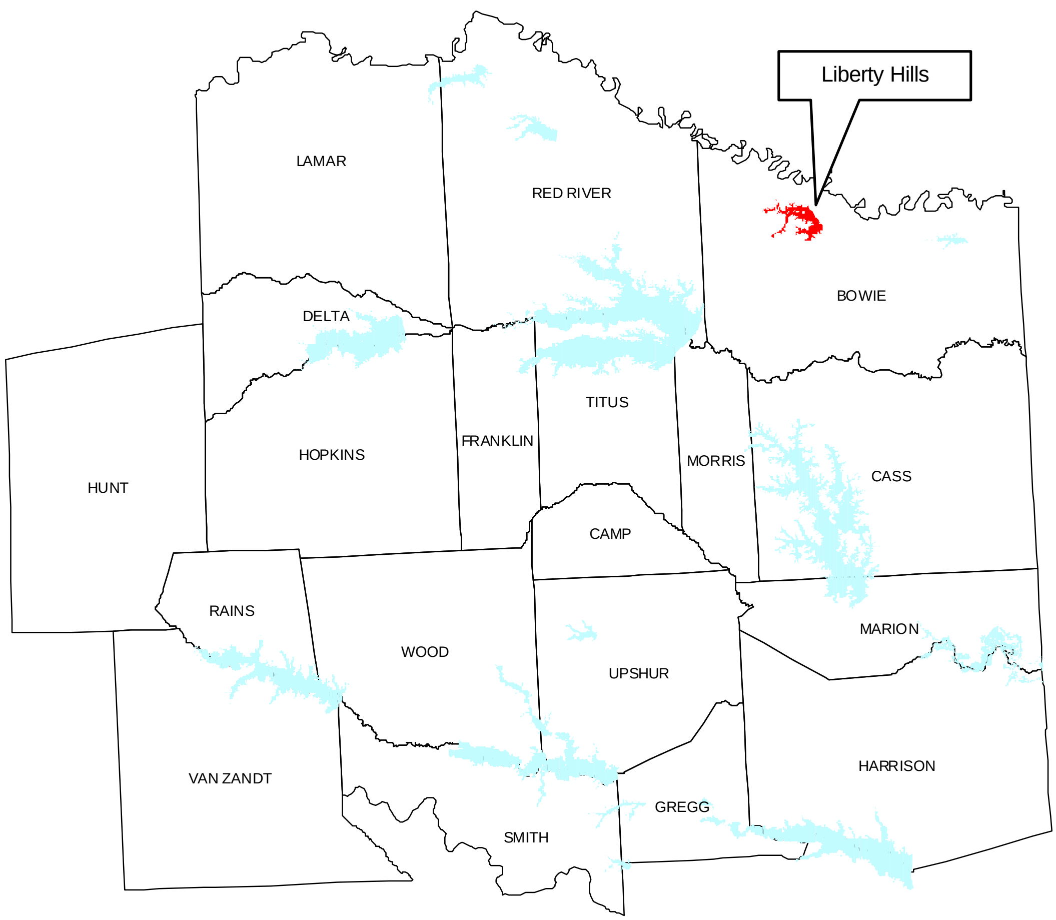
[21] www.tnris.state.tx.us

5.10 LIBERTY HILLS

5.10.1 Summary of Prior Studies

5.10.1.1 Location

Figure 5.10-1 Location of Liberty Hills within the Region D Planning Region



The preferred alternative was similar to alternative 3 presented in the statement of findings prepared in 1975 by the District Engineer.[1] This alternative would be a multi-purpose lake about three miles upstream of the authorized site, near the Davenport Road crossing at river mile 7.8 *(See Appendix, Exhibit A, Vicinity Map).*

5.10.1.2 Impoundment Size and Volume

The land requirement for the project is approximately 6,622 acres based on measurement from delineation of the approximate footprint on USGS Quadrangle maps.

5.10.1.3 Site Geology and Topography

No information on geology and topography was provided for the Liberty Hills Reservoir area.

5.10.1.4 Dam Type and Size

No information on dam type and size was available from previous studies.

5.10.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to Liberty Hills damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.10.1.6 Water Quality

No information on water quality was available from previous studies of the potential Liberty Hills Reservoir.

5.10.1.7 Project Yield for Water Supply

No information on project yield for water supply was available from previous studies of the potential Liberty Hills Reservoir.

5.10.1.8 Other Potential Benefits

No information on other potential benefits was available from previous studies of the potential Liberty Hills Reservoir.

5.10.1.9 Land Acquisition and Easement Requirements

No information on land acquisition and easement requirements were available from previous studies of the potential Liberty Hills Reservoir.

5.10.1.9.1 Potential Land Use Conflicts

No information on potential land use conflicts was available from previous studies of the potential Liberty Hills Reservoir.

5.10.1.10 Project Costs

No information on project costs was available from previous studies of the potential Liberty Hills Reservoir.

5.10.2 Environmental Overview –Affected Environment and Environmental Consequences

5.10.2.1 Geological Elements

5.10.2.1.1 Physiography

The potential Liberty Hills reservoir is located in the Post Oak Savannah vegetative region. The Post Oak Savannah vegetative region covers approximately 6.85 million acres of land. It averages 30-45 inches of precipitation annual with 235 to 280 frost-free days. The topography is nearly level to gently rolling with an elevation of 300-800 feet above msl. The Post Oak Savannah vegetative region lies just to the west of the Pineywoods vegetative region and mixes considerably with the Blackland Prairies vegetative region in the south. The Post Oak Savannah vegetative region, is a gently rolling, moderately dissected wooded plain.

Upland soils are gray, slightly acid sandy loams commonly shallow over gray, mottled or red, firm clayey subsoils. They are generally droughty and have claypans at varying depth, restricting moisture percolation. The bottomland soils are reddish brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial. Short oak trees occur in association with tallgrasses. Thicketization occurs in the absence of recurring fires or other methods of woody plant suppression.[2]

5.10.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River Counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[3]

5.10.2.1.3 Soils

The area of the potential reservoir, Liberty Hills, contains eight major soil groups.[9] These groups are Sawyer-Eyalu-Sacul, Whakana-Vesey-Ruston, and Wrightsville-Mckamie-Ruston. Approximately 19.8 percent of the area is Sayer-Eylau-Sacul group, 51.9 percent Whakana-Vesey-Ruston, and 28.3 Wrightsville-Mckamie-Ruston. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Eylau

The Eylau series consists of deep, moderately well-drained, moderately slowly permeable soils that formed in thick loamy Coastal Plain sediments on uplands. Slopes are dominantly 1 to 2 percent but range from 0 to 5 percent. Mean annual precipitation ranges from 45 to 55 inches. Mean annual temperature ranges from 64 degrees to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64 inches. A perched water table is at 2 to 3 feet below the surface from February to May. Most of the acreage is in improved pasture of bermudagrass, bahiagrass, dallisgrass, and pine-oak woodland. A few areas are used for cropland. Native vegetation consists of loblolly pine, southern red oak, sweetgum, post oak, hickory, beaked panicum, longleaf uniola, and annuals.

McKamie

The McKamie series consists of deep, well-drained, very slowly permeable soils that formed in clayey alluvial sediments on Pleistocene age stream terraces. These soils are on broad gently sloping to strongly sloping coastal plains. Slope is dominantly 1 to 8 percent but ranges up to 20 percent near escarpments adjacent to drainageways. Climate is warm and humid, mean annual precipitation is 48 inches, and mean annual temperature is 64 degrees F near the type location. A small part is used for growing crops and pasture. Most of the soil is in forest. The associated Forest plantations are mostly of pine.

Ruston

The Ruston series consists of very deep, well-drained, moderately permeable soils that formed in loamy marine or stream deposits on uplands of the Western and Southern Coastal Plains. These soils are on nearly level to moderately sloping uplands of the Western and Southern Coastal Plains on slope gradients of 0 to 8 percent. The climate is warm and humid with mean annual temperature of 65 degrees F., and mean annual precipitation of 59 inches near the type location. Principal use is woodland consisting of southern pine and some hardwoods with understories of shrubs or grasses. A small acreage is used for cotton, corn, soybeans, small grain, truck crops, and pasture. A considerable portion of the acreage formerly cultivated has been converted to pasture or southern pine woodland.

Sacul

The Sacul series consists of very deep, moderately well-drained, slowly permeable soils that formed in acid, loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 2 to 25 percent but range from 1 to 40 percent. The average annual air temperature ranges from about 60 to 66 degrees F and the average annual precipitation ranges from about 48 to 54 inches. Most of the acreage is in woodland, with some area in pasture. The forest vegetation is shortleaf and loblolly pine, red oak, sweetgum, and dogwood. Bermudagrass and bahiagrass are the principal pasture grasses used.

Sawyer

The Sawyer series consists of very deep, moderately well-drained, slowly permeable soils that formed in loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 1 to 8 percent but range to 25 percent. The average annual temperature ranges from about 60 to 66 degrees F. and the average annual precipitation ranges from about 48 to 54 inches. Most areas of this soil are in forests of loblolly and shortleaf pine. Cleared areas are dominantly used for pasture. The native vegetation was mixed shortleaf pine and hardwood forest.

Vesey

The Vesey series consists of deep, well-drained, moderately permeable soils on uplands and high stream terraces in loamy fluvial and marine sediments. Slopes are mainly 1to 5 percent, but range to 20 percent. At the type location, the average temperature is about 65 degrees F.; the mean annual rainfall is about 45 inches; and the Thornthwaite P-E index is about 76. Most of this soil is used for woodland and pasture. A few areas are used for growing corn, grain sorghum, soybeans, and watermelons. Native vegetation is mixed pine and hardwood forest that include shortleaf and loblolly pine, red oak, sweetgum, and post oak.

Whakana

The Whakana series consists of deep well-drained, moderately permeable soils on high terraces along the Red River formed in loamy alluvium. Slopes range from 0 to 20 percent but are mainly less than 5 percent. This soil is used mainly for pasture. A few areas are planted to corn and soybeans and a few areas are woodland. Native vegetation is hardwood and pine forest consisting of loblolly and shortleaf pine, red oak, sweetgum, and post oak with indiangrass, big bluestemgrass, little bluestemgrass, pinehill bluestemgrass, and longleaf uniola.

Wrightsville

The Wrightsville series consists of very deep, poorly drained, very slowly permeable soils that formed in old silty and clayey alluvium. These soils are on level to depressional areas on old stream terraces. Slopes are less than 1 percent. Mean annual temperature is 62 degrees F., and mean annual precipitation is 46 inches. Mean annual temperature ranges from 60 degrees to 65 degrees F., and the mean annual precipitation ranges from 44 to 52 inches. This soil has a seasonal perched water table. Most of these soils are in forest or pasture. Some areas are used for rice, soybeans, and cotton. Native trees are sweetgum, water oak, and willow oak.

5.10.2.2 Hydrological Elements

5.10.2.2.1 Surface Water

The potential reservoir is located within the Red River Basin on Mud Creek. Mud Creek drains into the Red River. This portion of the Red River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 202 (Red River below Lake Texoma). This 194-mile segment originates from the Arkansas-Oklahoma State Line in Bowie county to Denison Dam in Grayson county. This segment is classified as "water quality limited" and designated uses are for contact recreation, high aquatic life, and public water supply. No water quality problems are known to exist in this segment.[4]

5.10.2.2.2 Ground Water

Bowie county is located within the Nacatoch Aquifer. The Nacotoch Aquifer occurs in a narrow band in northeast Texas and extends eastward into Arkansas and Louisiana. Pumpagefrom the aquifer totaled 3,484 acre-feet in 1994, 74 percent which was used for municipal purposes.

The Nacatoch Formation, composed of one to three sequences of sands separated by impermeable layers of mudstone or clay, was deposited in the East Texas basin during the Cretaceous Period. The aquifer also includes a hydrologically connected mantle of alluvium up to 80 feet thick where is covers the Nacatoch along major drainage ways. The south and east baasinward dip of the formation is interrupted by the Mexia-Talco fault zone, which alters the normal flow direction and adversely affects the chemical quality of the groundwater. Groundwater in this aquifer is usually under artesian conditions except in shallow wells on the outcrop where water-table conditions exist.

The quality of groundwater in the aquifer is generally alkaline, high in sodium bicarbonate, and soft. Dissolved-solids concentrations increase in the downdip portion of the aquifer and are significantly higher downdip of faults. In areas where the Nacatoch occurs as multiple sand layers, the upper layer contains the best-quality water. The water quality is generally acceptable for most uses, however, the high degree of mineralization precludes its use for irrigation in some areas.

Annual availability, equivalent to annual effective recharge, for the Nacatoch Aquifer is estimated to be 3,030 acre-feet. Recharge to the aquifer occurs mainly from precipitation on the outcrop. Aquifer water levels have been significantly lowered in some areas as a result of pumpage exceeding the effective recharge.[5]

5.10.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Liberty Hills reservoir will cause water to be impounded on Mud Creek as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the Liberty Hills reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.10.2.4 Biological Elements

5.10.2.4.1 Vegetation

The potential Liberty Hills reservoir is centrally located within the Austroriparian province[6] and is within the Post Oak Savannah region.[7] The Post Oak Savannah vegetation area typically has a gently rolling to hilly topography, with moderately dissected wooded plain. The soil composition for this community consists of gray, slightly acidic sandy loams, and reddish brown to dark gray, slightly acidic to calcareous, loamy to clayey alluvial. The Post Oak Savannah soils support short oak trees and tallgrasses. Trees in the region consist of post oak and blackjack oak, elms, junipers, hackberries, and hickories. Yaupon, American beautyberry, coralberry, greenbriar, and grapes are shrubs and vines that are characteristic to the area. Grasses in the area includes little bluestem, indiangrass, switchgrass, silver bluestem, Texas wintergrass, purpletop, narrowleaf wildoats, beaked panicum, brownseed paspalum, threeawn, broomsedge bluestem, splitbeard bluestem, rosette grasses, and lovegrasses. Forbs in the region consist of wild indigo, indigobrush, sennas, tickclover, lespedeza, prairie-clovers, western ragweed, crotons, and sneezeweeds. There has been some vegetation introduced into the area, including bermudagrass, bahiagrass, weeping lovegrass, and clover.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Liberty Hills reservoir location include Pine Hardwood (55%) and Other (45%).

In accordance to *Water and Wildlife, 1990*, The potential Liberty Hills reservoir contains five cover types within its proposed boundaries. The resource categories are: Grasses (28%), Mixed Bottomland Hardwood Forest (25%), Hardwood-Pine Forest (25%), Pine-Hardwood and Other (4%).[8]

5.10.2.4.2 Fish and Wildlife

The result of the potential Liberty Hills reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Kilgore reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter. [9]

5.10.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists eight birds, three fish, two mammals, three reptiles, and one vascular plant to potentially occur or have habitat within the potential Liberty Hills project location (Table 5.10-1). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.10-1 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Bowie County).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Cerulean Warbler	*Dendroica cerulea*		R
Henslow's Sparrow	*Ammodramus henslowii*		R
Least Tern	*Sterna antillarum***	LE	NL
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Arkansas meadow-rue	*Thalictrum arkansanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status

(Texas Department of Transportation, Annotated County Lists of Rare Species for Bowie County, 1999.)

5.10.2.5 Ecological Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Liberty Hills reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.10.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows one hydric soil association is within the potential Liberty Hills reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.10.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith county. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Liberty Hills reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.10.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-county study area. The potential Liberty Hills reservoir is located within the Red River basin, which represents a negligible quantity of bottomland hardwood in Texas. There are no USFWS designated priority bottomland hardwoods located within or adjacent to the potential reservoir.[10] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.10.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within or adjacent to the footprint of the potential Liberty Hills reservoir.

5.10.2.10 Social and Economic Conditions

The potential reservoir is located in Bowie county. The population of this county according to the 1990 Census is 81,665. The Texas State Data Center has estimated the 2020 population to be approximately 89,105. This corresponds to a nine-percent growth in Bowie county.[11] The median household income for Bowie county in 1989 was $24,237.[12]

5.10.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Liberty Hills reservoir will affect portions of Bowie county.

Historical and Archeological Resources for the area was determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.10-2.[19]

Table 5.10-2 Historical and Archeological Resources for Liberty Hills.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Bowie	155	NA	97	46	11	1

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.10-3) details the results of previous cultural studies that have been performed on the area since 1879. Although Bowie county has been investigated more thoroughly than other counties for cultural resources due to federal mandated cultural surveys, there is a potential for additional archeological sites to be located due to the potentialreservoir construction.[13]

Table 5.10-3 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Bowie	53	126	52	21	252
Sub-total	53	126	52	21	252

* Significance refers to National Register criteria.
Source: THC, 1993.

5.10.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.10-4.

Table 5.10-4 Chronological Framework Northeast Texas Archeological Region.

Period	***Dates***
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.10-5 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.10-5 Archeological Resources with Associated Periods.

County	***Paleoindian***	***Archiac***	***Early Ceramic***	***Formative Caddoan Early Caddoan Middle Caddoan***	***Late Caddoan***
Bowie			11	7	23

Source: THC, 1993, and Perttula T. K., 1999.[14]

5.10.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.10.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.10-6 depicts the percent coverage by major land uses within the reservoir study area.[15]

Table 5.10-6 Land Use for the Potential Liberty Hills Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	47%
Deciduous Forest Land	7%
Mixed Forest Land	38%
Evergreen Forest Land	5%
Reservoirs	1%
Transitional Areas	2%
Other	1%

5.10.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites and municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there is one municipal solid waste landfill sites and no Superfund sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[16]

5.10.2.14 Potential Environmental Impact Summary

Table 5.10-7 Potential Environmental Impact Summary for Liberty Hills.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
1- Municipal Solid Waste Landfill	Moderate

---

[1] Driskill, John G., Colonel, CE, District Engineer. 11 February 1975. *Statement of Findings, Big Pine Lake, Big Pine Creek, Texas*. Alternative 3.

[2]Hatch, Stephan L. , Kancheepuram M. Gandi, and Larry E. Brown. July 1990. *Checklist of the Vascular Plants of Texas*. College Station, Texas: Texas Agricultural Exper. Station.

[3] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[4] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96*. Austin, Texas. TNRCC.

[5] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the Stte Water Plan*. Austin, Texas. TWDB.

[6] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science,* 2:93-117.

[7] Gould, F. W. 1975 Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[8] Frye R. G. and Curtis. 1990. Texas Water and Wildlife, An Assessment of Direct Impacts to Wildlife Habitat from Future Water Development Projects. *Texas Parks and Wildlife Department Report No. PWD-BK-7100-147-5/90*, May.

[9] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[10] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[11] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[12] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[13] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[14] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[15] www.tnris.state.tx.us----Gis

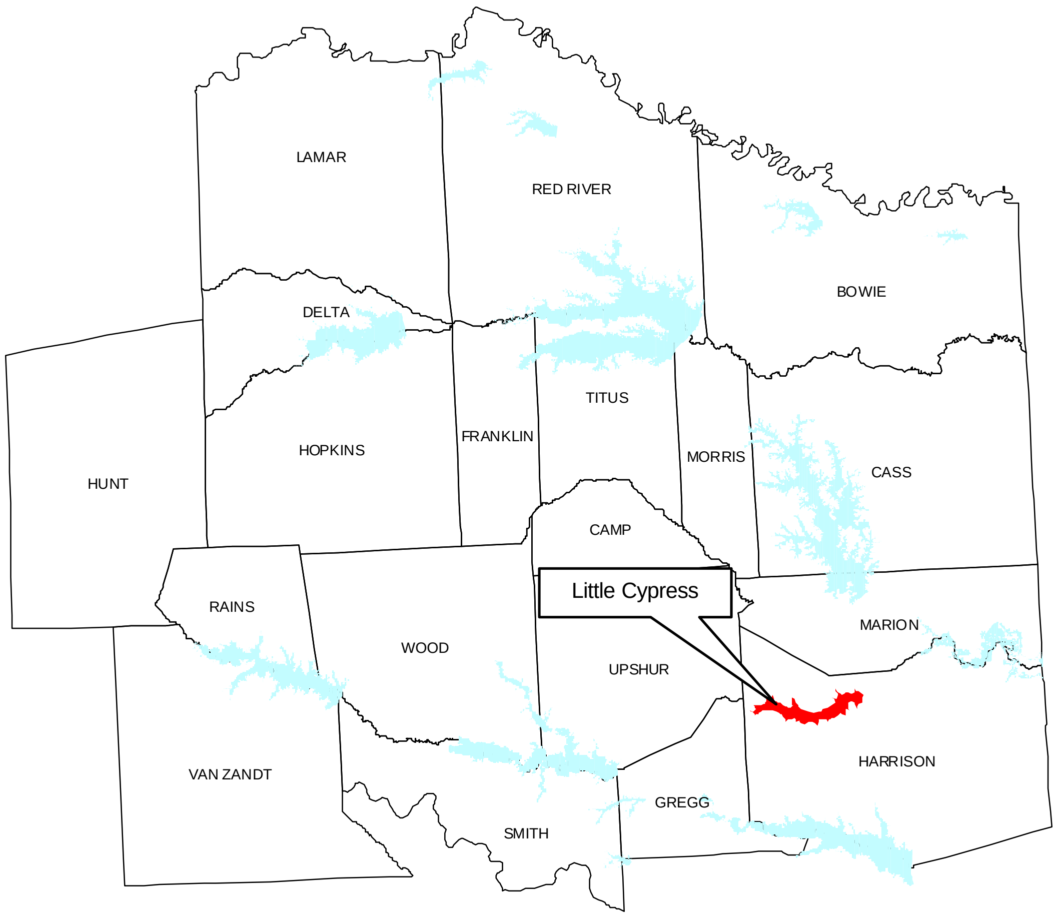
[16] www.tnris.state.tx.us----GIS

5.11 LITTLE CYPRESS

5.11.1 Summary of Prior Studies

5.11.1.1 Location

Figure 5.11-1 Location of Little Cypress within the Region D Planning Region



The Little Cypress Reservoir Dam is located at River Mile 21.3 on the Little Cypress Bayou. This is approximately 9 miles northwest of the City of Marshall[1] in Harrison County *(See Appendix, Exhibit A, Vicinity Map).*

5.11.1.2 Impoundment Size and Volume

With a conservation pool Elevation of 233.1 feet, the reservoir will have storage of 217,324 acre-ft, a surface area of 15,763 acres and a supply yield of 200 cfs. The corresponding approximated sediment storage is 10,800 acre-ft.[1] The maximum design surface water elevation is 252.0 ft msl.

5.11.1.3 Site Geology and Topography

The Cypress Bayou Basin is underlain by southeasterly dipping sand, clay, glauconite and lignite of the Wilcox and Claiborne Groups of the Tertiary age. Most of the Texas iron ore production comes from formations within the basin.[1]

5.11.1.4 Dam Type and Size

The dam crest elevation is 256.5 ft with a maximum design surface water elevation of 252.0 ft msl. The dam is a 58 ft high earth fill dam with a crest length of 7,000 ft and freeboard height of 4.5 ft. Downstream flood damage reduction as well as economic data was considered in the spillway optimization analysis which is based upon a 200 cfs yield. The Little Cypress Reservoir spillway optimizes at the 400 ft crest length. The spillway is an ogee weir type with a crest elevation 233.1 ft. The outlet works has one 10 ft diameter conduit with an invert elevation of 203.0 ft and two 4.5 ft by 10 ft gates.1

5.11.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the Little Cypress damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.11.1.5.1 Water Suppliers

The three major municipal and industrial water suppliers for the Cypress Bayou Basin are the Sulphur Municipal Water District, Northeast Texas Municipal Water District and Sabine River Authority.[2] The SRMWD serves Delta, Hopkins and Hunt counties and owns 26.3 percent of the storage space in Lake Cooper. The NTMWD serves Marion, Upshur, Morris, Cass and Camp counties and owns storage rights in Lake O' the Pines Reservoir. The SRA serves at least in part Rains, Woods, Gregg, Panola, Shelby, Savine, Newton, Orange and Jasper Counties and owns Lake Fork and Lake Tawakoni. Municipal water customers include the Cities of Tyler, Longview, Texarkana, Paris, Marshall and Kilgore.[2]

5.11.1.5.2 Water Needs

Table 5.11-1[2] lists by county up to the year 2040 the projected water needs for the Cypress Bayou Basin.

Table 5.11-1 Water Supply Needs by County (mgd)

County	*1980*	*1990*	*2000*	*2010*	*2020*	*2030*	*2040*
Camp							
Franklin							
Gregg						1.6	15.5
Harrison		1.4	5.9	11.5	18.6	25.3	33.6
Marion							
Morris		3.6	11.5	25.0	35.8	50.0	74.7
Titus							
Upshur			0.7	1.6	2.9	4.0	5.2
Wood							
Totals		**5.0**	**18.1**	**38.1**	**57.3**	**80.9**	**129.0**

5.11.1.5.3 Existing Permits

A total of 91 water rights permits equating 540,058 acre-feet of annual permitted water use exist for Cypress Bayou Basin.[2]

5.11.1.5.4 Reservoir Inflows

The Little Cypress Reservoir encompasses a drainage area of 617 square miles. Reservoir inflows are use in conjunction with area-capacity characteristics of the reservoir site to determine the design flood for the spillway. "The spillway design flood is one-half of the probable maximum flood followed in four days by the probable maximum flood."[3] The "Watershed Runoff Computer Model for Historical and Hypothetical Storm Events" developed by the Southwestern Division was used in a HEC-5 model for all alternatives considered for the Little Cypress Reservoir. The 200 cfs was maintained and dam height was analyzed hydrologically and hydraulically when the optimum spillway crest length was determined in which crest elevation is conservation pool elevation.[1]

5.11.1.5.5 Water Surface Profile

Determination of the hydraulic characteristics used mathematical models of the existing conditions taken from USGS quad map topography, bridge and levee survey supplements, sounding equipment, degradation ranges. Information for the Manning formula came from field investigation, photograph inspection and correlation with recorded gauge data all used in HEC-2 analyses of water surface profiles.[3]

5.11.1.5.6 Pass-Through Flows for Downstream Maintenance

Minimum discharge is important to protect downstream environmental requirements. A July 1984 planning aid letter published by USFWS presented a preliminary maintenance flow recommendation shown on Table 5.11-2.[1] The preliminary recommendation does not include flushing flows, as well as some other considerations such as spring spawning requirements. With a Resource Category 2 rating by the USFWS, a full and in-kind mitigation will be recommended.[1]

Table 5.11-2 Minimum Continuous Discharge

Jan	***Feb***	***March***	***April***	***May***	***June***	***July***	***Aug***	***Sept***	***Oct***	***Nov***	***Dec***
100	100	100	100	100	100	75	75	75	75	75	100

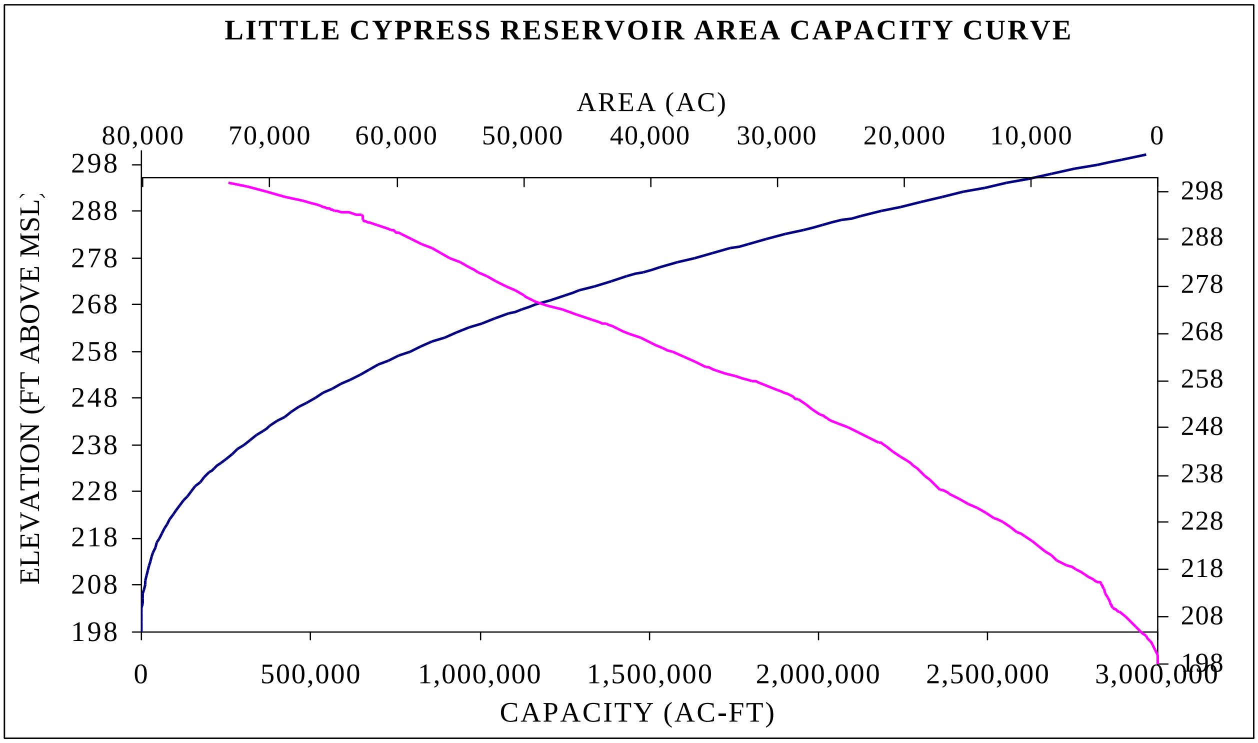
A study conducted with the combined efforts of the USFWS, Texas Parks and Wildlife Department, Waterways Experiment Station, and Fort Worth District, Corps of Engineers in 1984 and 1985 provided a modified maintenance flow recommendation. This recommendation does include flushing flows of greater than 425 cfs for short durations periodically from January through May, a minimum of 10 cfs during the dry months of August through October, and up to a high of 270 cfs in April and May.[1]

Stream loss mitigation is, in part, dependent upon an agreement between the Texas Parks and Wildlife Department, WES and USFWS over minimum continuous discharge for instream maintenance.

5.11.1.5.7 Area Capacity Data

The elevation-area-capacity relationship (also referred to as area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. See Figure 5.11-2[3] for the Little Cypress Reservoir Area Capacity Curve. The relationship is based on the topographic characteristics of the land to be inundated by the reservoir. The relationship is based upon existing conditions taken from USGS quad map topography of the land to be inundated by the reservoir. Also taken into account is the accumulation of sedimentation that will occur over the life of the reservoir up to the year 2040.

Figure 5.11-2. Area Capacity Curve



5.11.1.6 Water Quality

Water quality in the area is generally good, and analyses indicate the good quality will be maintained in the reservoir. Because of expected lower biochemical oxygen demand and nutrient load, dissolved oxygen levels will be high. The Cypress Valley Basin experiences some industrial waste discharges, chromium and zinc, and oilfield brine disposal is carefully monitored.[1]

5.11.1.7 Project Yield for Water Supply

The water supply yield for the Little Cypress Reservoir was determined to be 200 cfs, which is 129 mgd without implementation of conservation measures and 125.7 mgd with implementation of conservation measures. The 129 mgd yield determination is based upon the 2040 projected water needs of the counties located within the Cypress Valley Watershed. An earlier preliminary study[3] proposed a larger dam for a larger yield, which was later modified in favor of maintaining willingness of the user to buy the water by considering a yield only up to the 2040 water supply needs.[1]

5.11.1.8 Other Potential Benefits

Potential benefits associated with construction of the Little Cypress Reservoir include water supply, recreation, and some amount of flood control.

5.11.1.9 Land Acquisition and Easement Requirements

The fee acquisition elevation for the reservoir is at 241.7 ft msl with a surface area of 20,172 acres.[1]

Of the 15,763 acres of land that would be inundated in the conservation pool, about 11,350 contain productive bottomland hardwoods. An HEP (Habitat Evaluation Procedure) conducted by the USFWS estimated that 35,088 acres would need to be acquired for compensation due to bottomland hardwood losses, and about 14,730 acres would need to be acquired to compensation for riparian habitat losses.[1]

5.11.1.9.1 Potential Land Use Conflicts

According to USACE, 1987, the Little Cypress Reservoir site contained several oil and gas fields as of 1979. A few of these fields fall below elevation 255.0, only 3 ft above the maximum water surface elevation of 252.0 ft and 21.9 ft above the conservation pool level of 233.1 ft msl.

A 1982 study by the Department of Interior, Bureau of Mines estimated that deposits of approximately 30 million tons of lignite were near the Little Cypress damsite.[1] However, larger and more profitable sites exist elsewhere, rendering those in the damsite of little interest. As a result, no land conflict considerations for lignite has been included.

5.11.1.10 Updated Project Costs

Opinions of probable project cost for the Little Cypress Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1986.[1] The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor's Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

According to January 1986 values, the economic project capital cost was $153,617,000. The Army Corps of Engineers obtained that cost from a July 1984 estimate and updated them using the ENR indexes. The earlier mentioned changes resulted in a higher cost estimate than the initial analysis. Please refer to

5.11.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies. The land cost for the reservoir was taken as a lump sum for the land purchase, easement and recreation specific.

5.11.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures.

5.11.1.10.3 Construction Costs

As shown in

Table 5.11-3, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

Table 5.11-3 Construction Costs

Item #	Description	Quantity	Unit	Total Cost ($)
1	Reservoirs	1	L.S.	$3,230,000
2	Dams	1	L.S.	$22,509,000
3	Roads, Railroads, Bridges	1	L.S.	$500,000
4	Recreation Facilities	1	L.S.	$22,920,000
5	Cultural Resource Preservation	1	L.S.	$1,133,000
6	Buildings, Grounds, Utilities	1	L.S.	$382,000
7	Operation Equipment	1	L.S.	$229,000
	Base Construction Capital Cost Unescalated Subtotal (BCS)			**$50,903,000**
	Mobilization (5% of BCS)			$2,545,150
			Subtotal:	$53,448,150
	OH & P (15% of Subtotal)			$8,017,230
	Construction Capital Cost Subtotal (CCC)			**$61,465,400**

5.11.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 144,900 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $290,759,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Little Cypress Reservoir, the O&M is $1,240,840 and the annualized debt service is $20,586,600. The firm yield is then divided into the total annualized cost of $21,827,440 to yield a unit cost of $150.64 per acre-foot ($0.47/1,000 gal) of firm yield. These annualized costs are summarized in contained in the executive summary.

5.11.2 Environmental Overview –Affected Environment and Environmental Consequences

5.11.2.1 Geological Elements

5.11.2.1.1 Physiography

The potential Little Cypress reservoir is located within the Pineywoods vegetative region of Texas. The Pineywoods area is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods vegetative region lies entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods vegetative region. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dallisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.

5.11.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River Counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[4]

5.11.2.1.3 Soils

The area of the potential reservoir, Little Cypress, contains (12) twelve major soil groups.[9] These groups are Bowie-Cuthbert-Kirvin, Lilbert-Darco-Briley, Latch-Mollville-Bienville, and Iuka-Guyton-Mantachie. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Bienville

The Bienville series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils, formed in sandy coastal plain sediments on nearly level or gently sloping stream terraces. The typical slope is dominantly 1 to 3 percent, but ranges from 0 to 5 percent. Bienville soils are on stream terraces in the Gulf Coastal Plains. A water table is at depths of 4 to 6 feet in late winter and early spring. These soils formed in sandy alluvium mainly from sandy coastal plain sediments. The climate is warm and humid. Mean annual precipitation ranges from 45 to 62 inches and mean annual temperature ranges from 60 to 70 degrees F. Most acreage is in woodland, dominantly mixed hardwood and pine. This soil series is typically used for cotton, corn, and truck crops within cleared areas.

Bowie

The Bowie series consists of very deep, well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain deposits. These soils are on broad very gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The climate is humid; mean annual precipitation ranges from 40 to 50 inches; and mean annual temperature from 64 to 69 degrees F. The Thornthwaite annual P.E. index exceeds 64. The frost-free days range from 220 to 250. Elevation ranges from 150 to 600 feet above msl. Runoff is low on 1 to 3 percent slopes, medium on 3 to 5 percent slopes, and high on 5 to 8 percent slopes. A perched water table is at a depth of 3.5 to 5 feet during winter and early spring in most years. The principal use is for pasture and forest. Some areas are used for growing corn, peanuts, sweet potatoes, peaches, watermelons and other vegetables or fruit crops. Pasture is mainly bermudagrass or bahiagrass. Forests consists of loblolly and shortleaf pines, sweetgum, red oak, and hickory trees with tall and midgrasses.

Briley

The Briley series consists of very deep, sandy, well-drained, moderately permeable soils that formed in sandy and loamy Coastal Plain sediments. These soils are on gently sloping to moderately steep broad interstream divides. Slopes are dominantly 2 to 5 percent, but range from 1 to 20 percent. Mean annual rainfall ranges from 40 to 48 inches and is evenly distributed throughout the year. Frost-free days range from 240 to 275 days and elevation ranges from 350 to 600 feet above msl. Mean annual temperature ranges from 64 degrees to 69 degrees F., and the Thornthwaite P-E index exceeds 64. The soil type is used mainly for woodlands of loblolly and shortleaf pine and for pastures of improved bermudagrass.

Cuthbert

The Cuthbert series consists of soils that are moderately deep to weakly consolidated sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on strongly sloping to steep uplands. Slopes are dominantly 8 to 25 percent, but range from 5 to 40 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 56 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 750 feet above msl. Mean annual temperature ranges from 63 to 67 degrees F, and Thornthwaite annual P-E indexes exceed 64. Runoff is medium for slopes of 5 to 20 percent and high for slopes greater than 20 percent. Cuthbert soils are used mainly for woodland and pastureland. The principal trees are shortleaf and loblolly pine, red oak, sweetgum, and other hardwoods. Pastures include common and improved bermudagrass, bahiagrass, and weeping lovegrass.

Darco

The Darco series consists of very deep, somewhat excessively drained, moderately permeable soils that formed in sandy and loamy deposits on uplands. It is gently sloping to steep and slopes range from 1 to 25 percent. The climate is warm and humid. The average annual rainfall ranges from 40 to 50 inches. Frost-free days range from 230 to 260. Elevation ranges from 400 to 700 feet above msl. The frost-free rainfall ranges from 25 to 30 inches. The mean annual temperature ranges from 63 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 84. Runoff is negligible on 1 to 3 percent slopes, very low on 3 to 5 percent slopes, low on 5 to 20 percent slopes, and medium on slopes greater than 20 percent. Most of the soil is used for pasture or woodland. Pastures are mainly in coastal bermudagrass or weeping lovegrass. Native trees include loblolly pine, shortleaf pine, red oak, and hickory. Watermelons, peanuts, small grain for grazing, and vegetables are grown in some areas.

Guyton

The Guyton series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in thick loamy sediments. These soils are on Coastal Plain local stream floodplains and in

depressional areas on late Pleistocene age terraces. Slopes range from 0 to 1 percent. The climate is warm and humid. Mean annual temperature ranges from 60 to 70 degrees F. Average annual rainfall ranges from 42 to 62 inches. Where runoff is ponded, drainage is very poor. Runoff is slow to ponded. A seasonal high water table is at 0 to 1.5 feet below the surface from December through May, except where ponded. Where ponded, it is from 1 foot above the surface to 0.5 foot below the surface most of the time. In places, the soils are subject to rare, occasional, or frequent flooding. Most areas are in woodland. Water oak, bald cypress, water tupelo, loblolly pine, and shortleaf pine are dominant in the drainageways. On broad terraces, bald cypress and water tupelo generally are absent and sweetgum dominates. Some areas are used as pastureland or cropland.

Iuka

The Iuka series consists of deep, moderately well-drained, moderately permeable soils that formed in stratified loamy and sandy alluvial sediments. These soils are on nearly level floodplains. They are saturated with water at depths of 1 foot to 3 feet below the surface during wet seasons and are subject to flooding. Slopes range from 0 to 2 percent. The climate is warm and humid. Near the type location the average daily temperature for January is 42 degrees F., the average daily temperature for July is 79 degrees F., the mean annual temperature is about 61 degrees F., and the mean annual precipitation is about 54 inches. Iuka soils are rarely to commonly flooded. A water table is at depths of 12 or more inches, and the soil is commonly saturated with water between 12 and 40 inches during some season of most years. Much of the soil has been cleared and cultivated. It is cropped to corn, soybeans, small grains, truck crops, and hay or is in pasture. Native vegetation is forest of water oak, willow, beech, sweetgum, hickory, maple, ironwood, eastern cottonwood, alder, white oak, and in some places, pine.

Kirvin

The Kirvin series consists of soils that are deep to stratified sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on gently sloping to moderately steep convex uplands. Slope is dominantly 2 to 8 percent, but ranges from 1 to 15 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 48 inches, with frost-free rainfall of 25 to 30 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 650 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. Runoff is very low on 1 to 3 percent slopes, low on 3 to 5 percent slopes, and medium on 5 to 15 percent slopes. Principal use is for pastureland and woodland. Bermudagrass is the main pasture grass. Forests are of shortleaf, slash, and loblolly pine, red oak, sweetgum, and other hardwood trees. A few areas are used for growing truck crops, cotton, corn, and oats.

Latch

The Latch series consists of very deep, moderately well drained, moderately permeable soils on stream terraces. These nearly level to gently sloping soils formed in sandy alluvial sediments. Slopes range from 0 to 3 percent. These nearly level to gently sloping soils are on oblong and low oval mounds less than an acre to about 5 acres in size along stream terraces. They are typically mapped as a part of a soil complex. These soils formed on sandy alluvial terraces of late Pleistocene and Recent Age in the West Coastal Plains. Frost-free days range from 230 to 270 days and elevation ranges from 250 to 400 feet above msl. Mean annual precipitation is 42 to 50 inches. Mean annual temperature ranges from 64 degrees to 66 degrees F. and the Thornthwaite annual P-E indices ranges from 68 to 80. Latch soils are moderately well drained. There is a perched water table for brief periods during the winter and spring seasons. This soil series is used mainly for forest and pasture. Forest vegetation includes loblolly pine, sweetgum, post oak, willow oak, water oak, and elm with an understory of American beautyberry, southern bayberry, green briar, and shade tolerant forbs and grasses.

Lilbert

The Lilbert series consists of very deep, well-drained, moderately slowly permeable soils. These soils formed in sandy and loamy deposits on uplands. Water runs off the surface slowly. Slopes range from 1 to 8 percent. A perched water table may occur in late winter to early spring from 3 to 6 feet below the soil surface. Average annual temperature ranges from 64 to 69 degrees F., the mean annual precipitation ranges from 40 to 50 inches. Frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 240 to 275. Elevation ranges from 350 to 600 feet above msl. The Thornthwaite P-E index is 66 to about 80. Runoff is slow. The areas where this soil type occurs are used mainly for woodland and pasture. However, some areas are used for cropland. Native vegetation consists of loblolly pine, shortleaf pine, hickory, sweetgum, red oak, and other hardwoods.

Mantachie

The Mantachie series consists of somewhat poorly drained, moderately permeable soils. They formed in loamy alluvium. These soils are on floodplains. They usually flood late in winter and early in spring. The seasonal high water table is at a depth of 1.0 to 1.5 feet. Slope is dominantly less than 1 percent but ranges to 3 percent. Near the type location the mean annual temperature is about 63 degrees F., and the mean annual precipitation is about 53 inches. These soils are subject to rare, occasional, or frequent flooding for brief to long duration, unless protected. The water table is within 1.0 to 1.5 feet of the surface during periods of high rainfall. Most areas of these soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture, and hay. Some areas are in bottomland hardwoods. Common trees are green ash, eastern cottonwood, cherrybark oak, loblolly pine, sweetgum, and yellow-poplar.

Mollville

The Mollville series consists of very deep, poorly drained, slowly permeable soils that formed in thick stratified sandy and loamy sediments, in nearly level or depressional areas on terraces. Mollville soils are typically on first level terraces. However, they are on third or higher level terraces of some large river systems. Slopes are less than 1 percent with plain or concave surfaces. The soils formed in sandy and loamy alluvial sediments. The surfaces typically have been reworked by wind. The climate is humid. The mean annual precipitation ranges from 42 to 56 inches. The mean annual temperature is from 64 to 68 degrees F. Frost-free days range from 220 to 260 and the elevation ranges from 150 to 450 feet above msl. The soil is ponded during the winter and spring mainly for brief to long durations after heavy or prolonged rainfall. A perched water table is at a depth of 0 to 12 inches for brief to long periods to include a cumulative annual duration of 2 to 4 months during most years. During the other years the soil is typically wet for longer periods. The soil is mainly in hardwood forest of water oak, sweetgum, blackgum, and post oak.

5.11.2.2 Hydrological Elements

5.11.2.2.1 Surface Water

The potential reservoir is located within the Cypress Creek Basin on Little Cypress Bayou. This portion of Little Cypress Bayou is included in the Texas Natural Resource Conservation Commission (TNRCC) – The State of Texas Water Quality inventory Surface Water Quality Monitoring program ’96 as stream segment 0409 (Little Cypress Bayou [Creek]). This 76-mile segment originates from the confluence with Big Cypress Creek in Harrison county to a point 0.6 miles upstream of FM 2088 in Wood county. This segment is classified as “water quality limited” and designated uses are for contact recreation, high aquatic life, and public water supply. Due to elevated levels of dissolved cadmium and lead in water, the designated high aquatic life use is not supported in the lower 25 miles of the segment.[10]

5.11.2.2.2 Ground Water

The potential Little Cypress reservoir is located in Harrison county within both the Carrizo-Wilcox Aquifer and the Queen City Aquifer. The potential reservoir is located in the outcrop region of the Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeastern part of the aquifer.

This aquifer extends in a band across most of the state from the Frio River in South Texas northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson county. Total pumpage for all uses in 1994 was 16,319 ac-ft.

The potential reservoir is also within the Queen City Aquifer. Sand, loosely cemented sandstone, and interbeded clay units of the Queen City Formation of the Tertiary Claiborne Group make up the aquifer as delineated within Texas. These rocks dip gently to the south and southeast toward the Gulf Coast. Although total aquifer thickness is usually less than 500 feet, it can approach 700 feet in some areas of northeast Texas. In the outcrop area, water occurs under water-table conditions while in the downdip subsurface, where the Queen City is covered by younger, non water-bearing rocks, the water is under artesian conditions. Usable quality water is generally found within the outcrop and for a few miles downdip, but in some areas it may occur down to depths of approximately 2,000 feet. Yields of individual wells are commonly low, but exceed 400 gal/min.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent however, quality deteriorates with depth in the downdip direction. The water may have high acidity (low pH) in much of northeast Texas and relatively high iron concentrations in localized areas. Hydrogen sulfide gas is sometimes present. Fortunately, each of these naturally occurring conditions may be treated relatively easily and economically.

While large amounts of usable quality groundwater are contained within the rocks of the Queen City, yields are low. Estimates of the availability of water from the Queen City Aquifer are based on recharge to the aquifer. Because of differences in topography, vegetative cover, and other factors, only two percent of the annual rainfall is estimated recharge in the Trinity, Colorado, Guadalupe, San Antonio and Neches River basins. Approximately five percent is estimated recharge in the Neches, Sulphur, Sabine, and Cypress Creek Basins. Total annual effective recharge to the aquifer is estimated to be 682,100 ac-ft.[5]

5.11.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential reservoir will cause water to be impounded on the Little Cypress as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Little Cypress reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.11.2.4 Biological Elements

5.11.2.4.1 Vegetation

The potential Little Cypress reservoir is centrally located within the Austroriparian province[6] and is within the Pineywoods region.[7] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Little Cypress reservoir location include Pine Hardwood (55%), Other (43%), and Willow Oak Water Oak (2%)

5.11.2.4.2 Fish and Wildlife

The result of the potential Little Cypress reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Little Cypress reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter. [8]

5.11.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists six birds, four fish, five mammals, five reptiles, and three vascular plants to potentially occur or have habitat within the potential project location (Table 5.11-4). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.11-4 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Harrison County).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Blackside Darter	*Percina maculata*		T
Bluehead Shiner	*Notropis hubbsi*		T
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Rafinesque's Big-Eared Bat	*Corynorhinus rafinesquii*		T
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Neches River rose-mallow	*Hibiscus dasycalyx*	C1	
Southern Lady's-Slipper	*Cypripedium kentuckiense*		R
Texas Trillium	*Trillium pusillum var. texanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status

E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Harrison County, 1999.)

5.11.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Little Cypress reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.11.2.6 Wetlands

The term “wetlands” encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: “Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows five hydric soil associations are within the potential Little Cypress reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.11.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland “credits” that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith county. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Little Cypress reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.11.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Little Cypress reservoir is located within the Cypress Creek basin, which represents approximately 8% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;

- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-County study area. The potential Little Cypress reservoir is within and adjacent to the Little Cypress Bayou site and listed as priority two.[9] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.11.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There are no known conservation easements within the footprint of the potential Little Cypress reservoir.

5.11.2.10 Social and Economic Conditions

The potential reservoir is located in Harrison county. The population of this county according to the 1990 Census is 57,483. The Texas State Data Center has estimated the 2020 population to be approximately 72,814. This corresponds to a 27 percent increase in Harrison county.[10] The median household income for Harrison county in 1989 was 22,625.[11]

5.11.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Little Cypress reservoir will affect portions Upshur county.

Historical and Archeological Resources for the area was determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.11-5.[19]

Table 5.11-5 Historical and Archeological Resources for Little Cypress.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Harrison	239	1	115	100	17	6

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.11-6) details the results of previous cultural studies that have been performed on the area since 1879. Some counties have been investigated more thoroughly than the other counties for cultural resources. This is important to note because there is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Upsher county.[12]

Table 5.11-6 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	***Not Significant****	***Unknown Significance***	***Probably Significant***	***Significant***	***Total***
Harrison**	84	59	23	5	171
Sub-total	84	59	23	5	171

* Significance refers to National Register criteria.
** County tabulations are incomplete.
Source: THC, 1993.

5.11.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.11-7.

Table 5.11-7 Chronological Framework Northeast Texas Archeological Region.

Period	***Dates***
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.11-8 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.11-8 Archeological Resources with Associated Periods.

County	***Paleoindian***	***Archiac***	***Early Ceramic***	***Formative Caddoan Early Caddoan Middle Caddoan***	***Late Caddoan***
Harrison			2	6	13

Source: THC, 1993, and Perttula T. K., 1999.[13]

5.11.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that

have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.11.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.11-9 depicts the percent coverage by major land uses within the reservoir study area.[14]

Table 5.11-9 Land Use for the Potential Little Cypress Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	45%
Deciduous Forest Land	4%
Mixed Forest Land	50%
Other	1%

5.11.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites and municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are no Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[15]

5.11.2.14 Potential Environmental Impact Summary

Table 5.11-10 Potential Environmental Impact Summary for Little Cypress.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
1-USFWS Priority Bottomland Hardwood Area	Moderate

---

[1] COE. 1987. Fort Worth District, U.S. Army Corps of Engineers, Feasibility Report of Cypress Bayou Basin, Texas, February, 1987.

[2] COE. Fort Worth District, U.S. Army Corps of Engineers, Cypress Bayou Basin Study Reconaissance Report, September, 1998.

[3] COE. Fort Worth District, U.S. Army Corps of Engineers, Cypress Bayou Basin Study Reconaissance Report, July, 1981.

[4] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[5] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan.* Austin, Texas. TWDB.

[6] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[7] Gould, F. W. 1975. Texas Plants: Aa Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[8] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[9] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[10] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[11] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[12] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[13] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[14] www.tnris.state.tx.us ----GIS

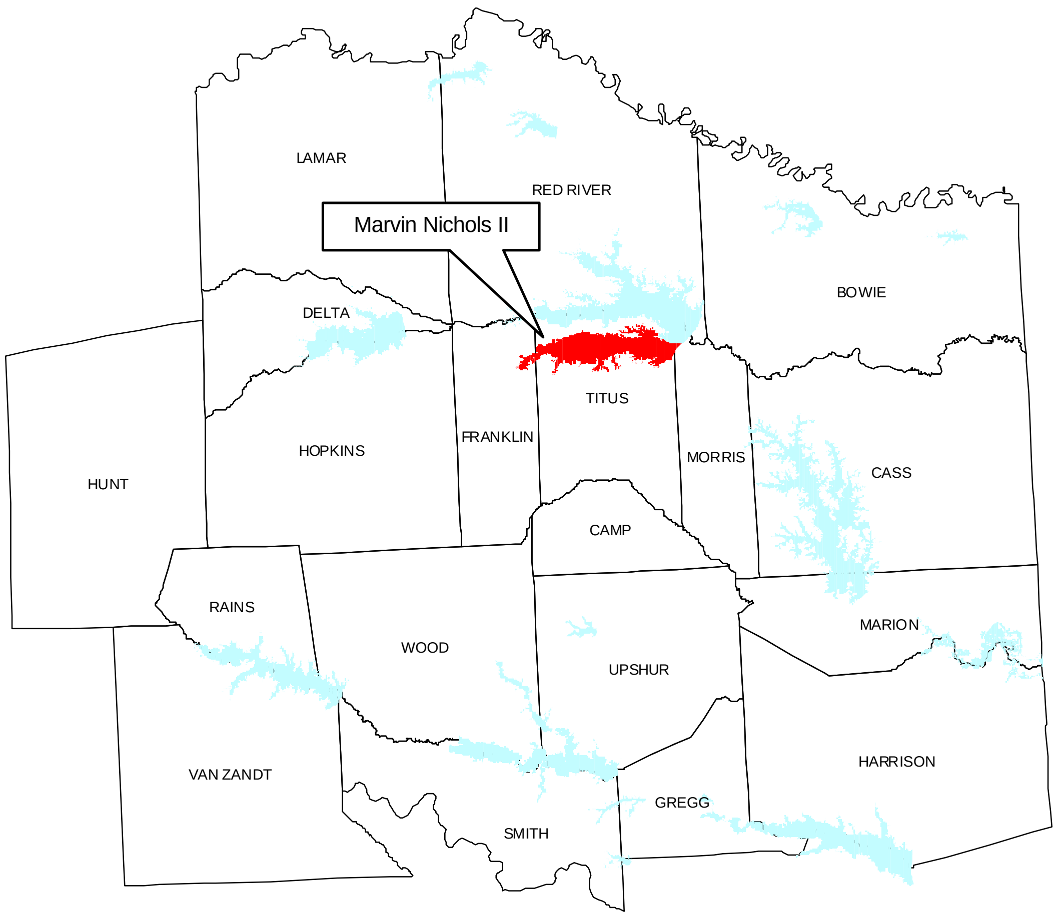
[15] www.tnris.state.tx.us-----GIS

5.12 MARVIN NICHOLS II

5.12.1 Summary of Prior Studies

5.12.1.1 Location

Figure 5.12-1 Location of Marvin Nichols II within the Region D Planning Region



The Marvin Nichols II damsite is located on White Oak Creek in Morris and Titus Counties *(See Appendix, Exhibit A, Vicinity Map).*

5.12.1.2 Impoundment Size and Volume

The total watershed is approximately 662 square miles and the land requirement for the project is approximately 35,900 acres. Impoundment volume is approximately 772,000 acre-feet at a conservation pool elevation of 312.0 feet.

5.12.1.3 Site Geology and Topography

No information on geology and topography was available for the Marvin Nichols II Reservoir area.

5.12.1.4 Dam Type and Size

No information on dam type and size was available for the Marvin Nichols II Reservoir.

5.12.1.5 Hydrology and Hydraulics

Monthly runoff to the site for the period 1940-1986 was developed for the 1990 Study for Tarrant County Water Control and Improvement District No. 1.

The amount and distribution of naturalized streamflows throughout the basin tributary to Marvin Nichols II damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

5.12.1.6 Water Quality

No information on water quality was available from previous studies.

5.12.1.7 Project Yield for Water Supply

The Marvin Nichols II Reservoir will provide a water supply of 280,100 ac-ft/yr. This yield accounts for environmental releases.[1]

5.12.1.8 Other Potential Benefits

The project would provide recreation facilities for a number of annual visitors.

5.12.1.9 Land Acquisition and Easement Requirements

Approximate easement based on area in conservation pool is 35,900 acres.

5.12.1.9.1 Potential Land Use Conflicts

No know information regarding potential land use conflicts is presently available.

5.12.1.10 Project Costs

Probable capital cost of Reservoir only is $250,316,000 in 1989 dollars (not updated).[1]

The capital cost per acre-foot of annual firm yield on this basis is $893.67.

5.12.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies. Too little information was provided in the initial cost estimate to estimate the land cost as a separate item in the other project costs.

5.12.2 Environmental Overview –Affected Environment and Environmental Consequences

5.12.2.1 Geological Elements

5.12.2.1.1 Physiography

The potential Nichols II reservoir is located within the Blackland Prairies. The Blackland Prairie covers approximately 12.6 million acres of land. It averages 30-45 inches of precipitation annually with 230 to 280 frost-free days. The topography is nearly level to rolling with an elevation of 250 to 700 feet above msl. The Blackland Prairie area intermingles with the Post Oak Savannah in the southwest and has division known as the San Antonio and Fayette Prairies. This rolling and well-dissected prairie represents the southern extension of the true prairie that occurs from Texas to Canada.

The upland Blacklands are dark, calcareous shrink-swell clayey soils, changing gradually with depth to light marls or chalks. Bottomland soils are generally reddish brown to dark gray, slightly acid to calcareous, loamy to clayey and alluvial. The soils are inherently productive and fertile, but many have lost productivity through erosion and continuous cropping.

The Blackland Prairie is characterized by little relief and dark, thick, plastic clay soils. All outcropping strata are generally classified as sedimentary. The exposed bedrock is composed of nearshore and shoreline marine sediment deposited at the edge of the Gulf Coast Embayment by a shallow Cretaceous sea existing approximately 100 million years ago. Sediment deposited in this sea consists of sand, silt, and clay and formed layers that incline eastward toward the embayment at an average rate of 45 feet per mile.[2]

5.12.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[3]

5.12.2.1.3 Soils

The area of the reservoir contains five major soil groups.[9] These groups are Derly-Raino-Talco, Estes-Mantachie-Bienville, Kaufman-Gladewater-Texark, Nahatche-Crockette-Woodtell, and Woodtell-Freestone-Bernaldo. Approximately 28.5 percent of the area is Derly-Raino-Talco, 47.1 percent Estes-Mantachie-Bienville, 1.4 percnet Kaufman-Gladewater-Texark, 8.5 percent Nahatche-Crockett-Woodtell, 14.5 percent Woodtell-Freestone-Bernaldo. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Bernaldo

The Bernaldo series consists of very deep, well-drained, moderately permeable soils that formed in loamy alluvial deposits. The soils are on nearly level to moderately sloping stream terraces. Slopes are dominantly less than 5 percent but range from 0 to 8 percent. Bernaldo soils are on nearly level to moderately sloping areas about 10 to 130 feet above present streams. The average annual precipitation ranges from 40 to 48 inches and the mean annual temperature ranges from 64 to 68 degrees F. Frost-free days range from 240 to 260 and elevation ranges from 200 to 550 feet above msl. Thornthwaite annual P-E indexes range from 64 to 84. Most acreage is in woodland with dominant pine species of loblolly and shortleaf and many oak species and other southern hardwoods. Some areas are in pasture. Pastures are mainly in improved or common bermudagrass, bahiagrass, overseeded with legumes of crimson and arrowleaf clovers, vetch or singletary peas. Small areas are farmed to corn, small grains for grazing, sorghum for grazing and hay, and truck crops.

Bienville

The Bienville series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils, formed in sandy coastal plain sediments on nearly level or gently sloping stream terraces. The typical slope is dominantly 1 to 3 percent, but ranges from 0 to 5 percent. Bienville soils are on stream terraces in the Gulf Coastal Plains. A water table is at depths of 4 to 6 feet in late winter and early spring. These soils formed in sandy alluvium mainly from sandy coastal plain sediments. The climate is warm and humid. Mean annual precipitation ranges from 45 to 62 inches and mean annual temperature ranges from 60 to 70 degrees F. Most acreage is in woodland, dominantly mixed hardwood and pine. This soil series is typically used for cotton, corn, and truck crops within cleared areas.

Crockett

The Crockett series consists of nearly level to moderately sloping soils that are deep to weathered shale. They are moderately well-drained, and very slowly permeable, on uplands. Slopes are dominantly 1 to 5 percent, but range from 0 to 10 percent. Mean annual temperatures ranges from 64 to 70 degrees F., and mean annual precipitation ranges from 32 to 45 inches. Frost-free days range from 230 to 275 days, and elevation ranges from 200 to 800 feet. Thornthwaite P- E indexes range from 50 to 75. The soil is mainly used for growing cotton, grain sorghums, and small grain, but more than half the acreage is now in pastures. Native vegetation within the series is predominately prairie grasses such as bluestems, indiangrass, switchgrass, and gramas, with scattered elm, hackberry, and mesquite trees.

Derly

The Derly series consists of very deep, poorly drained, very slowly permeable soils mainly on Pleistocene Age Terraces formed in loamy and clayey sediments about 30 to 80 feet above present floodplains. Slopes range from 0 to 1 percent. The average annual temperature ranges from 63 to about 68 degrees F.; the average annual rainfall ranges from 36 to 46 inches. Frost-free days ranges from 230 to 275, and the elevation ranges from 150 to 400 feet above msl. Thornthwaite P-E index ranges from 60 to 68. Water is ponded on the surface for brief to long periods during the winter and spring seasons of most years. Most of the acreage is in pasture and woodland. Native vegetation is an overstory of elm, post oak, willow oak, and water oak. Grasses include such species as beaked panicum, longleaf uniola, and sedges. Bermudagrass, dallisgrass, and fescuegrass are the dominant pasture plants.

Estes

The Estes series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in acid clayey and loamy alluvium in the Coastal Plains. These flood plain soils have slopes ranging from 0 to 1 percent. Mean annual precipitation is 45 to 55 inches. Frost-free days range from 235 to 250. The elevation ranges from 200 to 450 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. This soil is used mainly for woodland or wildlife land. A few areas are used for improved pastures of bahiagrass, fescue or dallisgrass. The native vegetation is a mixed hardwood forest. The major commercial trees are water oak, willow oak and sweetgum. There are a few scattered green ash, elm, hackberry, mulberry, hickory, pecan and widely scattered native pine with an understory of grasses and shrubs.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Gladewater

The Gladewater series consists of very deep, somewhat poorly drained, very slowly permeable soils on floodplains formed in clayey alluvium in floodplains. Slope ranges from 0 to 1 percent. The mean annual precipitation ranges from 38 to 46 inches and mean air temperature ranges from 64 to 68 degrees F. Frost-free days range from 235 to 275 days and elevation is 200 to 400 feet above msl. Thornthwaite P-E index ranges from about 62 to 74. Depressional areas are very poorly drained. Most of the acreage is in pasture or forest. Some areas are in native pasture or range. Pasture areas are introduced grasses such as dallisgrass and fescue. Forested areas are in mixed hardwoods including water oak, willow oak, cedar elm and black willow.

Kaufman

The Kaufman series consists of very deep, moderately well-drained, very slowly permeable soils on floodplains formed in clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 2 percent. Mean annual precipitation ranges from 35 to 50 inches, and mean annual temperature ranges from 62 to 70 degrees F. Frost-free days range from 230 to 280 days and elevation ranges from 100 to 550 feet above msl. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in pasture of dallisgrass, bermudagrass, and fescues. A few areas are used for producing cotton, corn, sorghums, and soybeans. Native vegetation is hardwoods such as elm, hackberry, oak, ash, and grasses which includes species of andropogon, paspalum, panicum, and tripsacum.

Mantachie

The Mantachie series consists of somewhat poorly drained, moderately permeable soils. They formed in loamy alluvium. These soils are on floodplains. They usually flood late in winter and early in spring. The seasonal high water table is at a depth of 1.0 to 1.5 feet. Slope is dominantly less than 1 percent but ranges to 3 percent. Near the type location the mean annual temperature is about 63 degrees F., and the mean annual precipitation is about 53 inches. These soils are subject to rare, occasional, or frequent flooding for brief to long duration, unless protected. The water table is within 1.0 to 1.5 feet of the surface during periods of high rainfall. Most areas of these soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture, and hay. Some areas are in bottomland hardwoods. Common trees are green ash, eastern cottonwood, cherrybark oak, loblolly pine, sweetgum, and yellow-poplar.

Nahatche

The Nahatche series consists of very deep, somewhat poorly drained, moderately permeable soils on floodplains, formed in stratified loamy alluvium. Slopes range from 0 to 1 percent. These soils are flooded from one to several times each year for a duration of a few days to about one month in most areas, unless protected. Some areas are rarely flooded or occasionally flooded. Mean annual temperature ranges from 65 to 70 degrees F. and the mean annual precipitation ranges from 40 to 52 inches. Frost-free days range from 235 to 270 days and elevation ranges from 100 to 400 feet. The Thornthwaite P-E indexes range from 62 to 82. Most of the soil is used for woodland or pasture. The native vegetation is loblolly pine, shortleaf pine, cypress, American sycamore, water oak, willow oak, cottonwood, sweetgum, southern sweetbay, pecan, and green ash. Herbaceous plants include Virginia wildrye, rusty seed paspalum, beaked panicum, and low panicum. Improved pasture grasses include coastal bermudagrass, and bahiagrass.

Raino

The Raino series consists of very deep, moderately well-drained, very slowly permeable soils on stream terraces or remmants of terraces on erosional uplands 50 to 200 feet above present stream terraces in loamy and clayey sediments. Slopes range from 0 to 2 percent. The mean annual precipitation is 40 to 48 inches. Frost-free days range from 235 to 275 and elevation ranges from 250 to 450 feet above msl. The average annual temperature is 64 to 69 degrees F. and the Thornthwaite P-E index is 64 to 84. Most of the acreage is in pasture. Bermudagrass, pensacolagrass, bahiagrass, and dallisgrass are the dominant pasture plants. Some native grasses include longleaf uniola, beaked panicum, purpletop, and bluestems. Overstory is mainly blackjack oak, post oak, hickory, water oak, elm, and pine in the eastern portion of series province.

Talco

The Talco series consists of deep, somewhat poorly drained, slowly permeable soils on stream terraces on remmants there of 50 to 200 feet above present streams in loamy alluvial sediments of Pleistocene Age. Slopes range from 0 to 2 percent. Mean annual precipitation is 42 to 48 inches. Mean annual temperature ranges from 62 to 66 degrees F. and the Thornthwaite annual P-E index ranges from 68 to 76. Ponding occurs for brief periods during the winter and spring months. Most of the acreage is in forest and pasture. Forest vegetation includes willow oak, water oak, post oak, red oak, sweetgum, black gum, elm, and loblolly pine.

Texark

The Texark series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in clayey alluvium, on nearly level floodplains. Slopes are 0 to 1 percent. Average annual precipitation ranges from 40 to 55 inches, average annual temperature is 62 degrees to 70 degrees F. Annual Thornthwaite P-E indices exceed 50.

Woodtell

The Woodtell series consists of soils that are deep to stratified shale and loamy materials on gently sloping stream divides. They are well-drained and very slowly permeable. The slope ranges from 1 to 20 percent. Woodtell soils are strongly to moderately steep side slopes of uplands. Slope gradients are mainly 2 to 12 percent but range from 1 to 20 percent. The soils formed in materials weathered from unconsolidated, stratified loamy, clayey, and shaly materials of Eocene age mainly in the Wilcox and Cook Mountian formations. The average annual rainfall ranges from 40 to 46 inches. The mean annual temperature is about 62 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 78. Frost-free days range from 230 to 270 and elevation ranges from 300 to 650 feet above msl. These soils are used mainly for pasture. Native vegetation is mainly post oak, blackjack oak, elm and red oak in a fairly dense savannah. In open areas tall and mid grasses such as bluestems, tridens and panicums are common with longleaf uniola under the tree canopy. American beautyberry and hawthorn species are also a part of the understory. The main pasture plants are bermudagrass and bahiagrass with crimson and arrowleaf clovers. There are scattered shortleaf and loblolly pine with small plantations and a some dense pine areas on the eastern side of the series province. Some areas are planted to small grain for winter grazing.

5.12.2.2 Hydrological Elements

5.12.2.2.1 Surface Water

The reservoir is located on the Sulphur River. This portion of the Sulphur River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0303 (Sulphur/South Sulphur River). This 181 mile segment originates from a point 0.9 miles downstream of Bassett Creek in Bowie/Cass County to Cooper Lake Dam in Delta/Hopkins County. This segment is classified as "water quality limited" and designated uses are for contact recreation and high aquatic life.

The lower and upper portions of this segment periodically show depressed levels of oxygen and elevated levels of nutrients. Sluggish flow, coupled with nutrient and suspended sediment loading from point and nonpoint sources, likely contributes to the problems regarding dissolved oxygen and nutrients.[4]

5.12.2.2.2 Ground Water

The reservoir is located within the Trinity Aquifer and Nacatoch Aquifer. The Trinity Aquifer consists of early Cretaceous age rocks of the Trinity Group formations which occur in a band from the Red River in north Texas to the Hill Country of south-central Texas and provides water in all or part of 55 counties. Usable quality water (containing less than 3,000 mg/l dissolved solids) occurs to depths of up to about 3,500 feet.

Water quality from the Trinity Aquifer is acceptable for most municipal and industrial purposes, however excess concentrations of certain constituents in many places exceed drinking-water standards for municipal supplies. Heavy pumpage and water-level declines in the north central Texas region have contributed to deteriorating water quality in the aquifer. Water quality naturally deteriorates in the downdip direction of all the Trinity water-bearing units.

The Nacatoch Aquifer occurs in a narrow band in northeast Texas and extends eastward into Arkansas and Louisiana. Pumpage from the aquifer totaled 3,484 acre-feet in 1994, 74 percent of which was used for municipal purposes.

The Nacatoch formation, composed of one to three sequences of sands separated by impermeable layers of mudstone or clay, was deposited in the East Texas basin during the Cretaceous Period. The aquifer also includes a hydrologically connected mantle of alluvium up to 80 feet thick where it covers the Nacatoch along major drainage ways. The south and east basinward dip of the formation is interrupted by the Mexia-Talco fault zone, which alters the normal flow direction and adversely affected the chemical quality of the groundwater. Groundwater in this aquifer is usually under artesian conditions except in shallow wells on the outcrop where water-table conditions exist.

The water quality of groundwater in the aquifer is generally alkaline, high in sodium bicarbonate, and soft. Dissolved-solids concentrations increase in the downdip portion of the aquifer and are significantly higher downdip of faults. In areas where the Nacatoch occurs as multiple sand layers, the upper layer contains the best-quality water. The water quality is generally acceptable for most uses, however, the high degree of mineralization precludes its use for irrigation in some areas.

Annual availability, equivalent to annual effective recharge, for the Nacatoch Aquifer is estimated to be 3,030 ac-ft. Recharge to the aquifer occurs mainly from precipitation on the outcrop. Aquifer water levels have been significantly lowered in some areas as a result of pumpage exceeding the effective recharge.[5]

5.12.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Marvin Nichols II reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Marvin Nichols II reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.12.2.4 Biological Elements

5.12.2.4.1 Vegetation

The potential Marvin Nichols II reservoir is centrally located within the Austroriparian province[6] and is within the Post Oak Savannah region.[7] The Post Oak Savannah vegetation area typically has a gently rolling to hilly topography, with moderately dissected wooded plain. The soil composition for this community consists of gray, slightly acidic sandy loams, and reddish brown to dark gray, slightly acidic to calcareous, loamy to clayey alluvial. The Post Oak Savannah soils support short oak trees and tallgrasses. Trees in the region consist of post oak and blackjack oak, elms, junipers, hackberries, and hickories. Yaupon, American beautyberry, coralberry, greenbriar, and grapes are shrubs and vines that are characteristic to the area. Grasses in the area includes little bluestem, indiangrass, switchgrass, silver bluestem, Texas wintergrass, purpletop, narrowleaf wildoats, beaked panicum, brownseed paspalum, threeawn, broomsedge bluestem, splitbeard bluestem, rosette grasses, and lovegrasses. Forbs in the region consist of wild indigo, indigobrush, sennas, tickclover, lespedeza, prairie-clovers, western ragweed, crotons, and sneezeweeds. There has been some vegetation introduced into the area, including bermudagrass, bahiagrass, weeping lovegrass, and clover.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Marvin Nichols II reservoir location include Water Oak, Elm (49%), Pine Hardwood (24%), Post Oak Wooded Forest Grass (1%), and Other (26%).

5.12.2.4.2 Fish and Wildlife

The result of the potential Marvin Nichols II reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Marvin Nichols II reservoir is located within the Prairies and Lakes Eco-region. Some of the common wildlife in this region includes the plains pocket gopher, beaver, raccoon, porcupine, Texas kangaroo rat, hispid cotton rat, ornate box turtle, green-winged teal, bobwhite quail, red-shouldered hawk, scissortail flycatcher, white-tailed deer, Brazilian freetail bat, ringtail, nine-banded armadillo, eastern hognose snake, tarantula, Texas horned lizard, golden cheeked warbler, black-capped vireo, northern mockingbird, and guadelupe bass. [8]

5.12.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location(Table 5.12-1). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.12-1 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Morris and Titus Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Louisiana Black Bear	*Ursus americanus luteolus*	LT	T
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T

Sources: USFWS 1998, TPWD 1999.
USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Morris and Titus Counties, 1999.)

5.12.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the “regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Marvin Nichols II reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.12.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations and National Wetlands Inventory (NWI) maps. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Sesrvice) data shows eight hydric soil associations are within the potential Marvin Nichols II reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.12.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith County. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Marvin Nichols II reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.12.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Marvin Nichols II reservoir is located within the Sulphur River basin, which represents approximately 15% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the nineteen-county study area. The potential Marvin Nichols II reservoir is within and adjacent to the Sulphur River Bottom West site and is listed as a Priority 1 site.[9] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.12.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

There is one conservation easement located within or adjacent to the footprint of the potential Marvin Nichols II reservoir (Table 5.12-2).

Table 5.12-2 Conservation easements were identified in the Sulphur Basin.

Name	*Entity in Ownership*
White Oak Creek WMA	TPWD

5.12.2.10 Social and Economic Conditions

The reservoir is located in Delta and Hopkins Counties. The population of Delta County according to the 1990 Census is 4,857 and Hopkins County 28,833. The Texas State Data Center has estimated the 2020 population of Delta County to be 4,564 and Hopkins County to be 35,475.[10] This corresponds to a six percent decrease in population for Delta County and a 23 percent increase in population for Hopkins County.[11]

5.12.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Marvin Nichols II reservoir will affect portions of Morris and Titus counties.

Historical and Archeological Resources for the two county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.12-3.[19]

Table 5.12-3 Historical and Archeological Resources for Marvin Nichols II.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Morris	26	1	24	0	1	0
Titus	39	1	37	0	1	0

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.12-4) details the results of previous cultural studies that have been performed on the area since 1879. Although Titus County has been investigated more thoroughly than the other counties for cultural resources due to the construction of existing reservoirs and conveyance facilities, there is the potential for located additional archeological sites in the area of the potential reservoir. There is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Morris County.[12]

This Space Intentionally Left Blank

Table 5.12-4 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Morris	5	6	6	9	26
Titus	149	239	52	17	457
Sub-total	154	245	58	26	483

* Significance refers to National Register criteria.
Source : THC, 1993.

5.12.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.12-5.

Table 5.12-5 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.12-6 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.12-6. Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Franklin			1	5	14
Morris				1	15
Red River			5	12	14
Titus		1	4	14	27

Source: THC, 1993, and Perttula T. K., 1999.[13]

5.12.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.12.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.12-7 depicts the percent coverage by major land uses within the reservoir study area.[14]

Table 5.12-7 Land Use for the Potential Marvin Nichols II Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	53%
Deciduous Forest Land	43%
Mixed Forest Land	2%
Evergreen Forest Land	1%
Other	1%

5.12.2.13 Regulated Materials

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites, municipal solid waste landfill sites,... within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are no Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[15]

5.12.2.14 Potential Environmental Impact Summary

Table 5.12-8 Potential Environmental Impact Summary for Marvin Nichols II.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
USFWS Priority Bottomland Hardwood Area	Moderate
White Oak Wildlife Management Area Conflict	Substantial

[1] Freese and Nichols. May 2000 Studies.

[2] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96*. Austin, Texas. TNRCC.

[2] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan*. Austin, Texas. TWDB.

[2] Hatch, Stephan L. , Kancheepuram M. Gandi, and Larry E. Brown. July 1990. *Checklist of the Vascular Plants of Texas*. College Station, Texas: Texas Agricultural Exper. Station.

[3] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[4] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96*. Austin, Texas. TNRCC.

[5] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the Stte Water Plan*. Austin, Texas. TWDB.

[6] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[7] Gould, F. W. 1975 Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[8] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[9] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[10] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[11] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[12] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[13] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[14] www.tnris.state.tx.us

[15] Materials Resources----GIS

[15] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[15] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[15] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

---

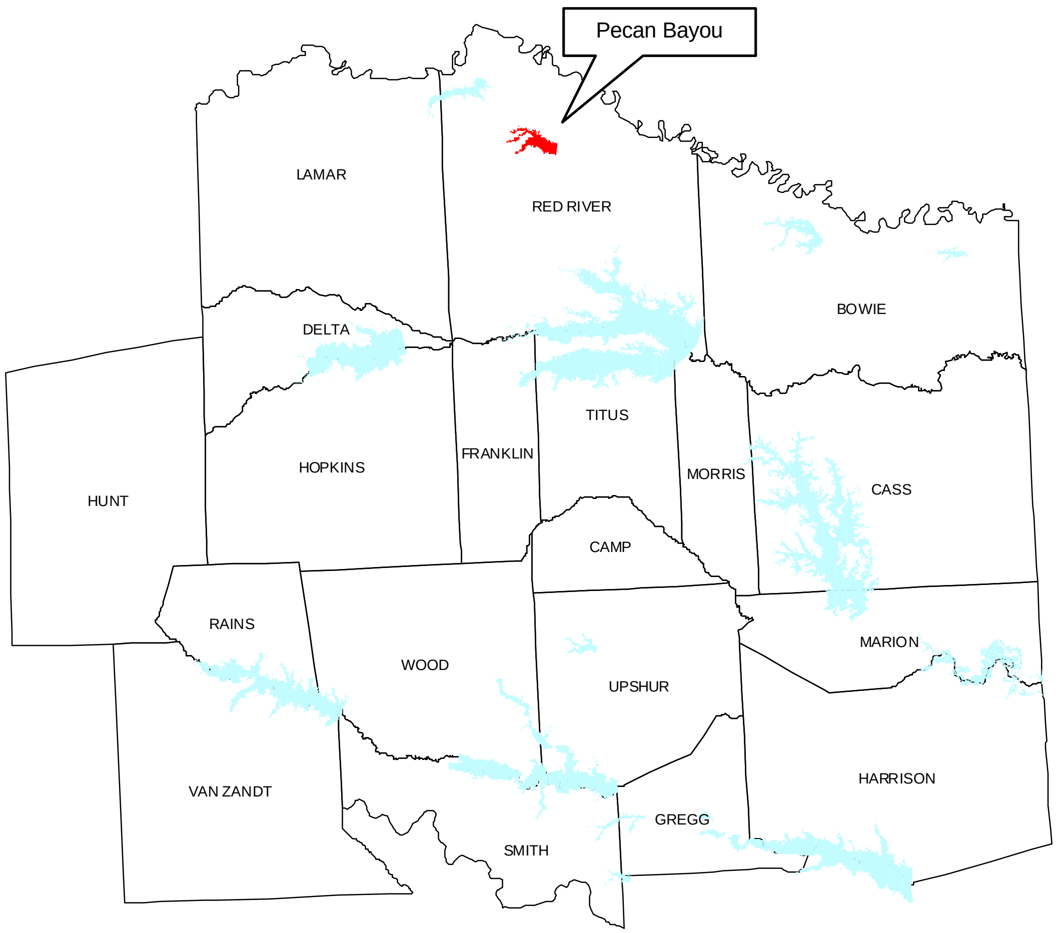
[15] [15]Hatch, Stephan L. , Kancheepuram M. Gandi, and Larry E. Brown. July 1990. *Checklist of the Vascular Plants of Texas.* College Station, Texas: Texas Agricultural Exper. Station.

5.13 PECAN BAYOU

5.13.1 Summary of Prior Studies

5.13.1.1 Location

Figure 5.13-1 Location of Pecan Bayou within the Region D Planning Region



The Pecan Bayou site[1] is in Red River county and is on a tributary of the Sulphur River. Twenty different sites were evaluated, of these, three sites were chosen as most probable by weighing individual factors shown in Table 1. The three sites[1] chosen were:

- McCoy Creek No. 2 – site 8, located about 18,000 ft away from Clarksville
- White Rock Creek – site 16, located approximately 48,000 ft away from Clarksville
- There are two alternatives for Young Creek – site 14, located approximately 24,000 ft away from Clarksville *(See Appendix, Exhibit A, Vicinity Map)*

5.13.1.2 Impoundment Size and Volume

For each alternative, USGS 7.5 minute quadrangle maps were used to estimate the normal pool and the PMF elevations or boundaries of the reservoir sites. A standard pool elevation or water depth of 20 feet was assumed for each reservoir and a PMF of ten feet was added to the standard pool to determine the approximate boundaries of the reservoir sites.[1]

The normal pool elevation at mean sea level, msl, area of inundation, and storage volume for each alternative are:

- 400 ft msl, 138 acres, and 916 acre-feet
- 360 ft msl, 197 acres, and 1998 acre-feet
- 370 ft msl, 112 acres, and 688 acre-feet

5.13.1.3 Site Geology and Topography

The "Soil Survey of Red River county, Texas" from the U.S. Department of Agriculture Soil Conservation Service, was used to determine if the soils within the normal pool area of the reservoir were suitable for water retainage. The "Geological Atlas of Texas, Texarkana Sheet" was used to determine the location of ground faults and the soil structure stability for dam construction.

The soil and geology[1] for each of the three alternatives are:

- Alternative 1 – Annona Chalk which should be acceptable for base construction and water retainage
- Alternatives 2 & 3 – Marlbrook Marl Clay which should be acceptable for dam construction and water retainage

All alternatives were free of faults according to the geologic atlas.

5.13.1.4 Dam Type and Size

For each dam design, the emergency and service spillways will be designed to pass the maximum design flow (PMF) at an elevation of ten feet above the normal pool elevation. An additional 4 feet was added to the peak flood elevation for freeboard and wave run-up. The top of dam elevation was therefore set at 14 feet above the normal pool level. The dam is an earth fill dam with a 3:1 upstream slope and a 4:1 downstream slope. The upstream face will be protected by riprap and the downstream face will be covered by vegetation. The dam will be design with an impervious clay cutoff wall.[1]

The top of dam elevation and length of dam for each alternative[1] are:

- 414 ft msl, and 3000 feet
- 374 ft msl, and 3000 ft
- 384 ft msl, and 2950 ft

The height of the dams are all assumed to be 34 feet.

5.13.1.4.1 Service Spillway

Two types of spillways were considered at each site, morning glory and ogee crest. For all four alternatives the spillway width was assumed to be 50 feet. The spillways are assumed to be ungated and are therefore set at the elevation of the normal pool elevation.

5.13.1.4.2 Emergency Spillway

The emergency spillway will be placed adjacent to the dam for each alternative. The elevation was set at 5 feet above the service spillway elevation. This is assumed to typically pass a moderately severe storm, such as the 100 year discharge.[1]

The required length of the different alternatives are:

- Alternative 1 – 180 ft
- Alternatives 2 & 3 – 200 ft

5.13.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to Pecan Bayou damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

All four alternatives were assumed to be able to pass the PMF without overtopping. A RESOP II analysis was performed to determine the firm yield. The parameters used in the model were drainage basin size, evaporation, runoff, physical characteristics of the drainage area and lake area versus elevation information.[1]

Since 20 locations were being considered, an estimate of the PMF flow was used to size the service and emergency spillways. The Meyers Formula was used to approximate flows for each alternative. The lengths of the spillways were sized using USACE Design Manual, "Hydraulic Design of Spillways – Low Overflow Spillways."

5.13.1.5.1 Reservoir Inflows

Ungauged tributaries of the Sulphur River feed the three sites being considered, therefore, in order to obtain reasonable streamflow data, flows from a neighboring gauged tributary (Boggy Creek near Daingerfield) were modified for input into the model.[1] The period of record is from 1944 to 1977.

5.13.1.5.2 Reservoir Site Characteristics

Area-Capacity data was developed from USGS Quadrangle maps.

5.13.1.5.3 Water Rights

The Texas Natural Resource Conservation Commission's (TNRCC) permitting section was contacted to determine if water appropriation for the potential reservoirs was possible. The TNRCC indicated that a model would need to be developed. However, for this level of study the 1989 Texas Water Commission study for Surface Water Availability was reviewed instead. Both Red River and Bowie Counties are designated as generally sufficient for new reservoir projects.

A review of the existing water rights permits[1] indicated that none of the water rights would be affected by the construction of a reservoir, and water appropriation for existing permitted users likely will not be of concern.

5.13.1.6 Water Quality

Water Quality standards from the EPA and TNRCC were reviewed to determine the recommended maximum constituent levels (MCL's) for drinking water. Three streams were sampled that are not feeder streams for the respective sites but were used since data was not available for those streams.

Of the nine inorganic primary MCL's regulated, Nitrate was the only one tested and was below the recommended MCL.[1]

Of the eight secondary inorganic MCL's, sulphate was the only one tested and was also below the MCL. Other secondary constituents that were tested were total dissolved solids (TDS) and pH. The TDS was below the MCL. The average of pH for 2 samples were above the MCL and the other sample was below.[1] A more detailed analysis of the feeder streams would be required before any conclusion of water quality could be made.

5.13.1.7 Project Yield for Water Supply

The results of the RESOP II model for the firm yield for each alternative are:

- firm yield equal to 1.32 MGD or 1,484 acre-feet/year
- firm yield equal to 1.57 MGD or 1,761 acre-feet/year
- firm yield equal to 1.67 MGD or 1,866 acre-feet/year

5.13.1.8 Other potential Benefits

The bulk of the study area has prospered because of the availability of water for growth and economic development. The west end of Bowie county and Red River county have not shared in this growth due to the uncertainty of adequate water supplies.

5.13.1.9 Land Acquisition and Easement Requirements

Land purchased will include those covered by the PMF.

5.13.1.9.1 Potential Land Use Conflicts

Three of the four alternatives require some road relocation. Alternative 2 would require 2,000 feet of Hwy 82 raised, which included an existing bridge. Alternative 3a and 3b require approximately 3,000 feet of farm road relocation. This could also serve as an entrance road to the new water treatment plant that is needed in for alternative 3b.

5.13.1.10 Project Costs

Opinions of probable project cost for the Pecan Bayou Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1996[1]. The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher capital cost estimate than the initial analysis. Please refer to

Table **5.13-1** for the Updated Project Cost and Table 5.13-2 for the Construction Cost.

5.13.1.10.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in

Table **5.13-1** as a lump sum cost. The assumed average developed cost per acre of land for the reservoir was $800/ac. If overhead and profit for the contractor and contingencies and engineering are included, the price per acre is $1,200. The take area for the reservoir system for purposes of this study is assumed to correspond to the PMF pool.

5.13.1.10.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in

Table **5.13-1**.

5.13.1.10.3 Construction Costs

As shown in Table 5.13-2, direct construction cost estimates were based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

Table 5.13-1 Updated Project Cost

Description	*Quantity*	*Unit*	*Cost ($)*	*Total Cost ($)*
CONSTRUCTION CAPITAL COST SUBTOTAL				
Dams & Reservoirs				$6,713,700
Relocations (conflict resolution)		L.S.		$500,000
Construction Capital Costs (CCC) Subtotal:				**$7,213,700**
OTHER PROJECT COSTS				
Engineering & Other Fees (35% of Total Construction)				$2,524,800
Land Cost		L.S.		$450,000
Studies, Mitigation, Permitting				$1,216,400
Mitigation Costs (equal to land cost)		L.S.	$450,000	
Permitting & Studies				
High classification (10% of Capital + Land)		L.S.	$766,400	
Interest During Construction				$1,085,000
Other Project Costs Subtotal:				**$5,276,200**
	Jan. 1995 Subtotal:			$12,489,900
20-City Average Escalation Factor	11.0%			$1,367,650
OPINION OF PROBABLE PROJECT COST				**$13,858,000**

Notes:

1. Original cost estimates were taken from MT&G and C&B, 1996.[1]
2. The engineering and other fees were increased to 35% and the construction costs (Table 5.13-2) overhead and profit was decreased to 15%.
3. Permitting, study, mitigation costs and interest during construction are included.

Table 5.13-2 Construction Costs

Item #	Description	Unit	Total Cost ($)
1	Contractor General Conditions	L.S.	$865,000
2	Site Work and Embankment	L.S.	$1,450,000
3	Treated Water Line	L.S.	$380,000
4	Raw Water Line	L.S.	$0
5	Concrete	L.S.	$875,000
6	Water Treatment Plant (1.0 MGD)	L.S.	$1,000,000
7	High Service Pump Station	L.S.	$240,000
8	Storage Reservoir (1.5 MGD)	L.S.	$750,000
	Base Construction Capital Cost Unescalated Subtotal (BCS)		**$5,560,000**
	Mobilization (5% of BCS)		$278,000
		Subtotal:	$5,838,000
	OH & P (15% of Subtotal)		$875,700
	Construction Capital Cost Subtotal (CCC)		**$6,713,700**

5.13.1.10.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 1,866 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $13,858,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Pecan Bayou Reservoir, the O&M is $207,870 and the annualized debt service is $981,200. The firm yield is then divided into the total annualized cost of $1,189,070 to yield a unit cost of $637.23 per acre-foot (1.96/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 contained in the executive summary.

5.13.2 Environmental Overview –Affected Environment and Environmental Consequences

5.13.2.1 Geological Elements

5.13.2.1.1 Physiography

The potential reservoir is located in the Post Oak Savannah vegetative region. The Post Oak Savannah vegetative region covers approximately 6.85 million acres of land. It averages 30-45 inches of precipitation annual with 235 to 280 frost-free days. The topography is nearly level to gently rolling with an elevation of 300-800 feet above msl. The Post Oak Savannah vegetative region lies just to the west of the Pineywoods vegetative region and mixes considerably with the Blackland Prairies vegetative region in the south. The Post Oak Savannah vegetative region is a gently rolling, moderately dissected wooded plain.

Upland soils are gray, slightly acid sandy loams commonly shallow over gray, mottled or red, firm clayey subsoils. They are generally droughty and have claypans at varying depth, restricting moisture percolation. The bottomland soils are reddish brown to dark gray, slightly acid to calcareous, loamy to clayey alluvial. Short oak trees occur in association with tall grasses. Thicketization occurs in the absence of recurring fires or other methods of woody plant suppression.[2]

5.13.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been "sinking", and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River Counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[3]

The area of the potential reservoir was formed during the upper cretaceous and the Pleistocene Periods. The area is composed of Alluvium, Fluviatile terrace deposits, Brownstone Marl, Blossom Sand, Bonham Formation and Annona Chalk.[4]

Alluviums are flood-plain deposits. It is found within the Red River drainage system and includes low terrace deposits not readily distinguishable on high altitude aerial photographs. The top surface is 8 +/- 3 feet above flood plain.

Fluviatile terrace deposits consist of gravel, sand, silt, and some silty clay. Basal gravel is well sorted, cross-bedded and grades upward into well-bedded sand and silt with some beds of silty clay. It is mostly red to reddish tan and the surface is smooth, and not greatly dissected. The soils are relative immature, and show distinct zonation. Both fresh-water and terrestrial molluscan faunas are identified. The maximum thickness is 30 feet.

Brownstone Marl is partly sandy and glauconitic as base, phophatic and dark gray. The weathers are yellowish gray with marine magafossils common. It is 80-175 feet thick and thins westward.

Blossom Sand is quartz sand, which is calcareous, glauconitic, ferruginous, and brown with thin clay interbeds. The weathers are brown and red. The upper part is abundant in marine megafossils in sandstone concretions. It is 20-250 feet thick and thins westward.

Bonham Formation is a marl, progressively more sandy eastward. Glauconite is abundant locally. It is waxy and greenish gray with weathers that are yellowish gray. It has clay bed near the middle, and is calcareous and abundantly glauconitic. Marine megafossils are common. It is 375-530 feet thick.

Annona Chalk is part argillaceous and sandy. It is thickly bedded to massive, hard, and bluish white. The weathers are white. Marine megafossils are scattered. It is approximately 450 feet thick and thins eastward.

5.13.2.1.3 Soils

The area of the potential reservoir, Pecan Bayou, contains nine major soil groups.[9] These groups are Annona-Freestone-Woodtell, Kaufman-Gladwater-Texark, and Sawyer-Eylau-Sacul. Approximately 14.3 percent of the area is Annona-Freestone-Woodtell, 72.8 percent Kaufman-Gladewater-Texark, and 12.9 percent Sayer-Eylau-Sacul. Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Annona

The Annona series consists of very deep, moderately well-drained, very slowly permeable soils. They formed in clayey sediments. These soils are on terraces of Pleistocene age. Slopes range from 0 to 8 percent. Mean annual temperature ranges from 64 to 68 degrees F., mean annual precipitation ranges from 40 to 48 inches, and the summer rainfall is about 25 to 30 inches. Frost-free days range from 230 to 280. The elevation ranges from 200 to 500 feet above msl. Thornthwaite annual P-E index ranges from 64 to 78. Runoff is low for 0 to 1 percent slopes, medium on 1 to 3 percent slopes, high on 3 to 5 percent slopes, and very high on 5 to 8 percent slopes. A saturated zone is perched above the Bt horizon for short periods following heavy rains. Almost all of this soil is in pasture and woodland. Forests are mixed hardwood and pine. Major hardwood species are red oak, post oak, sweetgum, and hickory. Needleleaf trees are shortleaf and loblolly pine. Pastures include improved bermudagrass, common bermudagrass, bahiagrass, with arrowleaf clover, crimson clover, and vetch overseeded. Some areas are used for growing corn, soybeans, grain sorghum, wheat, or hay crops.

Eylau

The Eylau series consists of deep, moderately well-drained, moderately slowly permeable soils that formed in thick loamy Coastal Plain sediments on uplands. Slopes are dominantly 1 to 2 percent but range from 0 to 5 percent. Mean annual precipitation ranges from 45 to 55 inches. Mean annual temperature ranges from 64 degrees to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64 inches. A perched water table is at 2 to 3 feet below the surface from February to May. Most of the acreage is in improved pasture of bermudagrass, bahiagrass, dallisgrass, and pine-oak woodland. A few areas are used for cropland. Native vegetation consists of loblolly pine, southern red oak, sweetgum, post oak, hickory, beaked panicum, longleaf uniola, and annuals.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Gladewater

The Gladewater series consists of very deep, somewhat poorly drained, very slowly permeable soils on floodplains formed in clayey alluvium in floodplains. Slope ranges from 0 to 1 percent. The mean annual precipitation ranges from 38 to 46 inches and mean air temperature ranges from 64 to 68 degrees F. Frost-free days range from 235 to 275 days and elevation is 200 to 400 feet above msl. Thornthwaite P-E index ranges from about 62 to 74. Depressional areas are very poorly drained. Most of the acreage is in pasture or forest. Some areas are in native pasture or range. Pasture areas are introduced grasses such as dallisgrass and fescue. Forested areas are in mixed hardwoods including water oak, willow oak, cedar elm and black willow.

Kaufman

The Kaufman series consists of very deep, moderately well-drained, very slowly permeable soils on floodplains formed in clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 2 percent. Mean annual precipitation ranges from 35 to 50 inches, and mean annual temperature ranges from 62 to 70 degrees F. Frost-free days range from 230 to 280 days and elevation ranges from 100 to 550 feet above msl. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in pasture of dallisgrass, bermudagrass, and fescues. A few areas are used for producing cotton, corn, sorghums, and soybeans. Native vegetation is hardwoods such as elm, hackberry, oak, ash, and grasses which includes species of andropogon, paspalum, panicum, and tripsacum.

Sacul

The Sacul series consists of very deep, moderately well-drained, slowly permeable soils that formed in acid, loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 2 to 25 percent but range from 1 to 40 percent. The average annual air temperature ranges from about 60 to 66 degrees F and the average annual precipitation ranges from about 48 to 54 inches. Most of the acreage is in woodland, with some area in pasture. The forest vegetation is shortleaf and loblolly pine, red oak, sweetgum, and dogwood. Bermudagrass and bahiagrass are the principal pasture grasses used.

Sawyer

The Sawyer series consists of very deep, moderately well-drained, slowly permeable soils that formed in loamy and clayey marine sediments on uplands of the Western and Southern Coastal Plains. Slopes are dominantly 1 to 8 percent but range to 25 percent. The average annual temperature ranges from about 60 to 66 degrees F. and the average annual precipitation ranges from about 48 to 54 inches. Most areas of this soil are in forests of loblolly and shortleaf pine. Cleared areas are dominantly used for pasture. The native vegetation was mixed shortleaf pine and hardwood forest.

Texark

The Texark series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in clayey alluvium floodplains that drain mainly from the Blackland Prairies. Slopes are 0 to 1 percent. Average annual precipitation ranges from 40 to 55 inches, average annual temperature is 62 degrees to 70 degrees F. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in forest, pasture, and wildlife habitat. Native vegetation conaiata of hardwood trees such as green ash, hackberry, water oak, willow oak, elm, and sweetgum. Understory vegetation consists of hawthorns, sedges, grasses, and annual weeds.

Woodtell

The Woodtell series consists of soils that are deep to stratified shale and loamy materials on gently sloping stream divides. They are well-drained and very slowly permeable. The slope ranges from 1 to 20 percent. Woodtell soils are strongly to moderately steep side slopes of uplands. Slope gradients are mainly 2 to 12 percent but range from 1 to 20 percent. The soils formed in materials weathered from unconsolidated, stratified loamy, clayey, and shaly materials of Eocene age mainly in the Wilcox and Cook Mountian formations. The average annual rainfall ranges from 40 to 46 inches. The mean annual temperature is about 62 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 78. Frost-free days range from 230 to 270 and elevation ranges from 300 to 650 feet above msl. These soils are used mainly for pasture. Native vegetation is mainly post oak, blackjack oak, elm and red oak in a fairly dense savannah. In open areas tall and mid grasses such as bluestems, tridens and panicums are common with longleaf uniola under the tree canopy. American beautyberry and hawthorn species are also a part of the understory. The main pasture plants are bermudagrass and bahiagrass with crimson and arrowleaf clovers. There are scattered shortleaf and loblolly pine with small plantations and a some dense pine areas on the eastern side of the series province. Some areas are planted to small grain for winter grazing.

5.13.2.2 Hydrological Elements

5.13.2.2.1 Surface Water

The potential reservoir is located within the Red River Basin on Pine Creek. Pecan Bayou drains into the Red River. This portion of the Red River is included in the Texas Natural Resource Conservation Commission (TNRCC) – *The State of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 202 (Red River below Lake Texoma). This 194-mile segment originates from the Arkansas-Oklahoma State Line in Bowie county to Denison Dam in Grayson county. This segment is classified as "water quality limited" and designated uses are for contact recreation, high aquatic life, and public water supply. No water quality problems are known to exist in this segment.[5]

5.13.2.2.2 Ground Water

Red River county is located within the Trinity Aquifer. The potential reservoir, Pecan Bayou, is within the downdip portion of the Trinity Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. Some water-bearing formations dip below the surface and are covered by other formations. This is the downdip. Water from the Antlers portion of the Trinity Aquifer is mainly used for irrigation in the outcrop area of north and central Texas.

The Trinity Aquifer consists of early Cretaceous age rocks of the Trinity Group formations which occur in a band from the Red River in north Texas to the Hill Country of south-central Texas and provides water in all or part of 55 counties. Usable quality water (containing less than 3,000 mg/l dissolved solids) occurs to depths of up to about 3,500 feet.

Water quality from the Trinity Aquifer is acceptable for most municipal and industrial purposes, however excess concentrations of certain constituents in many places exceed drinking-water standards for municipal supplies. Heavy pumpage and water-level declines in the north central Texas region have contributed to deteriorating water quality in the aquifer. Water quality naturally deteriorates in the downdip direction of all the Trinity water-bearing units.[6]

5.13.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Pecan Bayou reservoir will cause water to be impounded on the Pine Creek as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Pecan Bayou reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.13.2.4 Biological Elements

5.13.2.4.1 Vegetation

The potential Pecan Bayou reservoir is centrally located within the Texan province[7] and is within the Post Oak Savannah region.[8] The Post Oak Savannah vegetation area typically has a gently rolling to hilly topography, with moderately dissected wooded plain. The soil composition for this community consists of gray, slightly acidic sandy loams, and reddish brown to dark gray, slightly acidic to calcareous, loamy to clayey alluvial. The Post Oak Savannah soils support short oak trees and tallgrasses. Trees in the region consist of post oak and blackjack oak, elms, junipers, hackberries, and hickories. Yaupon, American beautyberry, coralberry, greenbriar, and grapes are shrubs and vines that are characteristic to the area. Grasses in the area includes little bluestem, indiangrass, switchgrass, silver bluestem, Texas wintergrass, purpletop, narrowleaf wildoats, beaked panicum, brownseed paspalum, threeawn, broomsedge bluestem, splitbeard bluestem, rosette grasses, and lovegrasses. Forbs in the region consist of wild indigo, indigobrush, sennas, tickclover, lespedeza, prairie-clovers, western ragweed, crotons, and sneezeweeds. There has been some vegetation introduced into the area, including bermudagrass, bahiagrass, weeping lovegrass, and clover.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Pecan Bayou reservoir location includes Pine Hardwood (100%).

5.13.2.4.2 Fish and Wildlife

The result of the potential Pecan Bayou reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Pecan Bayou reservoir is located within the Prairies and Lakes Eco-region. Some of the common wildlife in this region includes the plains pocket gopher, beaver, raccoon, porcupine, Texas kangaroo rat, hispid cotton rat, ornate box turtle, green-winged teal, bobwhite quail, red-shouldered hawk, scissortail flycatcher, white-tailed deer, Brazilian freetail bat, ringtail, nine-banded armadillo, eastern hognose snake, tarantula, Texas horned lizard, golden cheeked warbler, black-capped vireo, northern mockingbird, and guadelupe bass. [9]

5.13.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.13-3). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

Table 5.13-3 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Red River County).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Eskimo Curlew	*Numenius borealis*	LE	E
Least tern	*Sterna antillarum***	LE	NL
Fishes			
Creek Chubsucker	*Erimyzon oblongus*		T
Shovelnose Sturgeon	*Scaphirhychus platorynchus*		T
Western Sand Darter	*Etheostoma clarum*		T
Mammals			
Black Bear	*Ursus americanus*	T/SA	T
Reptiles			
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Arkansas meadow-rue	*Thalictrum arkansanum*		R

Sources: USFWS 1998, TPWD 1999.

USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Red River County, 1998a.)

5.13.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the “highest importance as potential ecologically unique stream segments.” There are no TPWD determined high importance potential ecologically unique streams within or adjacent to the footprint of the potential Pecan Bayou reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.13.2.6 Wetlands

The term “wetlands” encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: “Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.” In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (Natural Resource Conservation Service) data shows three hydric soil associations are within the potential Pecan Bayou reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.13.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith county. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are no known existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Pecan Bayou reservoir *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.13.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-county study area. The potential Pecan Bayou reservoir is located within the Red River basin, which represents a negligible quantity of the remaining bottomland hardwood in Texas.

There are no USFWS designated priority bottomland hardwoods located within or adjacent to this site.[10] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.13.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property.

Various private, state, or federal entities often manage these easements. Typically the entity enforces the restrictions of the easement.

There are no conservation easements located within the footprint of the potential Pecan Bayou reservoir.

5.13.2.10 Social and Economic Conditions

The potential reservoir is located in Red River county. The population of this county according to the 1990 Census is 14,317. The Texas State Data Center has estimated the 2020 population to be approximately 15,077. This corresponds to a five-percent growth in Red River county.[11] The median household income for Red River county in 1989 was $16,217.[12]

5.13.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Pecan Bayou reservoir will affect portions of Red River Counties.

Historical and Archeological Resources for the area was determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.13-4.[19]

Table 5.13-4 Historical and Archeological Resources for Pecan Bayou.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Red River	115	1	108	0	6	0

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.13-5) details the results of previous cultural studies that have been performed on the area since 1879. Some counties have been investigated more thoroughly than the other counties for cultural resources. This is important to note because there is a high potential for more archeological sites being discovered in counties that have not been excessively studied, such as Red River county.[13]

Table 5.13-5 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Red River	32	104	30	18	184
Sub-total	32	104	18	49	184

* Significance refers to National Register criteria.
Source: THC, 1993.

5.13.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the northeast Texas region has been determined and is presented in Table 5.13-6.

Table 5.13-6 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.13-7 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.13-7 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Red River			5	12	14

Source: THC, 1993, and Perttula T. K., 1999.[14]

5.13.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.13.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture.

Table 5.13-8 depicts the percent coverage by major land uses within the reservoir study area.[15]

This Space Intentionally Left Blank

Table 5.13-8 Land Use for the Potential Pecan Bayou Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	33%
Evergreen Forest Land	19%
Mixed Forest Land	47%
Mixed Rangeland	1%
Residential	1%

5.13.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites, municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are no Superfund sites, municipal solid waste landfill sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.

5.13.2.14 Potential Environmental Impact Summary

Table 5.13-9 Potential Environmental Impact Summary for Pecan Bayou.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown

This Space Intentionally Left Blank

[1] Murray, Thomas & Griggin, Inc. and Carter and Burgess. Regional Water Supply Planning Study – Red River and Bowie Counties. August, 1996.

[2]Hatch, Stephan L. , Kancheepuram M. Gandi, and Larry E. Brown. July 1990. *Checklist of the Vascular Plants of Texas.* College Station, Texas: Texas Agricultural Exper. Station.

[3] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[4] Bureau of Economic Geology. July 1966. "Geologic Atlas of Texas: Texarkana Sheet". Austin, Texas. The University of Texas.

[5] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96.* Austin, Texas. TNRCC.

[6] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the Stte Water Plan.* Austin, Texas. TWDB.

[7] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science,* 2:93-117.

[8] Gould, F. W. 1975 Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[9] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[10] United States Fish and Wildlife Service. 1984. *Texas Bottomland Hardwood Preservation Program, Category 3; Final Concept Plan*. Albuquerque, New Mexico: Department of the Interior, USFWS.

[11] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[12] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[13] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[14] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

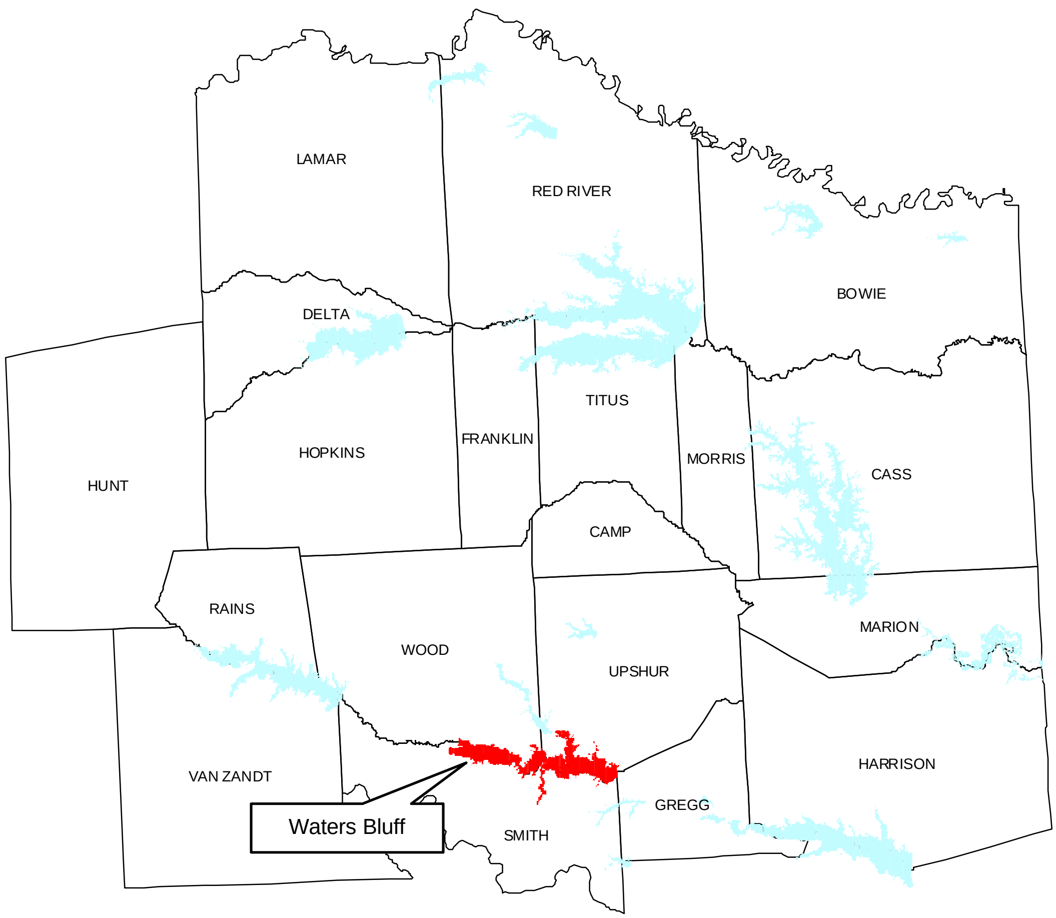
[15] www.tnris.state.tx.us ----GIS

5.14 WATERS BLUFF

5.14.1 Summary of Prior Studies

5.14.1.1 Location

Figure 5.14-1 Location of Waters Bluff within the Region D Planning Region



The Waters Bluff Reservoir Dam is located on the Sabine River about 3.5 miles upstream of the Highway 271 crossing and approximately 4 miles southwest of Gladewater, Texas. This is part of the Sabine River Basin above the Toledo Bend Reservoir and within Wood, Upshur and Smith Counties *(See Appendix, Exhibit A, Vicinity Map).*

5.14.1.2 Impoundment Size and Volume

With a conservation pool Elevation of 303 ft msl,[1] the reservoir will have a storage of 525,163 acre-ft, a surface area of 36,396 acres and a supply yield of 324,000 ac-ft/yr. The maximum flood elevation is 314.7 ft msl.

5.14.1.3 Site Geology and Topography

Basin soils consist of the Black land Prairie, East Texas Timberland, and Coastal Prairie types. Higher erosion susceptibility due to their sloping nature and clay texture has caused greater sediment production rates, a matter to be taken into consideration for reservoir operation analyses.[1]

Tertiary deposits of poorly consolidated sandstone, clay, and shale are the majority of the soils located within the study area. The two major groups are the Claiborne and Wilcox. The rocks forming the Wilcox Group were deposited about 52 million years ago and have two main formations which contain sandstone, shale and lignite. The rocks of the younger Clairborne Group were deposited from about 48 to 43 million years ago. Eight formations make up the Clairborne Group, two of which, the Carrizo and Queen City, are important aquifers for the region.[2] The Carrizo-Wilcox aquifer is by far the best supply of good quality water.

5.14.1.4 Dam Type and Size

The dam is a 70 ft high homogeneous earthen embankment with a top width of 25 ft, side slopes at 3:1, a crest length of 11,000 ft and a top dam elevation of 320 ft msl[3]. It will have a concrete gravity ogee spillway, crest elevation 276 ft msl, with eleven 40 ft wide by 28 ft high tainter gates for control[4]. The spillway design discharge is 218,350 cfs.

5.14.1.5 Hydrology and Hydraulics

The amount and distribution of naturalized streamflows throughout the basin tributary to the Waters Bluff damsite is fundamental to the analysis of water availability for existing water rights as required by Senate Bill 1. This data is also important to assess the potential unappropriated water when considering water availability for new water rights. The hydrologic data required for these studies generally include daily reservoir inflows, net reservoir evaporation data, and reservoir area and capacity characteristics.

Streamflows, evaporation, adjusted area-capacity relationship which reflect sedimentation and water rights information for streamflow maintenance are the major factors into the reservoir operation study for firm yield determination. A computer program, SIMYLD-II, developed by the Texas Water Development Board was used for reservoir studies within the Sabine River Basin. It was used for its effectiveness in analyzing water data in multi-basin systems.[5] The net contributing area to the reservoir is 1,386 square miles and the total drainage area is 2,735 square miles.[4] Input used in the reservoir operation study for Waters Bluff Reservoir included the following:

- reservoir inflows
- lake evaporation
- sediment volume
- area-capacity curve data

5.14.1.5.1 Spillway

A 6-hr unit hydrograph modeled after unit graphs developed in 1976 by COE was used in estimating the spillway design flood. Included in the analysis were direct rainfall rates, spills from Tawakoni Reservoir with a 6 period lag and spills from Lake Fork Reservoir with a 2 period lag.[4]

5.14.1.5.2 Reservoir Inflows

A period of record from January 1941 through December 1979 from USGS recording gauges throughout the study area was used to estimate reservoir inflows on a monthly basis. Adjustments for depletions of flow were made for known historic reservoir operation studies in which only reservoirs with a capacity of 5,000 ac-ft or greater were considered.[6] Adjustments for land treatment measures, farm ponds and minor reservoirs, floodwater-retarding structures and urbanization when determining natural runoff estimates. The critical drought period for the study area was from 1952 to 1957.[7] Lag time was excluded due to difficulty in accuracy of determination.

The Waters Bluff Reservoir encompasses a drainage area of 2,735 square miles. Data for the hydrologic studies of the reservoir inflows was obtained from the USGS Water Data Storage and Retrieval System

(WATSTORE) in Reston, Virginia. Monthly streamflow records from the existing gauges within the Sabine Watershed were used to estimate natural inflows. Naturalized streamflows represent streamflow conditions without man-made effects. The computer simulation model accounted for the effects of upstream reservoirs and water demands.[4]

5.14.1.5.3 Lake Evaporation

A period of record from January 1941 through December 1979 from the National Weather Service precipitation/evaporation stations throughout the study area was used to estimate net lake evaporation. Adjustments were made using contour maps broken into quadrangles.[7]

5.14.1.5.4 Sediment Volume

Data for suspended sediment load of Texas streamed was obtained from TDWR and USGS. Suspended-sediment rating curves and flow-duration curves were used to estimate sediment volume where an assumed unit weight of 70 lb/cf for particle size was used.[7]

5.14.1.5.5 Area Capacity Data

The elevation-area-capacity relationship (also referred to as area-capacity curve) for a reservoir is generally developed during the reservoir planning phase. The relationship is based upon existing conditions taken from USGS quad map topography of the land to be inundated by the reservoir.[7]

5.14.1.5.6 Pass-Through Flows for Downstream Maintenance

Minimum discharge is important to protect downstream environmental requirements. With firm yield operation of the reservoir, a minimum flow of 56 cfs would be maintained to help protect downstream habitat. This is less than the required 20 cfs minimum streamflow to sustain aquatic habitat as specified by the environmental mitigation plan. Higher flows will be released for short periods during historic low flow periods.[2]

5.14.1.6 Water Quality

Water from the Carrizo-Wilcox aquifer is generally good; however, corrosive water with high iron content can occur within the northeastern part of the aquifer.[7]

Potential for mineral development to impact water quality does exist for the Sabine River Basin. Dissolved metals such as selenium, aluminum, silver and mercury have been detected in the past near mining operations. However, no known mines exist in the area of interest; thus, it has no associated water quality issues.[1] Historical water data in the basin shows instances of exceedence with chloride, sulfate, fecal coliform, pH and dissolved oxygen. However, standards are not necessarily violated if the levels return to below limits, or above the limit in the case of dissolved oxygen, within a pre-determined amount of time.[8]

5.14.1.7 Project Yield for Water Supply

The project firm yield is 324,000 ac-ft/yr. The critical drought for the Waters Bluff Reservoir is from August 1952 through May 1957.[5]

5.14.1.7.1 Water Rights

Of the Upper and Lower Sabine Basin, the majority of the existing water rights exist in the upper basin, totaling 163 just in the area between Toledo Bend reservoir and Lake Fork and Iron Bridge Dams. The total permitted water rights for the upper Sabine Basin amount to approximately 723,000 ac-ft/yr.[1] This is the area of highest demand, and even the currently unused rights in the area will not be made available as they are being saved for future use.

5.14.1.8 Other Potential Benefits

Potential benefits associated with construction of the Waters Bluff Reservoir include water supply and recreation such as swimming and fishing. Hydropower to supplement growing energy needs is also applicable and it will change the cost estimates, which will be shown later in this report.[9]

5.14.1.9 Land Acquisition and Easement Requirements

Four mitigation banks and one non-development conservation easement are within the area that will hinder the land acquisition process. The Little Sandy conservation easement will require a Congressional override for development in the area to occur.[1]

Portions of the surface area that would be inundated contain bottomland hardwoods. Of the types of terrestrial habitat that would be affected by the creation of the reservoir, the most affected would be deciduous forested wetland (DFW).[2]

With regards to easements, mitigation banks and bottomland hardwoods, Waters Bluff is of highest concern among the Sabine River Basin reservoir sites and will have higher costs as a result.[1]

5.14.1.10 Potential Land Use Conflicts

Lignite reserves in the area are considered to be too deep to mine or are likewise inadequate to be commercially mineable.[7] Of the 5 oil and gas fields located adjacent to the site, the Fhawkins Field is the largest and had at most 5 producing wells in 1985 that would be inundated with the formation of the reservoir. All other fields are small and overall oil and gas conflict is minor.[8]

Approximately 7 prehistoric cultural sites are located in the reservoir area.[1]

Table 5.14-1 Reservoir Conflicts Table

No.	*Conflict*	*Cost*
1	Main Highways	$38,008,000
2	Light-Duty Roads	$9,582,500
3	Pipelines	$17,175,000
4	Power Lines	$1,500,000
5	Railroads	$9,250,000
6	Oil Wells	$253,140
7	Dwellings	$1,000,000
8	Fish Hatchery	$750,000
9	Pump Station	$1,250,000
10	Aquaduct	$1,850,000
11	Water/Wastewater Plant	$8,750,000
12	Gaging Station	$75,000
	Total:	**$89,443,640**

5.14.1.11 Local, State and Federal Permitting Requirements

Among the permitting requirements for water resource projects are environmental rules. The Waters Bluff site is on a navigable waterway and congressional override of the Little Sandy easement is required to obtain approval to construct the dame per the Rivers and Harbors Act of 1899.[1] This rule and others that may apply are listed in Table 5.14-2.

Table 5.14-2 Major Permitting Requirements

Permit	*Issuing Agency*	*Summary of Requirements*
Section 404 Permit, Clean Water Act of 1972	U.S. Army Corps of Engineers (COE)	Applicable to all new dams in the United States because they add new dredge or fill material to U.S. waters.
Section 10 Permit, Rivers & Harbors Act of 1899	U.S. Army Corps of Engineers	Usually applied for in conjunction with Section 404. Congressional approval required for construction of obstructions on navigable waters.
Section 7 Consultation & Section 10 Permit	U.S. Department of the Interior, Fish & Wildlife Service (USFWS)	Required for the incidental taking of endangered or threatened species. Mitigation is also generally a requirement as a condition of the permit.
Water Rights Permit	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone wanting to divert, use or store surface waters, or transfer surface water between basins. Includes environmental, hydrologic and conservation assessments.
Section 401 Certification, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Certification that projects obtaining a 404 permit will not degrade water quality below state standards.
TPDEX Discharge Permit, Clean Water Act of 1972	Texas Natural Resource Conservation Commission (TNRCC)	Requirement for anyone who discharges wastewater into the Sabine Basin.
Grant of Easement	Texas General Land Office	Requirement for projects that cross or impact state owned waterways.

5.14.1.12 Updated Project Costs

Opinions of probable project cost for the Waters Bluff Dam and reservoir system are developed in this section. Estimated project costs include costs for construction of the dam, dam appurtenances, cost of addressing land use conflict, land acquisition, and other cost items. Cost estimates are based on unit prices and data prevailing in 1998.1 The cost estimates are updated to the second quarter of 1999 (June) using the Engineering News Record Construction Cost Index (ENR-CCI) 20-city average construction cost indexes. According to ENR, the 20-city average indexes are generally more appropriate for estimating construction cost as they have more elements and have a smoother trend than the ENR Cost Index for individual cities.

The project costs updated in this study are intended to allow comparison among the alternative reservoir systems. These costs, which include capital costs and other project costs, are preliminary in nature and are based on available information, previous experience with similar projects, and preliminary project planning and layouts. The capital costs for reservoir system development include resolution of conflicts with existing facilities, pipelines and pump stations and reservoir dam construction and related costs. Other project costs include engineering and environmental studies, archaeological surveys and testing, costs of the permitting process and design of the dam and spillway.

The cost of engineering and environmental studies, archaeology and permitting is estimated based on recent experience with the development of major reservoirs in Texas. The cost of permitting a major reservoir is difficult to predict because of changing regulations and because of variations in the level of opposition from project to project. The cost of mitigation measures associated with reservoir development is difficult to predict because the measures required vary greatly from project to project.

Uniformity with the presentation of the project costs updates for all the reservoir sites required adjusting the format of previous cost estimates from various reports by different authors to fit a standard layout. As many reports were missing what are considered essential elements in preparing a project cost estimate for the reservoir site, they were added to each reservoir as necessary. Cost tables follow the guidelines for formatting standards set forth in "Exhibit B" as dictated by the Texas Water Development Board unless mentioned otherwise. The following adjustments were made for the construction costs:

- Reservoir cost estimates that did not include a Contractor Overhead and Profit contingency added at an assumed 15% of construction cost subtotal.
- Reservoir cost estimates that did not include a mobilization cost added at a 5% of Base Construction Subtotal.

The following adjustments were made for the other project costs:

- Reservoir cost estimates that did not include mitigation costs were added at an assumed equal to land cost as done by the Freese and Nichols *Sabine Watershed Management Plan*, 1999.
- Reservoir cost estimates that did not include permitting and/or studies costs were added at an assumed 10% of land cost.
- Engineering fees, which were taken at 35% of the Construction Capital Cost, include the following: engineering and design, contingencies, financial and legal services. Land costs, rights-of-way, permits, environmental and archaeological studies and mitigation are listed separately.
- To keep all cost update tables uniform, all cost estimates taken from reports authored by the Freese and Nichols 1999 Sabine Watershed Management Plan deleted the 20% contingency of the overall project cost. This contingency cost is covered in the 35% Engineering and Related Item Fee.
- Interest during construction was accrued assuming 4 years of construction using only the construction cost at a 6% interest rate and 4% investment.

These changes resulted in a higher capital cost estimate than the initial analysis. Please refer to

Table 5.14-3 for the Updated Project Cost and Table 5.14-4 for the Construction Cost.

5.14.1.12.1 Land Acquisition

The acquisition of land includes the purchase of land in the conservation pool, and flood easements for land above the conservation pool, the purchase of lignite rights, the costs associated with acquisition, and an allowance for contingencies as shown in

Table 5.14-3. The assumed average developed cost per acre of land for the reservoir was $2,300/ac. The take area for the reservoir system for purposes of this study is assumed to correspond to the conservation pool of about 36,400 acres plus the additional surface area attained above the conservation pool elevation, which together is approximately 45,495 ac.

5.14.1.12.2 Conflict Resolution

Conflict costs include the cost of necessary improvements to and protection for roadways, pipelines, oil and gas facilities, cemeteries, and other miscellaneous structures. This cost item is included in

Table 5.14-3.

5.14.1.12.3 Construction Costs

As shown in Table 5.14-4, direct construction cost estimates was based on the assumption that standard equipment and conventional construction practices would be used. The base construction subtotal (BCS) is the sum of the estimated construction costs for each major component. An allowance for mobilization, bonds and insurance was included in direct construction cost estimates. Those estimated costs for mobilization, bonds and insurance are based on percentages of the BCS. Allowances were also made for Contractors' overhead and profit. Major items included in Contractors' overhead were: (1) supervisory, administrative and general service personnel, (2) vehicles, (3) office equipment and supplies, (4) field office and shops, (5) communication, and (6) home office overhead. The estimated costs for overhead and profit are based on the summation of the BCS and the mobilization, bonds and insurance. The construction capital cost (CCC) is the sum of the BCS plus cost allowances for mobilization, bonds and insurance, and overhead and profit. The costs for facilities required to connect the reservoir system to the water users is not included.

This Space Intentionally Left Blank

Table 5.14-3. Updated Project Cost

Description	***Quantity***	***Unit***	***Unit Price ($)***	***Cost ($)***	***Total Cost ($)***
CONSTRUCTION CAPITAL COST SUBTOTAL					
Dams & Reservoirs					$70,369,000
Relocations (conflict resolution)		L.S.			$89,443,640
Construction Capital Costs (CCC) Subtotal:					**$159,812,700**
OTHER PROJECT COSTS					
Engineering & Other Fees (35% of Total Construction)					$55,934,500
Land Cost	45,495	Ac.	$2,300.00		$104,638,500
Studies, Mitigation, Permitting					$131,083,700
Mitigation				$104,638,500	
Permitting and Studies					
High classification (10% of Capital + Land)				$26,445,200	
Interest During Construction (4 yrs.)					$11,376,000
Other Project Costs Subtotal:					**$303,032,700**
		December 1998 Subtotal:			$462,845,400
20-City Average Escalation Factor	0.8%				$3,702,770
OPINION OF PROBABLE PROJECT COST					**$466,549,000**

Notes:

1. Original cost estimates were taken from F&N, 1999.
2. Interest during construction was included.
3. The engineering and other fees were increased to 35%.

Table 5.14-4 Construction Cost

Item #	*Description*	*Quantity*	*Unit*	*Unit Price ($)*	*Cost ($)*
	Dam Embankment				
1	Diversion and Care of Water		L.S.		$ 1,278,000
2	Clearing and Grubbing	90	Ac.	$532.50	$ 47,925
3	Excavation	860,200	C.Y.	$2.84	$ 2,442,968
4	Random Fill	716,400	C.Y.	$0.85	$ 608,940
5	Impervious Embankment Core	329,100	C.Y.	$0.85	$ 279,735
6	Soil Cement	55,450	C.Y.	$24.14	$ 1,338,563
7	Filter Material	78,500	C.Y.	$17.04	$ 1,337,640
8	Access Road and Road on Dam	32,200	S.Y.	$6.39	$ 205,758
9	Stripping and Inspection Trench	116,800	C.Y.	$2.13	$ 248,784
	Spillway				
10	Sill Concrete	24,850	C.Y.	$200.00	$ 4,970,000
11	Pier Concrete	19,300	C.Y.	$250.00	$ 4,825,000
12	Basin Concrete	22,340	C.Y.	$250.00	$ 5,585,000
13	Training Wall Concrete	18,800	C.Y.	$325.00	$ 6,110,000
14	Cement	24,740	Ton	$106.50	$ 2,634,810
15	Reinforcing Steel	5,700	Ton	$1,136.00	$ 6,475,200
16	Tainter Gates (40' X 28')	11	Ea.	$742,500.00	$ 8,167,500
17	Gate Anchorage		L.S.		$ 976,960
18	Gate Machinery		L.S.		$ 2,577,300
19	Maintenance Bulkheads	110,000	L.B.	$4.26	$ 468,600
20	Misc. Metals and Embeds	233,450	L.B.	$5.68	$ 1,325,996
21	Spillway Bridge		L.S.		$ 535,340
22	Foundation Drainage		L.S.		$ 1,299,300
23	Approach Slab	9,450	C.Y.	$250.00	$ 2,362,500
24	Stone Protection	31,850	Ton	$65.32	$ 2,080,442
25	Graded Filter Riprap	4,950	C.Y.	$17.04	$ 84,348
26	Upstream Impervious Blanket	11,650	C.Y.	$0.85	$ 9,903
27	Non-Overflow Section		L.S.		$ 1,327,700
	Base Construction Capital Cost Unescalated Subtotal (BCS)				**$ 58,276,520**
	Mobilization (5% of BCS)				$2,913,830
			Subtotal:		$ 61,190,350
	OH & P (15% of Subtotal)				$ 9,178,560
	Construction Capital Cost Subtotal (CCC)				**$ 70,369,000**

5.14.1.12.4 Annual Cost

A sound differentiator on site screening parameter is the unit cost per acre-foot of firm yield. Generally this key planning parameter is developed by obtaining the annual firm yield, which for this site is 324,000 acre-feet/year, as derived from reservoir operation studies, and has a total project cost of $466,549,000. The annualized cost is determined using a debt service of 40 years for a reservoir at an interest rate of 6% per year plus the annual operation and maintenance costs. The operation and maintenance costs are taken at 1.5% of the total construction cost. For Waters Bluff Reservoir, the O&M is $2,397,200 and the annualized debt service is $33,033,100. The firm yield is then divided into the total annualized cost of $35,430,300 to yield a unit cost of $109.36 per acre-foot ($0.34/1,000 gal) of firm yield. These annualized costs are summarized in Table 1.1-1 contained in the executive summary.

5.14.2 Environmental Overview –Affected Environment and Environmental Consequences

5.14.2.1 Geological Elements

5.14.2.1.1 Physiography

The potential reservoir is located within the Pineywoods vegetative region of Texas. The Pineywoods vegetative region is approximately 15.8 million acres of land. It averages 40-56 inches of rain yearly with 235-265 frost-free days. The topography is nearly level to gently undulating with an elevation of 200 to 799 feet above msl. The Pineywoods vegetative region lies entirely within the gulf Coastal Plains, which extend into Texas for 75 to 125 miles west of the Louisiana border. The area is nearly level to gently undulating, locally hilly, forested plain. Upland soils are generally acid, sandy loams and sands are gray, yellow, red or mottled sandy loam to clay subsoils. Bottomland soils are generally light brown to dark gray, acid to calcareous, loamy to clayey alluvial. Acid loamy soils are extensive in the floodplains of minor streams.

Timber production is the leading land use in the Pineywoods vegetative region. Forest grazing, tame pasture, feed grains, forages, fruits, and vegetables are common secondary land uses. Pine plantations and tame pastures currently occupy many areas previously forested or cultivated. Introduced grasses such as bermudagrass, dallisgrass, and bahiagrass and the cultivation of legumes and use of fertilizer make this a highly productive pasture area. The forests, rangelands, and pastures are used for timber, livestock, wildlife habitat, recreation, and water production.[10]

5.14.2.1.2 Geology

Soil surface outcroppings in the northeast Texas region are from the Cretaceous, Paleocene and Eocene periods. Bands of rocks become younger in the region from the northwest corner moving southeast and the soils range in color from light, acid sandy loams, clay loams and sands in the east to dark colored calcareous clays in the western part of the region. Northeast Texas is located just east of the Ouachita Mountains, a buried mountain range that reaches from southwest Texas through the Austin and Dallas areas and eventually runs eastward to the Appalachian Mountains. The formation of this mountain range 300 million years ago caused downwarping on either side, which caused erosion and sediment to settle in northeast Texas. For the past 60 million years, the northeast Texas region has been “sinking”, and rocks from earlier periods have been buried rather than exposed. The effects of sediment build-up from the mountain range run-off coupled with waters of the Gulf of Mexico flowing over the surface, lead to the formation of rich organic sediments that over time turned into oil and gas deposits. Salt deposits, compressed by dense, organic-rich muds, formed domes and spikes beneath the surface.

Mineral resources in the northeast Texas region are varied and abundant. Lamar and Red River Counties have chalk deposits buried beneath the surface. The southern half of the region is dotted with salt domes. This area also contains significant oil and gas deposits. Lignite, a low-grade form of coal, is also present in the northeast portion of the region.[11]

5.14.2.1.3 Soils

The area of the potential reservoir contains eight major soil groups.[9] These groups are Bowie-Cuthbert-Kirvin (8.3 percent), Cuthbert-Redsprings-Elrose (0.2 percent), Estes-Manachie-Bienville (35.5 percent), Iuka-Guyton-Manatachie (6.9 percent), Kaufman-Gladewter-Texark (28.1 percent), Latch-Mollville-Bienville (14.6 percent), Lilbert-Darco-Briley (3.7 percent), and Oakwood-Freestone-Cuthbert (2.9 percent). Descriptions of these soil associations are provided below with other information (i.e. temperature ranges, mean annual precipitation, etc.) generally associated with the location where the soil types are found within the proposed reservoir site.

Bienville

The Bienville series consists of very deep, somewhat excessively drained, moderately rapidly permeable soils, formed in sandy coastal plain sediments on nearly level or gently sloping stream terraces. The typical slope is dominantly 1 to 3 percent, but ranges from 0 to 5 percent. Bienville soils are on stream terraces in the Gulf Coastal Plains. A water table is at depths of 4 to 6 feet in late winter and early spring. These soils formed in sandy alluvium mainly from sandy coastal plain sediments. The climate is warm and humid. Mean annual precipitation ranges from 45 to 62 inches and mean annual temperature ranges from 60 to 70 degrees F. Most acreage is in woodland, dominantly mixed hardwood and pine. This soil series is typically used for cotton, corn, and truck crops within cleared areas.

Bowie

The Bowie series consists of very deep, well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain deposits. These soils are on broad very gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The climate is humid; mean annual precipitation ranges from 40 to 50 inches; and mean annual temperature from 64 to 69 degrees F. The Thornthwaite annual P.E. index exceeds 64. The frost-free days range from 220 to 250. Elevation ranges from 150 to 600 feet above msl. Runoff is low on 1 to 3 percent slopes, medium on 3 to 5 percent slopes, and high on 5 to 8 percent slopes. A perched water table is at a depth of 3.5 to 5 feet during winter and early spring in most years. The principal use is for pasture and forest. Some areas are used for growing corn, peanuts, sweet potatoes, peaches, watermelons and other vegetables or fruit crops. Pasture is mainly bermudagrass or bahiagrass. Forests consists of loblolly and shortleaf pines, sweetgum, red oak, and hickory trees with tall and midgrasses.

Briley

The Briley series consists of very deep, sandy, well-drained, moderately permeable soils that formed in sandy and loamy Coastal Plain sediments. These soils are on gently sloping to moderately steep broad interstream divides. Slopes are dominantly 2 to 5 percent, but range from 1 to 20 percent. Mean annual rainfall ranges from 40 to 48 inches and is evenly distributed throughout the year. Frost-free days range from 240 to 275 days and elevation ranges from 350 to 600 feet above msl. Mean annual temperature ranges from 64 degrees to 69 degrees F., and the Thornthwaite P-E index exceeds 64. The soil type is used mainly for woodlands of loblolly and shortleaf pine and for pastures of improved bermudagrass.

Cuthbert

The Cuthbert series consists of soils that are moderately deep to weakly consolidated sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on strongly sloping to steep uplands. Slopes are dominantly 8 to 25 percent, but range from 5 to 40 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 56 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 750 feet above msl. Mean annual temperature ranges from 63 to 67 degrees F, and Thornthwaite annual P-E indexes exceed 64. Runoff is medium for slopes of 5 to 20 percent and high for slopes greater than 20 percent. Cuthbert soils are used mainly for woodland and pastureland. The principal trees are shortleaf and loblolly pine, red oak, sweetgum, and other hardwoods. Pastures include common and improved bermudagrass, bahiagrass, and weeping lovegrass.

Darco

The Darco series consists of very deep, somewhat excessively drained, moderately permeable soils that formed in sandy and loamy deposits on uplands. It is gently sloping to steep and slopes range from 1 to 25 percent. The climate is warm and humid. The average annual rainfall ranges from 40 to 50 inches. Frost-free days range from 230 to 260. Elevation ranges from 400 to 700 feet above msl. The frost-free rainfall ranges from 25 to 30 inches. The mean annual temperature ranges from 63 to 68 degrees F., and the Thornthwaite P-E index ranges from 64 to 84. Runoff is negligible on 1 to 3 percent slopes, very low on 3 to 5 percent slopes, low on 5 to 20 percent slopes, and medium on slopes greater than 20 percent. Most of the soil is used for pasture or woodland. Pastures are mainly in coastal bermudagrass or weeping lovegrass. Native trees include loblolly pine, shortleaf pine, red oak, and hickory. Watermelons, peanuts, small grain for grazing, and vegetables are grown in some areas.

Elrose

The Elrose series consists of very deep, well-drained, moderately permeable soils on uplands. They formed in marine sediments high in glauconite. Slopes range from 1 to 12 percent. Average annual temperature ranges from 64 to 67 degrees F. Frost-free days range from 235 to 270. Elevation ranges from 350 to 750 feet above msl. The annual average rainfall ranges from 39 to 48 inches and the Thornthwaite P-E index is about 68. Most of the Elrose soils are used for pastureland or woodland. A few areas are cropped to corn, oats, peanuts, peas, and hay. Native vegetation is mixed pine and oak forests consisting of shortleaf pine, Southern red oaks, and sweetgum.

Estes

The Estes series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in acid clayey and loamy alluvium in the Coastal Plains. These flood plain soils have slopes ranging from 0 to 1 percent. Mean annual precipitation is 45 to 55 inches. Frost-free days range from 235 to 250. The elevation ranges from 200 to 450 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. This soil is used mainly for woodland or wildlife land. A few areas are used for improved pastures of bahiagrass, fescue or dallisgrass. The native vegetation is a mixed hardwood forest. The major commercial trees are water oak, willow oak and sweetgum. There are a few scattered green ash, elm, hackberry, mulberry, hickory, pecan and widely scattered native pine with an understory of grasses and shrubs.

Freestone

The Freestone series consists of very deep, moderately well-drained, slowly permeable soils on Pleistocene terraces or remnants of terraces on upland positions formed in loamy and clayey sediments. Slopes range from 0 to 5 percent, but are mainly 0 to 3 percent. The average annual rainfall ranges from 40 to 46 inches; the mean annual temperature ranges from 64 degrees to 68 degrees F. Frost-free days range from 225 to 265. Elevation ranges from 150 to 575 above msl. The Thornthwaite P-E indexes range from 64 to 75. A extremely thin perched water table is above the clay layer for brief to long periods in the spring season during most years. Most of the acreage is in pasture. Native trees include post oak, blackjack oak, hickory, sweetgum, and elm. Pine mainly in plantations are along the eastern and southern portions of the series province. Pasture grasses include bermuda, bahiagrass, and lovegrass. Most areas were at one time cultivated to cotton, corn, and sorghum.

Gladewater

The Gladewater series consists of very deep, somewhat poorly drained, very slowly permeable soils on floodplains formed in clayey alluvium in floodplains. Slope ranges from 0 to 1 percent. The mean annual precipitation ranges from 38 to 46 inches and mean air temperature ranges from 64 to 68 degrees F. Frost-free days range from 235 to 275 days and elevation is 200 to 400 feet above msl. Thornthwaite P-E index ranges from about 62 to 74. Depressional areas are very poorly drained. Most of the acreage is in pasture or forest. Some areas are in native pasture or range. Pasture areas are introduced grasses such as dallisgrass and fescue. Forested areas are in mixed hardwoods including water oak, willow oak, cedar elm and black willow.

Guyton

The Guyton series consists of very deep, poorly drained and very poorly drained, slowly permeable soils that formed in thick loamy sediments. These soils are on Coastal Plain local stream floodplains and in

depressional areas on late Pleistocene age terraces. Slopes range from 0 to 1 percent. The climate is warm and humid. Mean annual temperature ranges from 60 to 70 degrees F. Average annual rainfall ranges from 42 to 62 inches. Where runoff is ponded, drainage is very poor. Runoff is slow to ponded. A seasonal high water table is at 0 to 1.5 feet below the surface from December through May, except where ponded. Where ponded, it is from 1 foot above the surface to 0.5 foot below the surface most of the time. In places, the soils are subject to rare, occasional, or frequent flooding. Most areas are in woodland. Water oak, bald cypress, water tupelo, loblolly pine, and shortleaf pine are dominant in the drainageways. On broad terraces, bald cypress and water tupelo generally are absent and sweetgum dominates. Some areas are used as pastureland or cropland.

Iuka

The Iuka series consists of deep, moderately well-drained, moderately permeable soils that formed in stratified loamy and sandy alluvial sediments. These soils are on nearly level floodplains. They are saturated with water at depths of 1 foot to 3 feet below the surface during wet seasons and are subject to flooding. Slopes range from 0 to 2 percent. The climate is warm and humid. Near the type location the average daily temperature for January is 42 degrees F., the average daily temperature for July is 79 degrees F., the mean annual temperature is about 61 degrees F., and the mean annual precipitation is about 54 inches. Iuka soils are rarely to commonly flooded. A water table is at depths of 12 or more inches, and the soil is commonly saturated with water between 12 and 40 inches during some season of most years. Much of the soil has been cleared and cultivated. It is cropped to corn, soybeans, small grains, truck crops, and hay or is in pasture. Native vegetation is forest of water oak, willow, beech, sweetgum, hickory, maple, ironwood, eastern cottonwood, alder, white oak, and in some places, pine.

Kaufman

The Kaufman series consists of very deep, moderately well-drained, very slowly permeable soils on floodplains formed in clayey alluvium. Slopes are typically less than 1 percent, but range from 0 to 2 percent. Mean annual precipitation ranges from 35 to 50 inches, and mean annual temperature ranges from 62 to 70 degrees F. Frost-free days range from 230 to 280 days and elevation ranges from 100 to 550 feet above msl. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in pasture of dallisgrass, bermudagrass, and fescues. A few areas are used for producing cotton, corn, sorghums, and soybeans. Native vegetation is hardwoods such as elm, hackberry, oak, ash, and grasses which includes species of andropogon, paspalum, panicum, and tripsacum.

Kirvin

The Kirvin series consists of soils that are deep to stratified sandstone and shale. They are well-drained and moderately slowly permeable. These soils are on gently sloping to moderately steep convex uplands. Slope is dominantly 2 to 8 percent, but ranges from 1 to 15 percent. Climate is humid or subhumid. Mean annual precipitation ranges from 40 to 48 inches, with frost-free rainfall of 25 to 30 inches. Frost-free days range from 235 to 270 and elevation ranges from 400 to 650 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and the Thornthwaite annual P-E indexes exceed 64. Runoff is very low on 1 to 3 percent slopes, low on 3 to 5 percent slopes, and medium on 5 to 15 percent slopes. Principal use is for pastureland and woodland. Bermudagrass is the main pasture grass. Forests are of shortleaf, slash, and loblolly pine, red oak, sweetgum, and other hardwood trees. A few areas are used for growing truck crops, cotton, corn, and oats.

Latch

The Latch series consists of very deep, moderately well drained, moderately permeable soils on stream terraces. These nearly level to gently sloping soils formed in sandy alluvial sediments. Slopes range from 0 to 3 percent. These nearly level to gently sloping soils are on oblong and low oval mounds less than an acre to about 5 acres in size along stream terraces. They are typically mapped as a part of a soil complex. These soils formed on sandy alluvial terraces of late Pleistocene and Recent Age in the West

Coastal Plains. Frost-free days range from 230 to 270 days and elevation ranges from 250 to 400 feet above msl. Mean annual precipitation is 42 to 50 inches. Mean annual temperature ranges from 64 degrees to 66 degrees F. and the Thornthwaite annual P-E indices ranges from 68 to 80. Latch soils are moderately well drained. There is a perched water table for brief periods during the winter and spring seasons. This soil series is used mainly for forest and pasture. Forest vegetation includes loblolly pine, sweetgum, post oak, willow oak, water oak, and elm with an understory of American beautyberry, southern bayberry, green briar, and shade tolerant forbs and grasses.

Lilbert

The Lilbert series consists of very deep, well-drained, moderately slowly permeable soils. These soils formed in sandy and loamy deposits on uplands. Water runs off the surface slowly. Slopes range from 1 to 8 percent. A perched water table may occur in late winter to early spring from 3 to 6 feet below the soil surface. Average annual temperature ranges from 64 to 69 degrees F., the mean annual precipitation ranges from 40 to 50 inches. Frost-free precipitation ranges from 25 to 30 inches, and frost-free days range from 240 to 275. Elevation ranges from 350 to 600 feet above msl. The Thornthwaite P-E index is 66 to about 80. Runoff is slow. The areas where this soil type occurs are used mainly for woodland and pasture. However, some areas are used for cropland. Native vegetation consists of loblolly pine, shortleaf pine, hickory, sweetgum, red oak, and other hardwoods.

Manatachie

The Mantachie series consists of somewhat poorly drained, moderately permeable soils. They formed in loamy alluvium. These soils are on floodplains. They usually flood late in winter and early in spring. The seasonal high water table is at a depth of 1.0 to 1.5 feet. Slope is dominantly less than 1 percent but ranges to 3 percent. Near the type location the mean annual temperature is about 63 degrees F., and the mean annual precipitation is about 53 inches. These soils are subject to rare, occasional, or frequent flooding for brief to long duration, unless protected. The water table is within 1.0 to 1.5 feet of the surface during periods of high rainfall. Most areas of these soils have been cleared and are used for growing cotton, soybeans, corn, small grains, pasture, and hay. Some areas are in bottomland hardwoods. Common trees are green ash, eastern cottonwood, cherrybark oak, loblolly pine, sweetgum, and yellow-poplar.

Mollville

The Mollville series consists of very deep, poorly drained, slowly permeable soils that formed in thick stratified sandy and loamy sediments, in nearly level or depressional areas on terraces. Mollville soils are typically on first level terraces. However, they are on third or higher level terraces of some large river systems. Slopes are less than 1 percent with plain or concave surfaces. The soils formed in sandy and loamy alluvial sediments. The surfaces typically have been reworked by wind. The climate is humid. The mean annual precipitation ranges from 42 to 56 inches. The mean annual temperature is from 64 to 68 degrees F. Frost-free days range from 220 to 260 and the elevation ranges from 150 to 450 feet above msl. The soil is ponded during the winter and spring mainly for brief to long durations after heavy or prolonged rainfall. A perched water table is at a depth of 0 to 12 inches for brief to long periods to include a cumulative annual duration of 2 to 4 months during most years. During the other years the soil is typically wet for longer periods. The soil is mainly in hardwood forest of water oak, sweetgum, blackgum, and post oak.

Oakwood

The Oakwood series consists of very deep, moderately well-drained, moderately slowly permeable soils that formed in loamy Coastal Plain sediment. These soils are on broad gently sloping to moderately sloping uplands. Slopes range from 1 to 8 percent. The mean annual temperature ranges from about 64 to 68 degrees F. Mean annual precipitation ranges from 40 to 46 inches. Frost-free days range from 240 to 260 days and elevation ranges from 250 to 550 feet. Thornthwaite P-E indexes range from 64 to 72.

An apparent water table is at a depth of 3.5 to 5 feet during late winter and early spring during most years. Soils are mostly used for pasture and forest. Pastures are mainly improved bermudagrass or native grasses. This soil type is often used for growing corn, peanuts, sweet potatoes, peaches, grapes, melons and other vegetable crops. Forest vegetation includes loblolly pine, post oak, sweet gum, red oak, and hickory trees with an understory of grasses and shrubs.

Redsprings

The Redsprings series consists of soils that are deep to mixed marine sediments on gently sloping to steep uplands. Slopes are mainly 2 to 15 percent, but range from 2 to 40 percent. Slopes are slightly convex, and tend to be complex on the steeper gradients Climate is warm and humid. Mean annual precipitation ranges from 40 to 46 inches, with frost-free rainfall of 25 to 30 inches. The summer moisture deficit is 4 to 6 inches. Frost-free days range from 240 to 260 and elevation is 300 to 500 feet above msl. Mean annual temperature ranges from 64 to 68 degrees F., and Thornthwaite annual P-E index ranges from 64 to 84. Redsprings soils are well drained. Runoff is low on 2 to 5 percent slopes, medium on 5 to 20 percent slopes, and high on slopes over 20 percent. Redsprings soils are used predominantly for woodland and pasture. Forests consists mainly of red oak, post oak, hickory, loblolly and shortleaf pine trees with an understory of American beauty berry, greenbriar, native forbs and grasses. Pasture grasses are mainly improved species of bermudagrass and bahiagrass.

Texark

The Texark series consists of very deep, somewhat poorly drained, very slowly permeable soils that formed in clayey alluvium floodplains that drain mainly from the Blackland Prairies. Slopes are 0 to 1 percent. Average annual precipitation ranges from 40 to 55 inches, average annual temperature is 62 degrees to 70 degrees F. Annual Thornthwaite P-E indexes exceed 50. Most of the acreage is in forest, pasture, and wildlife habitat. Native vegetation conaiata of hardwood trees such as green ash, hackberry, water oak, willow oak, elm, and sweetgum. Understory vegetation consists of hawthorns, sedges, grasses, and annual weeds.

5.14.2.2 Hydrological Elements

5.14.2.2.1 Surface Water

The potential reservoir is located on the Sabine River. This portion of the Sabine River is included in the Texas Natural Resource Conservation Commission (TNRCC) - *The state of Texas Water Quality Inventory Surface Water Quality Monitoring Program '96* as stream segment 0506 (Sabine River below Lake Tawakoni). This 118-mile segment originates from a point 110 yards downstream of US 271 in Gregg county to Iron Bridge Dam in Rains county. This segment is classified as “effluent limited” and designated uses re for contact recreation, high aquatic life, and public water supply. Elevated levels of orthophosphorus are a concern in the lower 25 miles of the segment.[12]

5.14.2.2.2 Groundwater

Smith and Wood Counties are located within the Carrizo-Wilcox Aquifer and within outcrop region of the Queen City Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. Some water-bearing formations dip below the surface and are covered by other formations. This is the downdip. This aquifer extends in a band across most of the state from the Frio River in South Texas northeastward into Louisiana. This aquifer provides water for domestic and livestock purposes throughout most of its extent, significant amounts of water for municipal and industrial supply in northeast Texas, and water for irrigation in Wilson county. Total pumpage for all uses in 1994 was 16,319 ac-ft.

Sand, loosely cemented sandstone, and interbeded clay units of the Queen City Formation of the Tertiary Claiborne Group make up the aquifer as delineated within Texas. These rocks dip gently to the south and southeast toward the Gulf Coast. Although total aquifer thickness is usually less than 500 feet, it can approach 700 feet in some areas of northeast Texas. In the outcrop area, water occurs under water-table conditions while in the downdip subsurface, where the Queen City is covered by younger, non water-bearing rocks, the water is under artesian conditions. Usable quality water is generally found within the outcrop and for a few miles downdip, but in some areas it may occur down to depths of approximately 2,000 feet. Yields of individual wells are commonly low, but exceed 400 gal/min.

Throughout most of its extent, the chemical quality of the Queen City Aquifer water is excellent however, quality deteriorates with depth in the downdip direction. The water may have high acidity (low pH) in much of northeast Texas and relatively high iron concentrations in localized areas. Hydrogen sulfide gas is sometimes present. Fortunately, each of these naturally occurring conditions may be treated relatively easily and economically.

While large amounts of usable quality groundwater are contained within the rocks of the Queen City, yields are low. Estimates of the availability of water from the Queen City Aquifer are based on recharge to the aquifer. Because of differences in topography, vegetative cover, and other factors, only two percent of the annual rainfall is estimated recharge in the Trinity, Colorado, Guadelupe, San Antonio and Neches River basins. Approximately five percent is estimated recharge in the Neches, Sulphur, Sabine, and Cypress Creek Basins. Total annual effective recharge to the aquifer is estimated to be 682,100 ac-ft.

Carrizo-Wilcox Aquifer. The surface extent or outcrop of an aquifer is the area in which the host geological formations are exposed at the land surface. This area corresponds to the principal recharge zone for aquifers. This aquifer extends from the Rio Grande in south Texas northeastward into Arkansas and Louisiana providing water to call or parts of 60 counties. Total ground-water pumpage from the Carrizo-Wilcox in 1994 was 488,802 acre-feet. Municipal pumpage accounted for 31 percent of the total and irrigation accounted for 51 percent.

The Carrizo-Wilcox Aquifer is predominantly composed of sand, locally interbedded with gravel, silt, clay, and lignite deposited during the Tertiary Period. Where it is found at the surface, the aquifer exists under water-table conditions and in the subsurface it is under artesian conditions.

Regionally, water from the Carrizo-Wilcox is fresh to slightly saline with quality problems limited to localized areas. In the outcrop, the water is hard yet usually low in dissolved solids. Downdip, the water is softer, has a higher temperature, and contains more dissolved solids. Hydrogen sulfide and methane may occur locally. Excessively corrosive water with high iron content occurs naturally throughout much of the northeastern part of the aquifer.

Extremely large water-level declines have occurred in northeast Texas around Tyler and the Lufkin-Nacogdoches area. Much of the pumpages has been for municipal supply, but industrial pumpage is also significant.

5.14.2.3 Floodplains

The Congress of the United States passed the National Flood Insurance Act of 1968, in response to increasing losses from flooding. This act established the National Flood Insurance Program (NFIP) and "provided for the availability of flood insurance within communities that were willing to adopt floodplain management programs to mitigate future flood losses." Additionally, the act "required the identification of all floodplain areas within the United States and the establishment of flood-risk zones within those areas." The 1968 Act was expanded by the Flood Disaster Protection Act of 1973 which "added the mandatory purchase requirement and increased the awareness of floodplain mapping needs throughout the country. The responsibility for administration of the NFIP falls with the Federal Insurance Administration of the Federal Emergency Management Agency (FEMA)."

The potential Waters Bluff reservoir will cause water to be impounded on the Sulphur River as well as a number of smaller streams and tributaries. The impoundment will cause an increase to any floodplains that might be associated with the river and stream.

The development of the potential Waters Bluff reservoir will greatly influence the frequency and duration of flood events downstream of the project. This influence can be minimized by the passing of water of certain magnitudes, frequencies and timings so as to allow the contribution of upstream flows.

5.14.2.4 Biological Elements

5.14.2.4.1 Vegetation

The potential Waters Bluff reservoir is centrally located within the Austroriparian province[14] and is located in the Pineywoods region.[15] The Pineywoods vegetation area typically has a gently rolling to hilly-forested topography. The soil composition for this community consists of mostly pale to dark gray sonds or sandy loams that are generally acidic. Pineywoods soils support native pines including loblolly, shortleaf, and longleaf. Slash pine has been planted throughout the region. The major hardwoods in the area consist of sweetgum, oaks, water tupelo, blackgum , magnolias, elms, cottonwoods, hickories, walnuts, maples, American beech, ashes, and bald cypress. Grasses such as blackseed needlegrass, Virginia wildrye, Canada wildrye, purpletop, broadleaf woodoats, narrowleaf woodoats, eastern bluestem, giant cane carpetgrass, and brownseed paspalum are located within the forested areas. Prairie grasses include rosette and paspalum grasses. Bermudagrass, dallisgrass, and bahiagrass have all been introduced to the region. Shrubs and vines in the area consist of southern wax-myrtle, American beautyberry, grapes, bluebarries, hawthorns, greenbriars, rattan-vine, trumpet honeysuckle, dewberries, yellow jessamine, poison-ivy, dogwoods, redbud, and black-haws. Characteristic forbs consist of wild indigos, sennas, tick-clovers, milkpeas, clovers, vetches, goldenrods, sedges, breakbrushes, and orchids.

According to the Vegetation Types of Texas, TPWD divides the state into eight physiognomic categories: grasses, brush, shrub, parks, forest, woods, swamps, and marsh. An extensive number of plant associations have been determined and consolidated into 46 major cover types along with crops, water and urban/sparsely vegetated lands. According to this TPWD designation the vegetation types of the potential Waters Bluff reservoir location include Pine Hardwoods (21%), Water Oak, Elm (2%), Willow Oak Water (36%), and other (23%).

5.14.2.4.2 Fish and Wildlife

The result of the potential Waters Bluff reservoir is the decrease of stream and terrestrial habitat with an increase of deepwater and shoreline habitat.

The potential Waters Bluff reservoir is located within the Pineywoods Eco-region. Some of the common wildlife in this region includes the southern short-tailed shrew, Seminole bat, ringtail, Virginia opossum, Rafinesque's big-eared bat, eastern cottontail, common gray fox, striped skunk, bobcat, white-tailed deer, swamp rabbit, eastern gray squirrel, bull frog, Attwater's pocket gopher, marsh rice rat, eastern harvest mouse, prairie vole, and river otter.[16]

5.14.2.4.3 Endangered and Threatened Species

The USFWS and TPWD combined lists for threatened, endangered, or rare species lists seven birds, four fish, three mammals, one mollusk, four reptiles, and one vascular plant to potentially occur or have habitat within the potential project location (Table 5.14-5). The Endangered Species Act (ESA) of 1973 provides for the protection of all federally listed threatened and endangered species from take defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engauge in any such conduct." Harm is further defined by USFWS to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. Harass is defined by USFWS as actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering.

This Space Intentionally Left Blank

Table 5.14-5 Threatened, Endangered, or Rare Species of Potential Occurrence or Habitat in the Project Area (Gregg, Smith, Upshur, and Wood Counties).

Common Name	*Scientific Name*	*USFWS*	*TPWD*
Birds			
American Peregrine Falcon	*Falco peregrinus anatum***	DL	E
Arctic Peregrine Falcon	*Falco peregrinus tundrius***	DL	T
Bachman's Sparrow	*Aimophila aestivalis*		T
Bald Eagle	*Haliaeetus leucocephalus*	LT-PDL	T
Henslow's Sparrow	*Ammodramus henslowii*		R
Wood Stork	*Mycteria Americana*		T
Fishes			
Creek Chubsucker	*Erimyzon oblongus*		T
Paddlefish	*Polydon spathula*		T
Western Sand Darter	*Etheostoma clarum*		T
Mammals			
Plains Spotted Skunk	*Spilogale putorius interrupta*		R
Southeastern Myotis	*Myotis austroriparius*		R
Reptiles			
Alligator Snapping Turtle	*Macroclemys temminckii*		T
Louisiana Pine Snake	*Pituophis melanoleucus ruthveni*	C1	T
Scarlet Snake	*Cemophora coccinea*		T
Texas Garter Snake	*Thamnophis sirtalis annectens*		R
Texas Horned Lizard	*Phrynosoma cornutum*		T
Timber/Canebrake Rattlesnake	*Crotalus horridus*		T
Vascular Plants			
Rough-stem aster	*Aster puniceus* ssp. *Eliotti* var. *scabricaulis*		R
Texas Trillium	*Trillium pusillum* var. *texanum*		R

Sources: USFWS 1998, TPWD 1999.
USFWS: U.S. Fish and Wildlife Service Status
** Migratory Species Common to many or all Counties in Texas. May occur as migrants in Project Area.
LE Federally Listed Endangered (species in danger of extinction throughout all or a significant portion of its range)
LT Federally Listed Threatened (species which is likely to become endangered within the foreseeable future)
C1 Federal Candidate, Category 1; information supports proposing to list as endangered/threatened
E/SA, T/SA - Federally Endangered/Threatened by Similarity of Appearance
DL, PDL - Federally Delisted/Proposed Delisted

TPWD: Texas Parks and Wildlife Department Status
E Listed as Endangered in the State of Texas

T Listed as Threatened in the State of Texas
R Rare, but with no regulatory listing status
(Texas Department of Transportation, Annotated County Lists of Rare Species for Gregg, Smith Upsur and Wood Counties, 1999.)

5.14.2.5 Ecologically Significant Stream Segments

The Texas Administrative Code (31 TAC § 357.8) states that the "regional water planning groups may include in adopted regional water plans recommendations for all or part of river and stream segments of unique ecological value located within the regional water planning area by preparing a recommendation package consisting of a physical description giving the location of the stream segment, maps, and photographs of the stream segment and a site characterization of the stream segment documented by the supporting literature and data." The State Water Plan, which will be based upon the regional water plan, will identify segments that the TWDB recommends to the Texas legislature for consideration of the ecologically unique designation.

Streams designated by the legislature as "ecologically unique" are protected from a state agency or political subdivision obtaining a fee title or an easement that would destroy the ecological value of a river or stream segment. Ecologically unique streams are based on one or more of the following criteria:

- **Biological Function**: stream segments that consist of significant habitat value including both quality and quantity considering the degree of biodiversity, age, and uniqueness observed, terrestrial, wetland, aquatic, or estuarine habitats.
- **Hydrologic Function**: stream segments that are fringed by habitats that enhance water quality, decrease flooding, stabilize flow, or provide groundwater recharge and discharge.
- **Riparian Conservation Areas**: stream segments that are significantly bordered by areas in public ownership, such as state and federal refuges, wildlife management areas, preserves, parks, mitigation areas, or other areas held by governmental organizations or approved under a governmental plan for conservation purposes.
- **High Water Quality/Exceptional Aquatic Life/High Aesthetic Value**: stream segments that support critical habitats and exceptional aquatic life, which is dependent on or associated high water quality.
- **Threatened or Endangered Species/Unique Communities**: stream segments in which state or federally listed threatened and endangered species, unique, exemplary, or unusually extensive natural communities can be affected detrimentally by development projects.

The TPWD has prepared a report that documents the streams in the Region D Regional Water Planning Area that they have determined to be of significant ecological value.

Within the boundaries of the Region D, three hundred and sixty-one streams have been identified. Of these, fifteen streams in Region D have been determined by the TPWD to meet some or all of the five ecologically unique criteria. The TPWD has further determined five stream segments in Region D that are of the "highest importance as potential ecologically unique stream segments." The development of the potential Waters Bluff reservoir will affect two ecologically unique streams, Sabine River and Little Sandy Creek *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.14.2.6 Wetlands

The term "wetlands" encompasses a variety of wet environments—coastal and inland marshes, wet meadows, mudflats, ponds, bogs, bottomland hardwood forests and wooded swamps. The official definition used by the EPA and COE for administering the Section 404 Permit Program is: "Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In other words, the soils that form and the plants that grow in these areas are a result of the presence of water at or near the soil surface. Therefore, the identification of a wetland is based on 3 mandatory criteria: hydric soils, wetland vegetation, and the frequent or prolonged presence of water.

Wetland delineation, which describes the specific outline of a wetland, was not performed at any site. A general determination was made on the probability of wetland occurrence based upon hydric soils determinations. The presence of a hydric soil association would indicate the high probability of corresponding wetland areas. Current NRCS (National Resource Conservation Service) data shows six hydric soil associations are within the potential Waters Bluff reservoir footprint. The number of hydric soil associations does not indicate the number of potential wetlands, but rather that wetland areas (one or more) could occur where these hydric soil associations exist.

5.14.2.7 Wetland Mitigation Banks

Wetland Mitigation banking is a method by which mitigation for wetland impacts can occur in advance of project impacts by restoring, enhancing, creating and preserving wetlands. This action results in wetland "credits" that can be sold or used for project impacts. Mitigation banks have, in recent years, become more prevalent in the northeast Texas area. Currently, there are four established banks in the northeast Texas region, and all four are located in Smith county. The Anderson Tract Off-Site Mitigation Project includes 2,243 acres of bottomland hardwood forest northeast of Lindale within the Sabine River floodplain. The Byrd Tract Mitigation bank includes 483 acres of bottomland hardwood restoration lands in the Sabine River floodplains. The area had been previously timbered and is located near Gladewater. The Hawkins mitigation bank includes 175 acres of preserved and restored bottomland hardwoods located south of Hawkins in the Sabine River floodplain. The KLAMM mitigation bank includes 1,250 acres of preserved and restored bottomland hardwoods located south of Big Sandy in the Sabine River floodplain.

There are four existing or proposed wetland mitigation bank projects that are located near or adversely affected by the potential Waters Bluff reservoir. These are the Klamm Inc. mitigation bank, consisting of 1251 acres, the Byrd mitigation bank, consisting of 483 acres, the Anderson Tract mitigation bank, consisting of 4937 acres, and the Hawkins mitigation bank, consisting of 175 acres *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.14.2.8 Bottomland Hardwoods

Bottomland hardwood forests are considered to be among the highest quality and most productive wildlife habitats in Texas. The combination of parks, woods and forests, including bottomland Hardwoods comprise almost one-third of the remaining native habitat of the state. The potential Waters Bluff reservoir is located within the Sabine River basin, which represents approximately 22% of the remaining bottomland hardwood in Texas.

A program to preserve bottomland hardwood habitat and associated wildlife resources in Texas has been established by the FWS. Within the State of Texas, 62 bottomland hardwood sites were prioritized according to habitat quality and overall value to waterfowl as follows:

- Priority 1- excellent quality bottomlands of high value to waterfowl;
- Priority 2- good quality bottomlands with moderate waterfowl benefits;
- Priority 3- excellent quality bottomlands with minor waterfowl benefits because of small size, lack of management potential, or other factors;
- Priority 4- moderate quality bottomlands with minor waterfowl benefits;
- Priority 5- sites proposed for elimination from further study because of low quality and/or no waterfowl benefits; and
- Priority 6- sites recommended for future study.

Of the 62 identified sites within Texas, 18 are located within the 19-county study area. The potential Waters Bluff reservoir has areas considered as Priority 1 and Priority 2 sites [15] *(See Appendix, Exhibit E, Significant Potential Resource Conflicts).*

5.14.2.9 Conservation Easements

Conservation easements, like mitigation banks, are used as a tool to preserve, protect, or enhance wetland and other natural resource areas. However, conservation easements restrict the property owner from certain activities that would result in the degradation of the habitat quality or goals of the property. These easements are often managed by various private, state, or federal entities. Typically the entity enforces the restrictions of the easement.

Although not within the footprint of the reservoir, two existing conservation easements are located near the potential Waters Bluff reservoir (Table 5.14-6).

Table 5.14-6 Conservation easements were identified in the Sulphur Basin.

Name	*Entity in Ownership*
Little Sandy	USFWS
Old Sabine Bottom	WMA TPWD

5.14.2.10 Social and Economic Conditions

The potential reservoir is located in Smith and Wood Counties. The population of these counties according to the 1990 Census is 151,309 and 29,380, respectively. The Texas State Data Center has estimated the 2020 population of these counties to be 203,158 and 50,366. This corresponds to a 34 percent increase for Smith county and 71 percent increase for Wood county.[17] The median household income for Smith county in 1989 was $25,769 and for Wood county $20,885.[18]

5.14.2.11 Historical or Archaeological Resources

If identifiable cultural resources are discovered during project operation or construction, they will be protected and evaluated for inclusion in the National Register of Historic Places in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (30 CFR Part 800).

Cultural resources can be defined as prehistoric or historic sites, structures, districts, artifacts, or any physical evidence of human activity deemed significant to a culture, subculture, or community for any reason. The potential Waters Bluff reservoir will affect portions of Gregg, Smith, Upshur, and Wood counties.

Historical and Archeological Resources for the four county areas were determined through the Texas Historical Commission's (THC) Atlas Internet site, and through several publications that deal with the subject matter in the region. The total results from the Atlas site for the counties are presented in Table 5.14-7.[19]

Table 5.14-7 Historical and Archeological Resources for Waters Bluff.

County	*Records*	*Courthouses*	*Sawmills*	*Historical Markers*	*National Registered Listed Sites*	*Museums*
Gregg	175	1	87	78	4	5
Smith	98	0	85	0	9	4
Upshur	183	1	182	NA	NA	NA
Wood	139	1	88	42	7	1

Source: THC Texas Historic Atlas Site, April 2000.

Another publication (Table 5.14-8) details the results of previous cultural studies that have been performed on the area since 1879. Although Wood county has been investigated more thoroughly than the other counties with regards to cultural resources due to federal mandated cultural surveys, there is a potential for additional archeological sites to be discovered due to the potential construction of the reservoir. There is an even greater potential for more archeological sites being discovered in counties that have not been excessively studied, such as Gregg, Smith, and Upsher counties.[19]

Table 5.14-8 Evaluation of Existing Site Files, Northeast Texas Archeological Region.

County	*Not Significant**	*Unknown Significance*	*Probably Significant*	*Significant*	*Total*
Gregg	4	19	13	4	40
Smith	9	78	36	17	140
Upshur	18	30	24	12	84
Wood**	42	101	21	20	184
Sub-total	73	228	94	53	448

* Significance refers to National Register criteria.
** County tabulations are incomplete.
Source: THC, 1993.

5.14.2.11.1 Cultural History

Based on investigations of the archeological sites, a chronological framework for the Northeast Texas region has been determined and is presented in Table 5.14-9.

Table 5.14-9 Chronological Framework Northeast Texas Archeological Region.

Period	*Dates*
Paleoindian	9500 B.C. – 7000 B.C.
Archaic	7000 B.C. – 200 B.C.
Early Ceramic	200 B.C. – A.D. 800
Formative Caddoan	A.D. 800 – A.D. 1000
Early Caddoan	A.D. 1000 – A.D. 1200
Middle Caddoan	A.D. 1200 – A.D. 1400
Late Caddoan	A.D. 1400 – A.D. 1680
Historic Caddoan	A.D. 1680 – A.D. 1860

Source: THC, 1993.

The archeological record for the Eastern Planning Region suggest that although there appears to be remnants of pottery and evidence of farming, the primary culture was the hunting and gathering lifestyle. These human groups are believed to have culminated in hamlets, farmsteads, villages, and civic-ceremonial centers of the Caddoan tradition.

Table 5.14-10 displays the counties associated with the study area for this document with the corresponding period of discovered archeological sites.

Table 5.14-10 Archeological Resources with Associated Periods.

County	*Paleoindian*	*Archiac*	*Early Ceramic*	*Formative Caddoan Early Caddoan Middle Caddoan*	*Late Caddoan*
Gregg			1	4	7
Smith				16	13
Upshur			2	6	15
Wood			1	7	21

Source: THC, 1993, and Perttula T. K., 1999.[20]

5.14.2.11.2 Threats to Cultural Resources

Due to vandalism, the construction of reservoirs, and lignite mining, the regions archeological record is one of the most threatened in the state. Vandals have been looting the archeological resources in northeast Texas throughout the state's history. The vandals can steal the artifacts and make profits from them by selling them to collectors or antiquity outlets. Reservoirs and water conveyance facilities are also threats to archeological resources. In the northeast Texas area, there are more than 40 reservoirs that have over 500 acres, and have inundated 650,000 acres. Additionally, the construction of facilities to use the water from the reservoir sites, and increased population may cause a loss in archeological sites. Lignite mining occurs throughout the region. There are threats to archeological resources due to strip mining for lignite in the following counties: Hopkins, Titus, and Harrison.[20]

5.14.2.12 Land Use

A determination of the existing land use was achieved by utilizing existing EPA land use data. The reservoir study area includes and area within the proposed extent of the potential reservoir and within a one-mile buffer from the reservoir extent. The analyses indicate that the major land use occurring in the reservoir study area is Cropland and Pasture. Table 5.14-11 depicts the percent coverage by major land uses within the reservoir study area.[21]

Table 5.14-11 Land Use for the Potential Waters Bluff Reservoir Study Area.

Land Use Category	*Percentage of Reservoir Study Area*
Cropland and Pasture	29%
Deciduous Forest Land	29%
Mixed Forest Land	36%
Evergreen Forest Land	1%
Orchards	1%
Reservoirs	1%
Residential	1%
Other	2%

5.14.2.13 REGULATED MATERIALS

Available TNRCC data were used to determine the existance of recorded superfund clean-up sites and municipal solid waste landfill sites within the reservoir study area. The reservoir study area includes an area within the proposed extent of the potential reservoir and within a 1-mile buffer from the reservoir extent. The analyses indicate that there are six municipal solid waste landfill sites and no Superfund sites, permitted industrial and hazardous waste locations, or air quality monitoring stations located within reservoir study area. These locations are evenly dispersed throughout the region without increased density on or near the reservoir.[22]

5.14.2.14 Potential Environmental Impact Summary

Table 5.14-12 Potential Environmental Impact Summary for Waters Bluff.

Environmental Parameter	*Potential Impact Magnitude*
Several Threatened and Endangered Species	Unknown
2-Potential Ecologically Unique Stream Segments	Substantial
4-Existing or Proposed Wetland Mitigation Bank Conflicts	Substantial
2-USFWS Priority Bottomland Hardwood Areas	Moderate
2-Existing Conservation Easements	Substantial
6- Municipal Solid Waste Landfill Sites	Substantial

---

[1] Freese and Nichols, Inc. Comprehensive Sabine Watershed Management Plan. December, 1999.

[2] U.S. Army Corps of Engineers, Fort Worth District, Executive Summary Report on Texas Big Sandy Study, Texas, April, 1991.

[3] Espey, Juston & Associates, Inc. and Tudor Engineering Company. Update of the Master Plan for the Sabine River and Tributaries in Texas, Executive Summery. March, 1985.

[4] Sabine River Authority. Problems Relating to the Proposed Waters Bluff Reservoir and Other Surface Water Supply Projects in Texas. 1996.

[5] U.S. Army Corps of Engineers, Fort Worth District, Big Sandy Lake General Design Information, 1980-1985.

[6] U.S. Department of the Interior, Bureau of Reclamation. July 1990. Texas Big Sandy Study Supporting Materials, Volume E – Hydrology.

[7] Espey, Juston & Associates, Inc. and Tudor Engineering Company. Update of the Master Plan for the Sabine River and Tributaries in Texas, Hydrology Index. March, 1985.

[8] Espey, Juston & Associates, Inc. and Tudor Engineering Company. Update of the Master Plan for the Sabine River and Tributaries in Texas, Report. March, 1985.

[9] Freese and Nichols, Comprehensive Sabine Watershed Management Plan, Technical Memorandum Task 17 – Surface Water Projects Issues, Preliminary Screening of Previously Proposed Projects, February, 1999.

[10] Hatch, Stephan L., Kancheepuram M. Gandi, and Larry E. Brown. July 1990. *Checklist of the Vascular Plants of Texas*. College Station, Texas: Texas Agricultural Exper. Station.

[11] DRAFT Regional Water Management Plan. Chapter 1: Description of the Region. Northeast Texas Regional Water Planning Group. January 19, 2000.

[12] Texas Natural Resource Conservation Commission (TNRCC). 1996. *State of Water Quality Inventory Surface Water Quality Monitoring Program '96*. Austin, Texas. TNRCC.

[13] Texas Water Development Board (TWDB). 1997. *Water For Texas: A Consensus-Based Update to the State Water Plan*. Austin, Texas. TWDB.

[14] Blair, W. F. 1950. The Biotic Provinces of Texas. *Texas Journal of Science*, 2:93-117.

[15] Gould, F. W. 1975 Texas Plants: A Checklist and Ecological Summary. Texas A&M University Agricultural Experiment Station. MP-585/Revised. College Station, Texas.

[16] Texas Parks and Wildlife.2000.Exploring Texas [Online]. Available: http://www.tpwd.state.tx.us/expltx/p&lchart.htm. [May, 2000].

[17] Texas State Data Center. February 1998. "Projections of the Population of Texas and Counties in Texas by Age, Sex, and Race/Ethnicity for 1990-2030 [Online]. Available: http://txsdc.tamu.edu/cgi-bin/prjctn98.cgi [2000, May].

[18] United States Census Bureau. "Median Household Income by County: 1969, 1979, 1989" [Online]. Available: http://www.census.gov/hhes/income/histinc/county/county1.html [2000 May].

[19] Texas Historical Commission. 1993. Archeology in the Eastern Planning Region, Texas: A Planning Document. Edited by Kenmotsu, N. A. and T. K. Perttula. Department of Antiquities Protection Cultural Resource Management Report 3.

[20] Perttula T. K. 1999. Archaeology of the Hurricane Hill Site (41HP106), 19-32.

[21] www.tnris.state.tx.us

[22] www.tnris.state.tx.us

6.0 CONCLUSION

This Reservoir Site Assessment study has evaluated and assessed the potential and proposed reservoirs with regards to their location, impoundment size and volume, site geology and topography, dam type and size, hydrology and hydraulics, water quality, project yield for water supply, other potential benefits (e.g., flood control, hydro power generation, recreation), land acquisition and easement requirements, potential land use conflicts, local, state, and federal permitting requirements, cost estimates, and environmental overview.

This Reservoir Site Assessment study has also provided input into the development of the regional water plan for the North East Texas Region in order to accomplish a subtask of the North East Texas Regional Water Plan, which is to determine which sites for future reservoir development to include in the regional water plan.