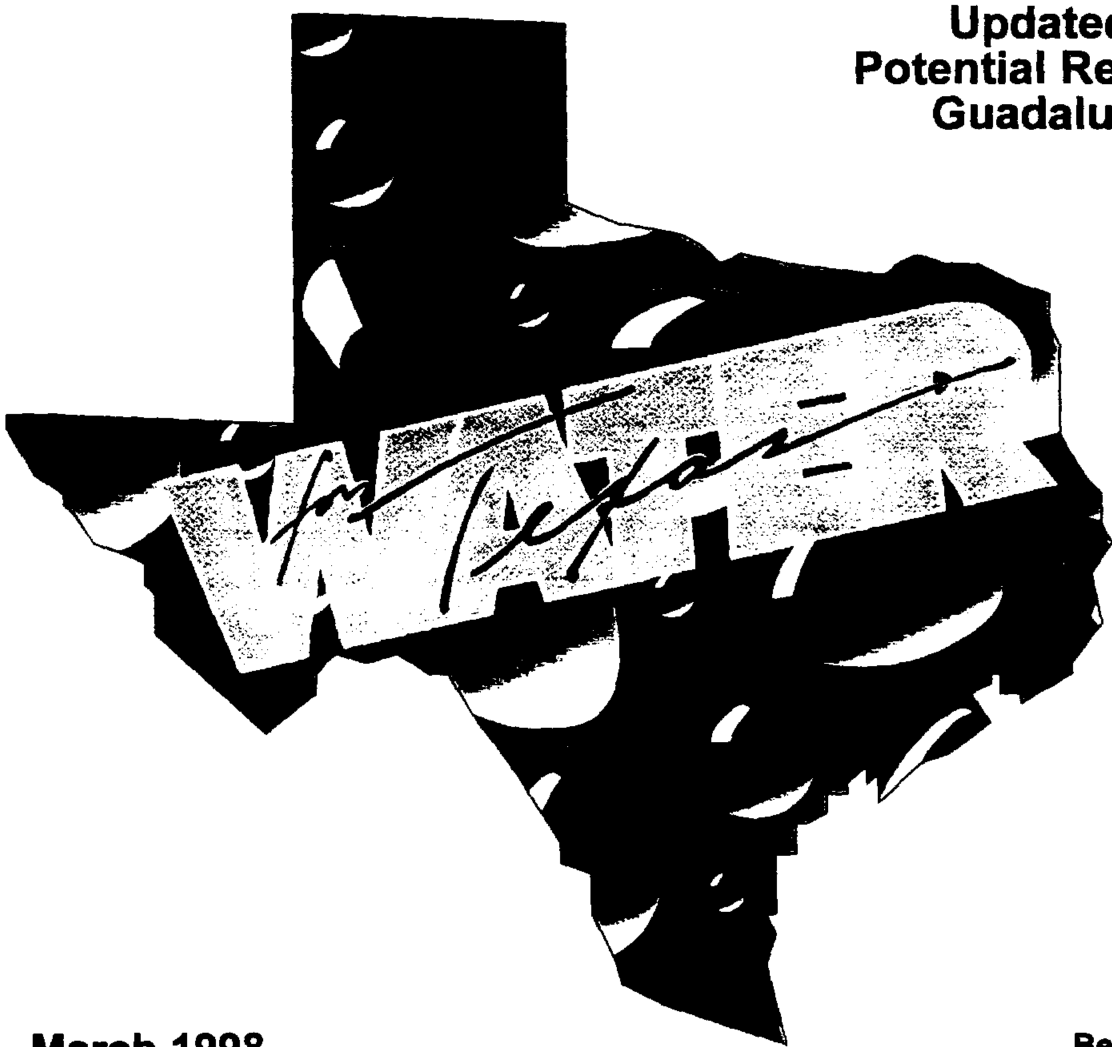
TRANS-TEXAS WATER PROGRAM

West Central Study Area

Phase II

Updated Evaluation of Potential Reservoirs in the Guadalupe River Basin



San Antonio River Authority

San Antonio Water System

Edwards Aquifer Authority

Guadalupe-Blanco River Authority

Lower Colorado River Authority

Bexar Metropolitan Water District

Nueces River Authority

Canyon Lake Water Supply Corporation

Bexar-Medina-Atascosa Counties WCID No. 1

Texas Natural Resource Conservation Commission

Texas Parks and Wildlife Department

Texas Water Development Board

March 1998

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HDR Engineering, Inc.

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TRANS-TEXAS WATER PROGRAM

WEST CENTRAL STUDY AREA

PHASE 2

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

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March 1998

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UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

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EXECUTIVE SUMMARY

In Phase I of the Trans-Texas Water Program for the West Central Study Area, six potential reservoirs located in the Guadalupe River Basin were evaluated: Cuero Reservoir (G-16), Lindenau Reservoir (G-17) (now referred to as Sandies Creek Reservoir), Guadalupe River Dam No. 7 (G-19), Gonzales Reservoir (G-20), Lockhart Reservoir (G-21), and Dilworth Reservoir (G-22)1. The firm yield for each of these reservoirs was estimated using a water availability model in conjunction with a reservoir operation model (G-16 and G-17), adapted from earlier reports by government agencies or consulting firms (G-19, G-20, and G-21), or estimated from the yield of a nearby, similar project (G-22). Some of these potential reservoir projects could not be compared directly because the Phase I yield estimates were not consistent with regards to water rights considerations, period-of-record hydrology, and/or environmental flow requirements. Since the completion of Phase I studies, the Texas Water Development Board, the Texas Natural Resource Conservation Commission, and the Texas Parks and Wildlife Department have recommended new environmental flow requirements to be utilized in water resources planning efforts (Environmental Water Needs Criteria of the Consensus Planning Process, or Consensus Criteria).

The objective of this study is to provide updated evaluations of each of these potential reservoirs in the Guadalupe River Basin, using a consistent methodology so that the firm yield estimates can be compared directly. A seventh project not previously considered in the Trans-Texas Water Program, Cloptin Crossing Reservoir, is also evaluated herein. The updated evaluations include yields estimated considering (1) upstream and downstream water rights, (2) a consistent period-of-record hydrology, and (3) environmental flow requirements consistent with the Consensus Criteria.

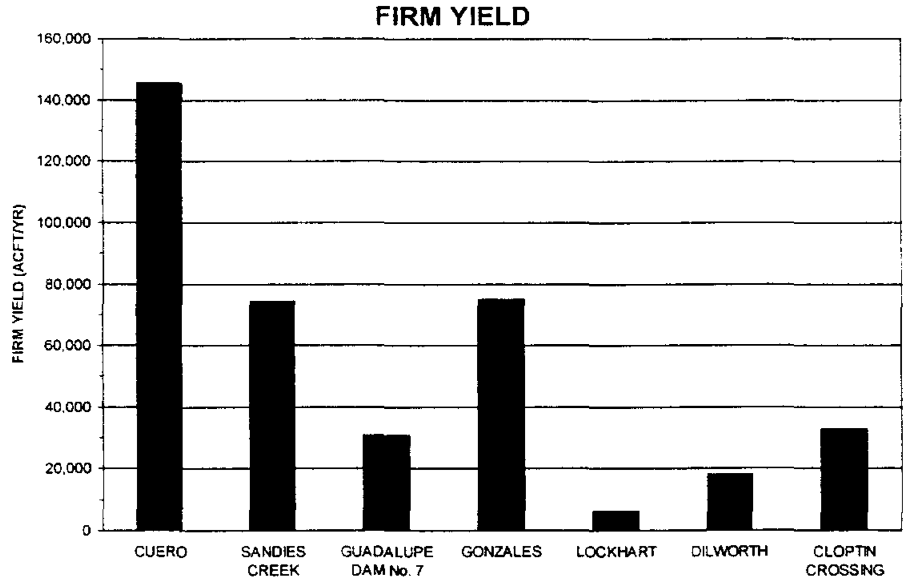
The availability of water to each of the projects was determined using an updated version of the Guadalupe-San Antonio River Basin Model[2] (GSA Model). The availability of water to each project was evaluated on a standalone basis, independent of the other projects.

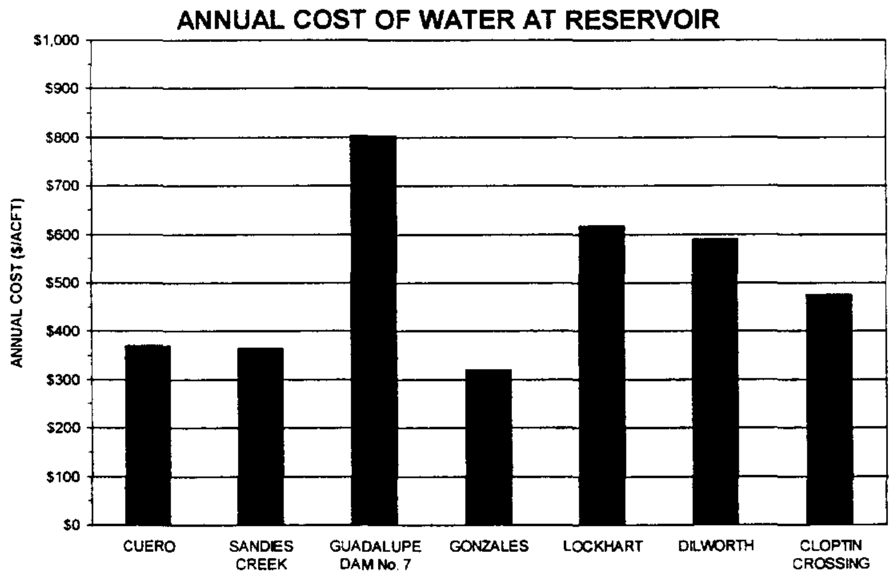
[1] HDR Engineering Inc., et al, Trans-Texas Water Program, West Central Study Area, Phase I Interim Report, Volume 2, San Antonio River Authority, et al., May, 1994.
[2] HDR Engineering, Inc., "Guadalupe-San Antonio River Basin Recharge Enhancement Study," Volumes I, II, and III, Edwards Underground Water District, September 1993.

Implementation of one project could reduce the availability of water to another project; hence, the firm yield estimated for one project cannot be added to that of another project.

The firm yield for each project was evaluated using a single-reservoir firm yield model, SIMDLY, developed by the Texas Water Development Board and modified for this study. The SIMDLY model was used to simulate the operation of each reservoir under a uniform demand using inflows estimated by the GSA Model. The SIMDLY model was modified to enable pass-through flows to satisfy the Consensus Criteria environmental flow requirements, in various combinations with flows passed to meet downstream senior rights and freshwater inflow requirements to the Guadalupe Estuary.

The cost of each project was updated from the Phase I cost estimate to first-quarter 1996 dollars, with additional consideration given to land acquisition and environmental mitigation costs for some projects. The conservation storage capacities, firm yields, total annual costs, and annual unit costs (dollars per acft) are shown in Figure ES-1, along with an objective assessment of the expected effort for permitting and implementation. The firm yields range from 6,339 acft/year for Lockhart Reservoir to 145,448 acft/year for Cuero Reservoir. Annual project costs range from $3,910,000 for Lockhart Reservoir to $53,910,000 for Cuero Reservoir. Annual unit costs range from $320/acft for Gonzales Reservoir to $804/acft for Guadalupe River Dam No. 7. The cost for Sandies Creek Reservoir includes facilities for diversion from the Guadalupe River near Cuero and transmission to the reservoir. The costs presented in this report are for raw water at the lake only, and include no additional transmission, treatment, or distribution costs.





Potential Reservoir	Conservation Storage Capacity (acft)	Annual Cost ($)	Firm Yield (acft/yr)	Annual Cost of Water @ Reservoir ($/acft)	Expected Effort for Permitting and Implementation
Cuero Reservoir (G-16)	1,167,000	$ 53,910,000	145,448	$ 371	Extremely High
Sandies Creek Reservoir (G-17)	606,280	$ 27,250,000	74,471	$ 366	Moderate
Guadalupe River Dam No. 7 (G-19)	600,000	$ 24,870,000	30,927	$ 804	Extremely High
Gonzales Reservoir (G-20)	560,000	$ 24,000,000	75,093	$ 320	Very High
Lockhart Reservoir (G-21)	50,000	$ 3,910,000	6,339	$ 617	Moderate
Dilworth Reservoir (G-22)	275,000	$ 10,740,000	18,195	$ 590	Moderate
Cloptin Crossing Reservoir (G-40)	274,900	$ 15,790,000	33,163	$ 476	High

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

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FIRM YIELDS AND COSTS OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

FIGURE ES-1

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1.0 INTRODUCTION

1.1 Background

The Trans-Texas Water Program for the West Central Study Area was begun in 1993 in response to the water supply needs of the 32-county region. In Phase I studies, six potential reservoirs located in the Guadalupe River Basin were evaluated to varying degrees: Cuero Reservoir (G-16), Lindenau Reservoir (G-17) (now referred to as Sandies Creek Reservoir), Guadalupe River Dam No. 7 (G-19), Gonzales Reservoir (G-20), Lockhart Reservoir (G-21), and Dilworth Reservoir (G-22).[1] The firm yield or dependable supply associated with each of these projects had been evaluated in earlier studies conducted by governmental agencies or consulting firms except Dilworth Reservoir, for which no previous yield estimates could be located. The firm yields of both Cuero and Sandies Creek Reservoirs were evaluated in detail during Phase I. The Phase I methodology evaluated the single-reservoir firm yields of Cuero and Sandies Creek Reservoirs, subject to senior water rights and the original environmental flow criteria adopted by the Trans-Texas Water Program (Appendix A). The firm yield estimates for Guadalupe River Dam No. 7, Gonzales, Lockhart, and Dilworth Reservoirs reported in Phase I were estimated from earlier studies and were not adjusted to account for environmental flow needs or additional water rights granted subsequent to the original studies.

1.2 Objective

The primary objective of this study is to provide an updated evaluation of each of the six potential reservoirs in the Guadalupe River Basin in Phase I, using consistent methodologies. This consistency will allow for direct comparisons among these projects, as well as comparisons with other water supply alternatives. A seventh project (not presented in Phase I), Cloptin Crossing Reservoir, is also evaluated herein. The new evaluations are based on firm yields estimated considering: (1) water rights granted subsequent to the original studies, (2) a consistent period-of-record hydrology, and (3) the Environmental Flow Needs Criteria of the Consensus Planning Process (Consensus Criteria, Appendix B). In order to serve as a reasonably complete reference summarizing preliminary evaluations of these potential reservoir projects, the

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[1] HDR Engineering, Inc. et al., Trans-Texas Water Program, West Central Study Area, Phase I Interim Report, Volume 2, May 1994.

Description of Alternative, Environmental Issues, and Implementation Issues sections originally presented in the Phase I Interim Report are included (with only minor revisions) herein.

2.0 GENERAL METHODOLOGY FOR UPDATED EVALUATIONS

2.1 Determination of Water Availability

Water available for impoundment in each of the potential reservoir projects was determined using an updated version of the Guadalupe-San Antonio River Basin Model[1] (GSA Model). The GSA Model was originally developed for the Edwards Underground Water District and has been refined in the course of the Trans-Texas Water Program. The GSA Model employs a monthly time step, proceeding with flow calculations in an upstream to downstream order simulating recharge, water rights diversions, return flows, channel losses, and reservoir operations. The model may be used to estimate quantities of water potentially available for impoundment or diversion at a specified location subject to water rights and specified monthly minimum streamflows. The GSA Model will also simulate the effects of such an impoundment or diversion on downstream flows. The GSA Model was modified in Phase II to estimate daily flows available at a specified location using monthly flows distributed according to an historical daily flow pattern. In addition, the GSA Model was modified to output daily streamflows passed to meet downstream flow requirements for senior water rights and environmental needs.

The availability of water to each project was determined on a standalone basis, independent of the other projects. Implementation of one project could reduce the availability of water to another potential project. Because of this, the firm yield estimated for a project cannot necessarily be added to the yield of another project.

2.2 Estimation of Firm Yield

The firm yield for each project was evaluated using a single-reservoir firm yield model, SIMDLY, developed by the Texas Water Development Board and modified for this study. The SIMDLY model was used to simulate the operation of each reservoir under a uniform monthly demand pattern. Inflows were the daily available flows estimated by the GSA Model. The SIMDLY model was modified to enable inflow passage in accordance with the Environmental Water Needs Criteria of the Consensus Planning Process (Consensus Criteria) in combination with inflows passed to meet downstream senior rights.

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[1] HDR Engineering, Inc., "Guadalupe-San Antonio River Basin Recharge Enhancement Study," Volumes I, II, and III, Edwards Underground Water District, September 1993.

2.3 Engineering and Costing

Reservoir construction cost data for the six projects evaluated in Phase 1 were updated from 1994 to first-quarter 1996 prices by multiplying by the ENRCCI ratio. The reservoir construction cost data for Cloptin Crossing Reservoir was calculated by applying a reservoir capital cost per unit capacity, based on similar reservoirs, to the Cloptin Crossing Reservoir capacity. Land acquisition costs within inundated pool areas were based on a recent land-value survey.[2] For projects inundating perennial streams, (Gonzales Reservoir, Guadalupe River Dam No. &, Cloptin Crossing Reservoir, and Cuero Reservoir), a strip of river frontage land 1,000 feet wide over the length of the inundated area was assigned a greater value, with the remainder of the inundated area valued according to the land-value survey. Costs to acquire land for environmental mitigation were assumed to be 80 percent of the land acquisition cost. All other project costs were assigned in accordance with Phase I methodology. Costs for the Sandies Creek Reservoir project include pump station and pipeline construction, operation and maintenance, and power costs related to the diversion from the Guadalupe River into the reservoir.

The costs presented herein are for raw water in each potential reservoir and do not include additional transmission, treatment, or distribution costs. Costs for relocation, mineral rights, mitigation, environmental and archaeological studies, and other significant items were not evaluated in great detail, but were estimated by approximate methods consistent with those applied in Phase I.

2.4 Environmental Considerations

The Texas Water Development Board, Texas Natural Resource Conservation Commission, and Texas Parks and Wildlife Department have recommended that the Environmental Water Needs Criteria of the Consensus Planning Process (Consensus Criteria) be utilized in water-resources planning efforts (Appendix B). These criteria are intended to ensure maintenance of streamflow for environmental needs, while allowing diversions and/or

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2 Gilliland and Semien, "Rural Land Values in the Southwest: First Half, 1997," Technical Report 1210, Real Estate Center, Texas A&M University, December 1997.

impoundments for water supply. A brief summary of the Consensus Criteria and discussion of terrestrial and aquatic habitat mitigation follow.

2.4.1 On-Channel Reservoir

Under the Consensus Criteria, the conservation storage of new project on-channel reservoirs is divided into three zones, for which different reservoir inflows need to be passed for environmental needs. Zone 1 occurs when reservoir contents are greater than 80 percent of capacity and inflows must be passed up to the monthly median daily naturalized flow. Zone 2 occurs when reservoir contents are between 50 and 80 percent of conservation capacity and inflows must be passed up to the monthly 25th percentile daily naturalized flow. Zone 3 occurs when reservoir contents fall below 50 percent of conservation capacity and inflows must be passed up to the established water quality standard, or the 7Q2 if a water quality standard has not been established for the stream segment. No reservoir storage is required to be released for maintenance of instream flows or freshwater inflows to bays and estuaries.

2.4.2 Direct Diversion

The environmental flow requirements for direct diversions are similar. When inflows are above the monthly median daily naturalized flow, flows are passed up to the monthly median daily naturalized flow (Zone 1). When inflows are between the monthly median and monthly 25-percentile daily naturalized flows, flows are passed up to the 25-percentile daily naturalized flow. When inflows are less than or equal to the monthly 25-percentile daily naturalized flow, the established water quality standard or the 7Q2 is passed.

2.4.3 Direct Diversion into Off-Channel Reservoir

A direct diversion into an off-channel reservoir is required to meet the direct diversion criteria for the diversion point, while the reservoir is required to meet the on-channel reservoir criteria for the reservoir location.

2.4.4 Mitigation Considerations

In reservoir development, impacts to vegetation and wildlife at the dam and burrow sites, and on inundated lands, are unavoidable. Compensation will almost certainly be required for impacts involving net loss of wetlands and to habitats utilized by endangered or threatened species. Texas Parks and Wildlife Department, which is a party to and receives notice of, all water rights applications, typically asks for complete compensation for all impacts to fish and wildlife habitat, and requires that compensation be based on replacement value of lost habitat. The U.S. Fish and Wildlife Service and Environmental Protection Agency, both of whom will comment on U.S. Army Corps of Engineers permits issued for dam construction, also generally base their mitigation or compensation requirements on replacing lost habitat value. This usually requires: (1) completion of a study specifically designed to evaluate the habitat values of the different vegetation/land use types occurring in the reservoir area, (2) similar studies of the candidate compensation sites, (3) development of an appropriate management plan that will produce the required increase in habitat value over the life of the project, and (4) securing a negotiated compensation agreement among the concerned parties (the applicant, resource agencies, landowners, and interested organizations and individuals).

3.0 UPDATED EVALUATION OF POTENTIAL RESERVOIRS

3.1 Cuero Reservoir (G-16)

3.1.1 Description of Alternative

Cuero Reservoir is a proposed major impoundment on the Guadalupe River in DeWitt and Gonzales Counties and would be located about 4 miles north of the town of Cuero. Numerous studies of the reservoir have been performed,[1,2] the latest of which is by Espey, Huston & Associates[3] in 1986, which provided the siting and basic data for this study. The location of the project is shown in Figure 3.1-1.

The dam would be an earthfill embankment with a gate-controlled concrete spillway to control the 4,166 square-mile watershed. The dam embankment would extend about 4.7 miles across the Guadalupe River valley and provide a conservation storage capacity of 1,167,000 acft at elevation 242 ft-MSL; at full conservation pool the surface area would be 41,500 acres; the probable maximum flood elevation would be 252 feet; and, approximately 50 miles of the Guadalupe River channel would be inundated by the reservoir.

Three alternative uses of water from this reservoir were studied in Phase I: (1) delivery to injection wells to recharge the Edwards Aquifer (Alt G-16A); (2) delivery to recharge structures in the Edwards Aquifer recharge zone (Alt G-16B); and (3) delivery to a water treatment plant and distribution in the SAWS municipal water system (Alt G-16C). Only the firm yield and cost of raw water at the reservoir were updated in Phase II.

3.1.2 Previous (Phase I) Yield Estimates

The firm yield of the proposed Cuero Reservoir was computed for Phase I utilizing the Trans-Texas Environmental Criteria (Appendix A). Firm yield was computed subject to three capacity thresholds which limit passage of reservoir inflows during times of drought as specified in the Trans-Texas Environmental Criteria. Other assumptions for yield computation included

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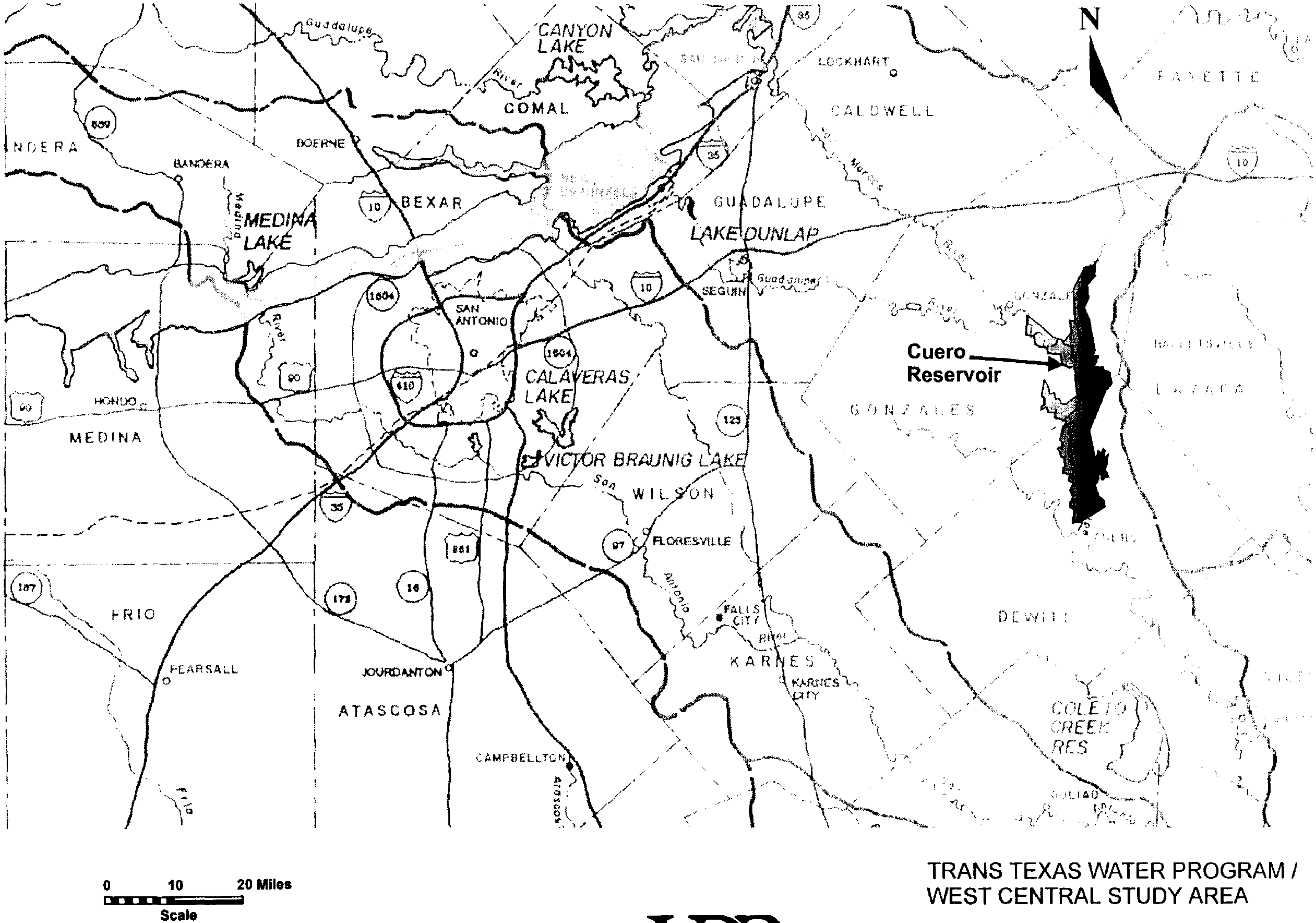
[1]Texas Water Development Board, "A Summary of the Preliminary Plan for Proposed Water Resources Development in the Guadalupe River Basin," July 1966

[2]U.S. Bureau of Reclamation, "Summary of Special Report, San Antonio - Guadalupe River Basins Study, Texas Basin Project," November 1978.

[3]Espey, Huston & Associates, Inc., "Water Availability Study for the Guadalupe and San Antonio River Basins," Guadalupe-Blanco River Authority, February 1986



UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

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TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

CUERO RESERVOIR ALTERNATIVE G-16

FIGURE 3.1-1

springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures, full utilization of existing water rights (including those associated with Applewhite Reservoir), and return flows set to 1988 levels. Hydropower water rights were subordinated to 0 cfs at Lake Dunlap.[4]

The Guadalupe - San Antonio River Basin Model[5] (GSA Model) was used to estimate monthly quantities of total streamflow and unappropriated streamflow potentially available at the reservoir site which, in turn, were used to compute the firm yield of Cuero Reservoir. For modeling purposes, streamflows for the Guadalupe River at Cuero (USGS# 08175800) less those for Sandies Creek near Westhoff (USGS# 08175000) were assumed to be representative of inflows to Cuero Reservoir. The firm yield of Cuero Reservoir was computed using an original model (RESSIM) specifically written to simulate reservoir operations subject to the Trans-Texas Environmental Criteria for new reservoirs, using water availability estimates from the GSA Model. A summary of the firm yield estimates for this scenario and the capacity thresholds analyzed is provided in Table 3.1-1. As is apparent in this table, the firm yield is quite sensitive to capacity threshold for drought contingency operations. Appendix C contains a summary of the inflow passage requirements applied to Cuero Reservoir in Phase I.

Table 3.1-1
Summary of Cuero Reservoir Firm Yield Estimates From Phase I

Estimate of Firm Yield (acft/yr)[1]		
Reservoir Capacity Threshold for Implementation of Drought Contingency Operations[2]		
60%	**40%**	**80%**
163,000	117,000	187,000

Notes:
[1]Includes the springflows from a fixed Edwards Aquifer pumpage of 400,000 acft/yr with existing recharge structures, full utilization of existing water rights (including Applewhite Reservoir), and return flows set to 1988 levels. Hydropower water rights were subordinated to 0 cfs at Lake Dunlap.
[2]The capacity threshold is the percentage of reservoir conservation storage that triggers a change from normal to drought contingency operations under the Trans-Texas Environmental Criteria for new reservoirs. Drought contingency operations provide for the release of inflows, up to the median monthly natural flow, during the January 1954 through December 1956 historical period.

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[4]Espey, Huston & Associates, Inc., "Engineering Analyses and Hydrologic Modeling to Determine the Effects of Subordination of Hydropower Water Rights," Guadalupe-Blanco River Authority, March 1993.
[5]HDR Engineering, Inc., "Guadalupe - San Antonio River Basin Recharge Enhancement Study," Volumes I, II, and III, Edwards Underground Water District, September 1993.

3.1.3 Updated (Phase II) Yield Estimate

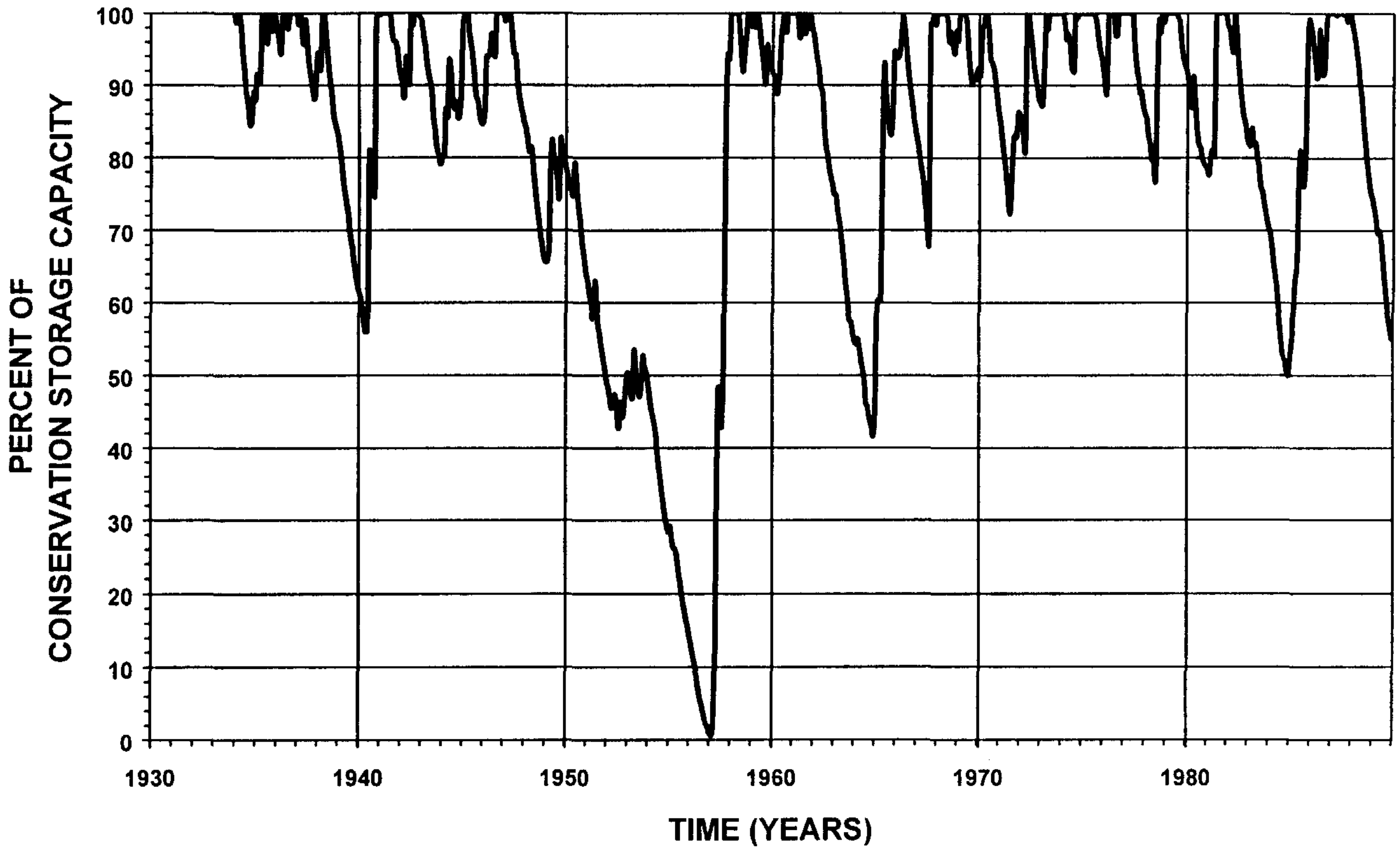
The firm yield of the proposed Cuero Reservoir was computed for this Phase II study utilizing the Consensus Criteria (Appendix B). The GSA Model was used to estimate daily total streamflow and unappropriated streamflow available at the reservoir site. General assumptions for this application of the GSA Model included:

- springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures
- full utilization of existing water rights
- return flows set to 1989 levels
- full subordination of hydropower rights to 0 cfs at Lake Dunlap

For modeling purposes, streamflows for the Guadalupe River at Cuero (USGS# 08175800), less those for Sandies Creek near Westhoff (USGS# 081750000), were assumed to be representative of inflows to the Cuero Reservoir site. These inflows represent the naturalized flows from above the reservoir site, adjusted for upstream water rights and return flows. The GSA Model computes streamflow available for impoundment without causing increased shortages to downstream rights. Daily streamflows passed through the reservoir to meet the requirements of downstream water rights and environmental needs are also computed.

The firm yield of Cuero Reservoir was computed using the inflows and pass-through flows computed by the GSA Model, and a modified version of the SIMDLY reservoir operation model. The streamflow statistics used to set the Consensus Criteria pass-through requirements are presented in Appendix D. Subject to a uniform seasonal demand pattern, the firm yield is 145,448 acft/yr.

Figure 3.1-2 illustrates simulated Cuero Reservoir storage fluctuations for the 1934-1989 historical period, subject to the firm yield of 145,448 acft/yr. Simulated reservoir storages remain above the Zone 2 trigger level (80 percent capacity) about 68 percent of the time and above the Zone 3 trigger level (50 percent capacity) about 90 percent of the time over the 1934-1989 historical period. During the 1947-1956 drought period, simulated reservoir levels



UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

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FIRM YIELD STORAGE TRACE CUERO RESERVOIR ALTERNATIVE G-16

FIGURE 3.1-2

stayed above the Zone 2 trigger level about 18 percent of the time, and above the Zone 3 trigger level about 55 percent of the time. Figure 3.1-3 illustrates simulated changes in streamflow caused by the reservoir at the project location and at the Saltwater Barrier. Mean annual freshwater inflows to the Guadalupe Estuary, as measured at the Saltwater Barrier, would be reduced about 206,000 acft, or about 13 percent.

3.1.4 Environmental Issues

The Cuero Reservoir project involves dam construction and inundation of approximately 41,500 acres along a 50-mile reach of the Guadalupe River (see Figure 3.1-1). The proposed reservoir spans portions of Gonzales and DeWitt counties. It is located in the Texas Blackland Prairies ecoregion,[6] in the ecotonal region between the Post Oak Savannah and Blackland Prairie vegetational regions,[7] and within the Texan biotic province as described by Blair.[8]

Within the floodplains, soils of the Meguin-Trinity association are found. These soils are somewhat poorly drained, calcareous loamy and clayey soils. They are well suited to range, improved pasture and crops. The Sarnosa-Shiner association is found on uplands. These are nearly level, well-drained, moderately permeable, calcareous loamy soils used for range and wildlife, but also suited to pasture.[9]

The upland forest community type is fairly limited in extent, comprising only about 5 percent of the woodland acreage within the boundaries of the reservoir site. Dominant overstory species within this community type include post oak, cedar elm, honey mesquite, and live oak. In the understory and shrub layers, honey mesquite, acacias, cedar elm, and prickly pear (*Opuntia* spp.) occur. Grasses and forb species comprise the herbaceous stratum in this community type.[10]

Bottomland and riparian forests comprise approximately 95 percent (about 10,792 acres) of the wooded acreage in the proposed reservoir site. A variety of reptiles, amphibians,

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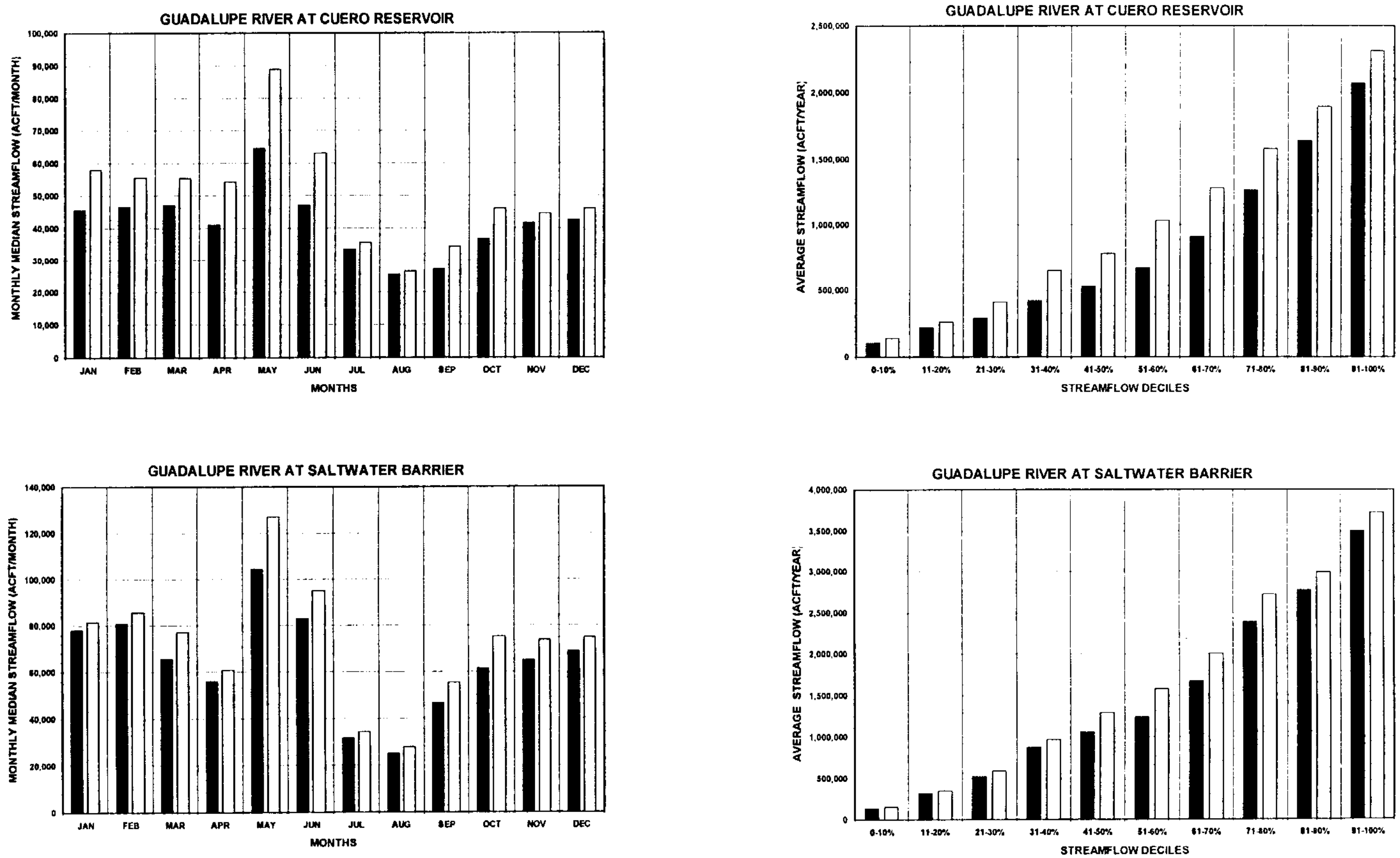
6Omernik, James M., 1986, "Ecoregions of the Conterminous United States," Annals of the Association of American Geographers, 77(1). pp. 118-125.

7Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas.

8Blair, W.F., 1950. The biotic provinces of Texas. Tex. J. Sci. 2:93-117.

9U.S. Department of Agriculture, Soil Conservation Service (SCS). 1978a. Soil Survey of DeWitt County, Texas. In cooperation with the Texas Agricultural Experiment Station, Texas A&M University, College Station.

10Espey, Huston & Associates, Inc. (EH&A). 1986. Water Availability Study for the Guadalupe and San Antonio River Basins. Prepared for San Antonio River Authority, Guadalupe-Blanco River Authority, and City of San Antonio.



LEGEND:

■ WITH PROJECT

□ WITHOUT PROJECT

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

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TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

CHANGES IN STREAMFLOW CUERO RESERVOIR ALTERNATIVE G-16

FIGURE 3.1-3

mammals, and bird species rely on these habitats for food and cover. These forest types are similar in terms of species composition and in terms of certain edaphic and hydrologic factors, but differ in extent due to differences in floodplain characteristics. Bottomland forest stands, which occur along the Guadalupe River, and where floodplains are wide along major streams, are characterized by a dense overstory canopy and a well-developed understory and shrub layer. Riparian forest stands generally occur in narrow floodplains of minor streams, and are thereby limited to narrow bands of woody vegetation immediately adjacent to the streams.

Brushland, which occupies approximately 6,991 acres, is the dominant community type in the wooded upland portions of the proposed reservoir site, and is also present in some lowland areas. This community type occurs primarily as a result of overgrazing and fire suppression, which have allowed woody species to increase in areas that were formerly covered by grasslands or savannah community types. The thick nature of the brushland vegetation makes this an excellent nesting habitat for a variety of bird species. It also provides ample food and cover for a number of rodents and other mammalian species, including the white-tailed deer and collared peccary. The protected Texas tortoise utilizes brush habitats for cover, and for food in the form of cacti and herbaceous undergrowth.[11]

The grassland community types represent approximately 13,796 acres within the proposed reservoir site, and include managed pastures, oilfields, and ROW. The majority of the grassland within the reservoir site is used as grazing land for livestock.

Substantial areas of cropland (approximately 6,691 acres) occur within the proposed reservoir site, primarily within the Guadalupe River floodplain. Principal crops grown in the region include grain sorghum, corn, cotton, wheat, and peanuts.[12]

Wetlands, which occupy approximately 2,402 acres within the proposed Cuero Reservoir site, include riverine habitats; palustrine forested, scrub/shrub, emergent, and open-water wetlands; and limited areas of lacustrine open-water habitat. Forested wetlands (i.e., swamps) are limited to areas within the Guadalupe River floodplain and occur primarily in association with oxbow lakes and sloughs. Scrub/shrub and emergent wetlands (i.e., marshes) occur in wet depressions and around the edges of aquatic habitats within the proposed reservoir site.

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11 Ibid.
12 Ibid

The aquatic habitats of the Guadalupe River in the Cuero Reservoir are dominated by the mainstream river and several major permanent creeks such as Peach, Denton McCoy, and Cuero. Both the mainstem river and permanent creeks are relatively low gradient streams with meandering channels. Numerous oxbows have been formed in the mainstem of the Guadalupe River. The banks of all permanent water bodies are generally relatively steep and comprised primarily of clay. However, some areas of Peach Creek and Denton Creek have sandy banks and sandy substrate. Generally, the bottom is clay in permanent water areas.[13]

The primary impacts that would result from construction and operation of the Cuero Reservoir include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. The Cuero Reservoir site would be permanently inundated to 242 ft-MSL with a surface area of 41,500 acres. Approximately 13,796 acres of grassland, 6,691 acres of cropland, 11,360 acres of woodlands, 6,991 acres of brushland, 1,464 acres of wetlands, 938 acres of riverine habitat, and 260 acres of developed land would be converted to open water upon dam construction. In addition to long-term impacts within the conservation pool, minor changes to existing resources situated between the conservation pool elevation and flood pool elevation could be anticipated due to occasional temporary inundation during flood events.

Potential downstream impacts would include modification of the streamflow regime below the dam, and reduced inflows to the Guadalupe Estuary. As a new reservoir without a current operating permit, Cuero Reservoir would likely be required to meet environmental flow requirements determined by a site-specific study.

A yield of 145,448 acft/year was computed subject to the Consensus Criteria. Modeling results indicate that the monthly median streamflow on the Guadalupe River at Cuero is reduced substantially throughout the year relative to without-project conditions, with the greatest reductions (approximately 12,700 to 24,700 acft/month) occurring in January, April, May and June. Annual streamflow deciles decrease uniformly relative to without project conditions (25-35 percent), for decile averages below the 70th percentile flows.

[13] Ibid.

The criteria for freshwater inflow to bays and estuaries are assumed to be met if theConsensus Criteria are met. The monthly median streamflow at the Saltwater Barrier would be reduced by a maximum of about 18 percent in October and May, with the reduction for other months ranging from 4 to 15 percent. Decreases in average streamflow at the Saltwater Barrier range from about 6 to 22 percent in all streamflow deciles. Mean annual flows at the Saltwater Barrier are projected to decline from 1,636,545 to 1,430,870 acft/yr. According to relationships established in Texas Department of Water Resources studies, this would be more than sufficient inflow to maintain the salinity structure of the Guadalupe Estuary (Alternative I, Sustenance).[14]

Plant and animal species listed by the USFWS and TPWD as endangered or threatened, and those with candidate status for listing in DeWitt and Gonzales counties are presented in Appendix F. Those species with potential habitat in the vicinity of the proposed reservoir are listed in Table 3.1-2. The Texas Natural Heritage Program records include reported occurrences of the Texas meadow-rue (*Thalictrum texanum*), a USFWS candidate species for protection, in Gonzales County along the Guadalupe River just upstream of the town of Gonzales,[15] which is located near the Cuero Reservoir site.

Of the species listed in Table 3.1-2, two are river dependent, Cagle's map turtle and the blue sucker. The Cagle's map turtle has been observed within the proposed reservoir area.[16] The blue sucker has not been recently reported in the lower Guadalupe River.[17] If the species is present, this reach would likely be rendered unsuitable for construction of a main-stem impoundment. A survey of the reservoir site will be required to determine whether populations of or potential habitat for species of concern occur.

Several important aquatic species that warrant attention are the river darter (*Percina shumardi*), the freshwater prawn (*Macrobrachium carcinus*), and the American eel (*Anguilla rostrata*). The river darter, an unprotected non-game fish, has been reported on the Guadalupe

[14]Texas Department of Water Resources, 1980, "Guadalupe Estuary: A Study of the Influence of Freshwater Inflows," LP-107, Austin, Texas.
[15]Texas Natural Heritage Program (TNHP). 1985 and 1994. Unpublished data from element records. Austin, Texas.
[16]Killebrew, F.C., 1991, "Habitat Characteristics and Feeding Ecology of Cagle's Map Turtle (*Graptemys caglei*) Within the Proposed Cuero and Lindenau Reservoir Sites," Prepared for Texas Parks and Wildlife Department under interagency contract with the Texas Water Development Board, 15 pp.
[17]Academy of Natural Sciences (ANS). 1991. A review of chemical and biological studies on the Guadalupe River, Texas, 1949-1989. Report No. 91-9. Acad. Nat. Sci. Phil. Philadelphia, PA.

Table 3.1-2
Important Species With Habitat Within the Cuero Reservoir Project Vicinity (G-16)

Common Name	Scientific Name	Habitat Preference	Listing Agency	
			USFWS	TPWD
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby resting sites	E	E
Zone-tailed Hawk	*Buteo albonotatus*	Canyons and wooded river bottoms in Southwest U.S.A.	NL	T
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	C1	NL
Texas Tortoise	*Gopherus berlandieri*	Open brush with grass understory; open grass and bare ground are avoided; occupies shallow depressions at base of bush or cactus, or uses underground burrows; active March-November	NL	T
Reticulate Collared Lizard	*Crotaphytus reticulatus*	South Texas Plains; usually thorn brush, mesquite-blackbrush	NL	T
Texas Horned Lizard	*Phrynosoma cornutum*	Open arid and semi-arid regions with sparse vegetation including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky, burrows in soil, or hides under rocks[1]	C2	T
Indigo Snake	*Drymarchon corais erebennus*	Grass prairies and sand hills; usually thorn brush woodland and mesquite savannah of coastal plain	NL	T
Texas Garter Snake	*Thamnophis sirtalis annectens*	Varied, especially wet areas; bottomlands and pastures	C2	NL
Blue Sucker	*Cycleptus elongatus*	Large rivers throughout Mississippi River Basin south and west in major freshwater streams of Texas to Rio Grande River	C2	T
Big Red Sage	*Salvia penstemonoides*	Moist creek and stream bed edges; historic; introduced in native plant nursery trade	C2	NL
Texas Meadow-rue	*Thalictrum texanum*	Coastal plains and savannah of south east Texas; known in Brazos and Waller Cos.; historic in Harris Co.	C2	NL
Mulenbrock's Umbrella Sedge	*Cyperus grayioides*	Prairie grasslands, moist meadows in Texas, Louisiana, Illinois	C2	NL
Prairie Dawn (also called Texas Bitterweed)	*Hymenoxys texana*	Gulf prairie and marshes in poorly drained depressions or at the base of mima mounds in open grasslands in almost barren areas; known in Ft. Bend and Harris Cos.; historic collection from LaSalle Co.	E	E

Source: TPWD, Unpublished files, Texas Natural Heritage Program, Texas Parks and Wildlife, Austin, Texas.
[1]Dixon, J.R., 1987, Amphibians and Reptiles of Texas. Texas A&M Press, College Station, Texas.

River in the Cuero project area.[18] The American eel and the freshwater prawn, although not recently collected, are known to have occurred historically in the Guadalupe River basin. Reservoir development would alter the fishery from that of a stream (lotic) habitat to a reservoir (lentic) habitat. Species dependent on a lotic habitat for their life cycle would be eliminated within the lentic habitat.

The proposed Cuero Reservoir has been subjected to an intensive cultural resources investigation. A total of 357 archaeological sites were recorded at or below the 270 ft-MSL contour elevation, including five previously recorded sites that were revisited in a survey conducted by the Texas Historical Commission (THC) and the Texas Water Development Board.[19]

Sites containing prehistoric components accounted for 293 of the 357 sites recorded, and ranged from Paleo-Indian to Historic occupations. Archaeological testing and surface collection for 133 sites, additional survey of about 3,300 acres of land not accessible at the time of initial survey, extensive historical records research, and controlled excavations of 14 sites within and on the margin of the area to be flooded were recommended by Fox et al.[20] prior to project inundation. Areas not subjected to survey were not identified.

Nominated to the National Register of Historic Places (NRHP) in June 1974 by the THC, virtually the entire proposed Cuero Reservoir was accepted by Federal review agencies as the Cuero I Archaeological District in October 1974. The Cuero I Archeological District, located in DeWitt and Gonzales counties, extends over a 45-mile long area of the lower Guadalupe River Basin between Cuero and Gonzales. This area is larger than the area covered by the proposed Cuero Reservoir.

Outside the 242 ft-MSL flood pool, at about the 245 ft-MSL contour, is the Braches Home, located about 12 miles southeast of Gonzales. The house is listed on the NRHP. One historical marker commemorating Dr. W. W. White is located within the Cuero Reservoir area.

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[18]Espey, Huston & Associates, Inc., (EH&A), 1986, "Water Availability Study for the Guadalupe and San Antonio River Basin," Prepared for San Antonio River Authority, Guadalupe-Blanco River Authority and City of San Antonio, Volumes I and II, EH&A Document No. 85580, February.
[19]Fox, D.E., R.J. Mallouf, Nancy O'Malley and W.M. Sorrow, 1974, "Archaeological Resources of the Proposed Cuero I Reservoir, DeWitt and Gonzales Counties, Texas," *Archaeological Survey Report* No. 12, Texas Historical Commission and Texas Water Development Board, Austin.
[20]Ibid.

Four other markers commemorating the Cuero I Archaeological District, the Braches Home, the Sam Houston Oak, and the town of Concrete, are located between the 242 and 265 ft-MSL contours. The State Historic Building Inventory lists one structure within the proposed reservoir, the Miles Squire Bennett House. This house is located in DeWitt County approximately 2 miles north of the dam site. Only the foundation, chimney and cistern remain. The frame house has been disassembled.

No previously recorded Historic Architectural Buildings Survey (HABS) structures, Registered Log Cabins or Natural Landmarks are located within the proposed reservoir area.

Within the 242 ft-MSL reservoir elevation, an EH&A reconnaissance survey[21] identified 82 possibly significant historic resources, including seven cemeteries. Excluding the cemeteries, the potential resources are farmsteads, houses, and other buildings that may have been associated with the early communities of the area. At least twenty other possible historic structures and 18 cemeteries are located between the 242 and 300 ft-MSL contours. Down river from the dam, four structures and three cemeteries were also recorded. These cultural resources are noted due to their proximity to the proposed dam.

Laws have been implemented by the Federal and Texas State governments to protect cemeteries. These resources should either be avoided or dealt with appropriately. Special procedures for handling cemeteries, as outlined in Vernon's Annotated Revised Civil Statues of the State of Texas (Title 26, Article 912a-10 and 912a-11), will have to be followed for the Cuero Reservoir site.

Because the proposed Cuero I Reservoir has been intensively surveyed and consequently placed on the NRHP as the Cuero I Archaeological District, resurvey most likely will not be called for in the permitting process. The 3,300 acres not surveyed by Fox et al.[22] will most likely require survey.

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21 Espey, Huston & Associates, Inc., (EH&A), 1986, "Water Availability Study for the Guadalupe and San Antonio River Basin," Prepared for San Antonio River Authority, Guadalupe-Blanco River Authority and City of San Antonio, Volumes I and II, EH&A Document No. 85580, February.

22 Fox, D.E., R.J. Mallouf, Nancy O'Malley and W.M. Sorrow, 1974, "Archaeological Resources of the Proposed Cuero I Reservoir, DeWitt and Gonzales Counties, Texas," *Archaeological Survey Report* No. 12, Texas Historical Commission and Texas Water Development Board, Austin.

3.1.5 Water Quality and Treatability

[To be completed in subsequent phases of the study.]

3.1.6 Engineering and Costing

The cost estimate for the dam and reservoir is shown in Table 3.1-3. This estimate is an update of the Phase I estimate, which was an update of the previous cost estimate developed by EHA[23]. Financing the project over 25 years at an 8 percent annual interest rate results in an annual expense of $51,840,000. Annual operation and maintenance costs total $2,070,000. The annual costs, including debt service, and operation and maintenance, total $53,910,000. For an annual firm yield of 145,448 acft, the resulting annual cost of raw water at the reservoir is $371 per acft (Table 3.1-3).

3.1.7 Implementation Issues

An institutional arrangement is needed to implement this project including financing on a regional basis.

<u>Reservoir Alternative (G-16)</u>

1. It will be necessary to obtain these permits:
   a. TNRCC Water Right and Storage permits.
   b. TNRCC Interbasin Transfer Approval
   c. U.S. Army Corps of Engineers Sections 10 and 404 dredge and fill permits for the reservoir and pipelines.
   d. GLO Sand and Gravel Removal permits.
   e. GLO Easement for use of state-owned land.
   f. Coastal Coordinating Council review.
   g. TPWD Sand, Gravel, and Marl permit.
2. Permitting, at a minimum, will require these studies:
   a. Bay and estuary inflow impact.
   b. Habitat mitigation plan.
   c. Environmental studies.
   d. Cultural resources.
3. Land will need to be acquired through either negotiations or condemnation.
4. Relocations for the reservoir include:
   a. Highways and railroads
   b. Other utilities

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23 Espey, Huston & Associates, Inc., "Water Availability Study for the Guadalupe and San Antonio River Basins," Guadalupe-Blanco River Authority, February 1986.

Table 3.1-3
Cost Estimate Summary for Cuero Reservoir (G-16)
(1st Quarter 1996 Prices)

Item	Estimated Cost
Capital Costs	
Dam and Reservoir	$168,120,000
Total Capital Cost	**$168,120,000**
Engineering, Contingencies, and Legal Costs	58,840,000
Land Acquisition	160,520,000
Environmental Studies and Mitigation	124,830,000
Interest During Construction	40,980,000
Total Project Cost	**$553,290,000**
Annual Costs	
Annual Debt Service	$51,840,000
Annual Operation and Maintenance	20,070,000
Total Annual Cost	**$53,910,000**
Firm Yield (acft/yr)	145,448
Annual Cost of Raw Water at the Reservoir	$371/acft

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3.2 Sandies Creek Reservoir (G-17)

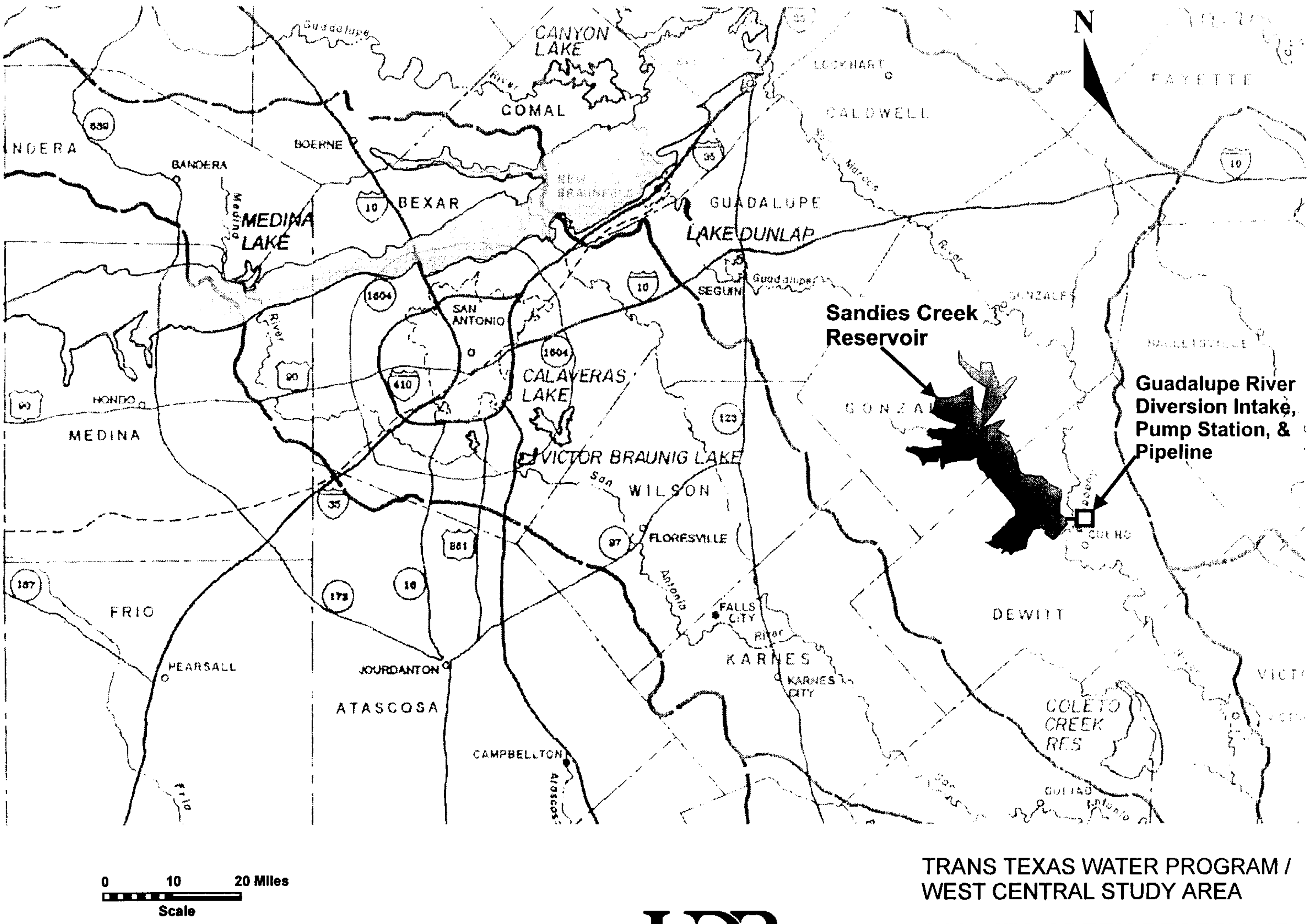
3.2.1 Description of Alternative

Sandies Creek Reservoir is a proposed reservoir located on Sandies Creek, a tributary of the Guadalupe River in DeWitt and Gonzales Counties. The project would impound water from the Sandies Creek watershed as well as water diverted from the Guadalupe River during periods of flow in excess of downstream needs. This reservoir was proposed as a water supply for in-basin needs as part of the Texas Basins Project[24] in the mid-1960's. Prior to Phase I, subsequent studies of the reservoir were performed,[25] the latest of which is by Espey, Huston & Associates, Inc.[26] in 1986, which provided the siting and basic data for this study. The location of the dam is shown in Figure 3.2-1.

The dam would be an earthfill embankment with an uncontrolled roller-compacted concrete spillway to control the 678 square mile watershed. The dam embankment would extend about 2 miles across the Sandies Creek valley, and provide a conservation storage capacity of 606,280 acft at elevation 232 ft-MSL; at conservation pool, the surface area would be 26,875 acres; the probable maximum flood elevation would be 244 ft-MSL; and, approximately 30 miles of Sandies Creek channel would be inundated by the reservoir.

Three alternative uses of water from this reservoir were studied in Phase I: (1) delivery to injection wells to recharge the Edwards Aquifer (Alt G-17A); (2) delivery to recharge structures in the Edwards Aquifer recharge zone (Alt G-17B); and (3) delivery to a water treatment plant and distribution in the San Antonio municipal water system (Alt G-17C). Only the firm yield and cost of raw water at the reservoir were updated in Phase II.

24United States Bureau of Reclamation, "Texas Basins Project," February 1965.
25Texas Water Development Board, "A Summary of the Preliminary Plan for Proposed Water Resources Development in the Guadalupe River Basin," July 1966.
26Espey, Huston & Associates, Inc., "Water Availability Study for the Guadalupe and San Antonio River Basins," Guadalupe-Blanco River Authority, February 1986.



UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

SANDIES CREEK RESERVOIR ALTERNATIVE G-17

FIGURE 3.2-1

3.2.2 Previous (Phase I) Yield Estimates

The firm yield of the proposed Sandies Creek Reservoir was computed for Phase I subject to three capacity thresholds which limit passage of reservoir inflows as specified in the Trans-Texas Environmental Criteria (Appendix A) during times of drought. Assumptions for yield computation included the springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures, full utilization of existing water rights (including those associated with Applewhite Reservoir), and return flows set to 1988 levels. Hydropower water rights were subordinated to 0 cfs at Lake Dunlap.[27]

The Guadalupe - San Antonio River Basin Model[28] (GSA Model) was used to estimate monthly quantities of total streamflow and unappropriated streamflow potentially available at the reservoir site which, in turn, were used to compute the firm yield of Sandies Creek Reservoir. For modeling purposes, streamflows for Sandies Creek near Westhoff (USGS# 08175000) were assumed to be representative of inflows to Sandies Creek Reservoir. Monthly estimates of unappropriated streamflow potentially available for diversion from the Guadalupe River at Cuero (USGS# 08175800) were determined applying the Trans-Texas Environmental Criteria and assuming full control of the Sandies Creek watershed above the proposed reservoir.

Diversions from the Guadalupe River to supplement natural inflows were included to increase the yield of the reservoir. Daily gaged flows for the Guadalupe River at Cuero for the 1964-89 period were analyzed in order to determine a typical percentage of water available on a monthly basis which could be diverted on a daily basis subject to downstream water rights, selected diversion rates, and daily streamflow variations. This analysis indicated that, on average, about 80 percent of the monthly volume of unappropriated streamflow (with the Trans-Texas Environmental Criteria applied) could be diverted to Sandies Creek Reservoir from the Guadalupe River when the daily distribution of flows was considered. Maximum monthly diversions to Sandies Creek Reservoir were, therefore, limited to 80 percent of the estimated water available in the Guadalupe River.

27 Espey, Huston & Associates, Inc., "Engineering Analyses and Hydrologic Modeling to Determine the Effects of Subordination of Hydropower Water Rights," Guadalupe-Blanco River Authority, March 1993.

28 HDR Engineering, Inc., "Guadalupe - San Antonio River Basin Recharge Enhancement Study," Volumes I, II, and III, Edwards Underground Water District, September 1993.

The firm yield of Sandies Creek Reservoir was computed using an original model (RESSIM) specifically written to simulate reservoir operations subject to the Trans-Texas Environmental Criteria for new reservoirs, using water availability estimates from the GSA Model. A sensitivity analysis was performed to assess the effect of the monthly diversion rate from the Guadalupe River on the firm yield of Sandies Creek Reservoir. Based on this analysis, a maximum monthly Guadalupe River diversion rate of 40,000 acft was selected for use in computing the firm yield. A summary of the firm yield estimates for this scenario and the capacity thresholds analyzed are provided in Table 3.2-1. As is apparent in this table, estimated firm yield for Sandies Creek Reservoir is relatively insensitive to the capacity threshold for drought contingency operations. Appendix C contains a summary of the inflow passage requirements applied to Sandies Creek Reservoir in Phase I.

Table 3.2-1
Summary of Sandies Creek Reservoir Firm Yield Estimates[2] From Phase I

	Estimate of Firm Yield (acft/yr)[1]		
	Reservoir Capacity Threshold for Implementation of Drought Contingency Operations[3]		
Scenario	**40%**	**60%**	**80%**
1	43,800	45,200	48,700

Notes:
[1]Firm yield based on diversion of unappropriated streamflow potentially available at the Guadalupe River at Cuero (USGS# 08175800) subject to a maximum diversion rate of 40,000 acft per month.
[2]All scenarios include the springflows from a fixed Edwards Aquifer pumpage of 400,000 acft/yr with existing recharge structures, full utilization of existing water rights (including Applewhite Reservoir), and return flows set to 1988 levels. Hydropower water rights were subordinated to 0 cfs at Lake Dunlap.
[3]The capacity threshold is the percentage of reservoir conservation storage that triggers a change from normal to drought contingency operations under the Trans-Texas Environmental Criteria for new reservoirs. Drought contingency operations provide for the release of inflows, up to the median monthly natural flow, during the January 1954 through December 1956 historical period.

The firm yield estimates for Sandies Creek Reservoir presented in Table 3.2-1 are substantially less than those estimated in earlier studies. For example, Espey, Huston & Associates reported the firm yield of Sandies Creek Reservoir to be about 107,000 acft/yr.[29] The

29 Espey, Huston & Associates, "Water Availability for the Guadalupe and San Antonio River Basins," Guadalupe-Blanco River Authority, February 1986.

primary reason for the difference in yield estimates is the limitation on the volume of water that can be pumped into the reservoir from the Guadalupe River imposed by the Trans-Texas Environmental Criteria. During the critical period (June 1947 to February 1957), the Trans-Texas Environmental Criteria allows for diversions to occur from the Guadalupe River in only 5 out of 117 months, or about 4 percent of the time. For the overall period analyzed, 1934 to 1989, diversions from the Guadalupe River could have occurred about 24 percent of the time. If diversions from the Guadalupe River were limited only by the passage of flows to honor downstream water rights, the firm yield of Sandies Creek Reservoir would be approximately 117,000 acft/yr.

3.2.3 Updated (Phase II) Yield Estimates

The firm yield of the proposed Sandies Creek Reservoir was computed for this Phase II study utilizing the Consensus Criteria (Appendix B). The GSA Model was used to estimate daily total streamflow and unappropriated streamflow available at the reservoir site. The GSA Model was also used to estimate daily estimates of unappropriated streamflow potentially available for diversion from the Guadalupe River upstream of the Sandies Creek confluence into Sandies Creek Reservoir, assuming full control of the Sandies Creek watershed above the proposed reservoir. General assumptions for this application of the GSA Model included:

- springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures
- full utilization of existing water rights
- return flows set to 1989 levels
- full subordination of hydropower rights to 0 cfs at Lake Dunlap

For modeling purposes, streamflows for Sandies Creek near Westhoff (USGS# 08175000) were assumed representative of inflows to Sandies Creek Reservoir. These inflows are the naturalized flows from above the reservoir site, adjusted for upstream water rights and return flows.

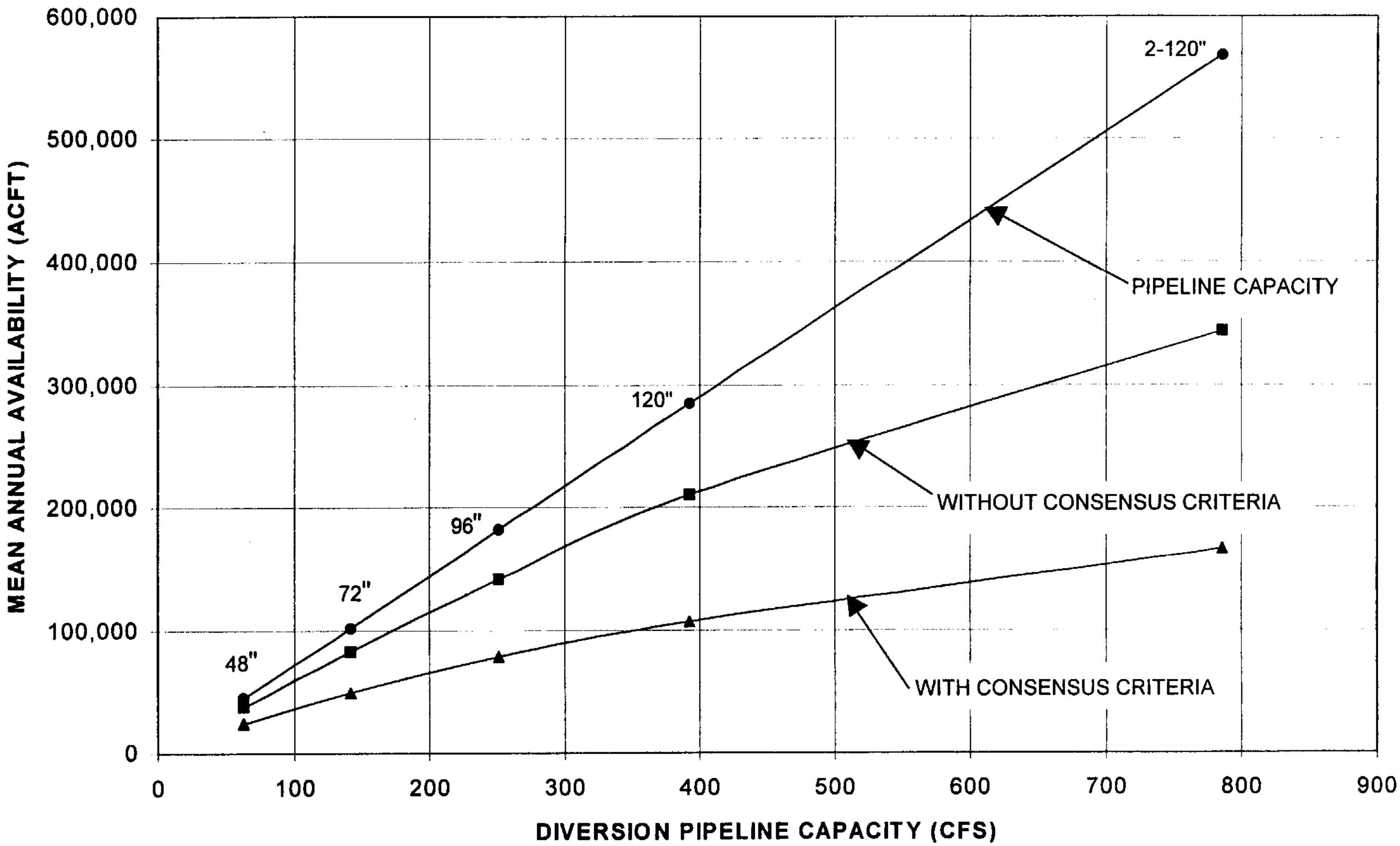
The GSA Model computed the streamflow available for diversion from the Guadalupe River into Sandies Creek Reservoir without causing increased shortages to downstream rights and subject to the Consensus Criteria for direct diversion. In addition, various maximum diversion capacities associated with potential diversion pipeline sizes (48-inch, 72-inch, 96-inch, 120-inch, and parallel 120-inch pipelines) were considered. Figure 3.2-2 presents the mean annual water available for the Guadalupe River diversion into Sandies Creek Reservoir for each of the diversion rates investigated. The mean annual water availability is constrained substantially by downstream water rights and environmental requirements, particularly as the pipeline diversion capacity increases.

The firm yield of Sandies Creek Reservoir was computed with the SIMDLY reservoir operation model, using the Sandies Creek inflows and the flows available for diversion from the Guadalupe River. Only inflows from the Sandies Creek watershed were subject to the Consensus Criteria pass-through requirements for Sandies Creek. The streamflow statistics used to determine the Consensus Criteria pass-through requirements are presented in Appendix D. Table 3.2-2 and Figure 3.2-3 present the firm yields associated with each of the Guadalupe River diversion rates investigated. The firm yield estimates were computed as uniform demands, with no monthly or seasonal variation.

Figure 3.2-4 illustrates the simulated Sandies Creek Reservoir storage fluctuations for the 1934-1989 historical period, subject to the firm yield of 74,471 acft/yr based on delivery of Guadalupe River diversions via two 120-inch pipelines. Simulated reservoir contents remain above the Zone 2 trigger level (80 percent capacity) about 66 percent of the time and above the Zone 3 trigger level (50 percent capacity) about 88 percent of the time over the 1934-1989 historical period. Reservoir levels are substantially lower during the 1947-19569 drought period, staying above the Zone 2 trigger level only about 4 percent of the time, and above the Zone 3 trigger level only about 38 percent of the time. Figure 3.2-5 illustrates the changes in streamflow caused by the reservoir, at the Cuero gage downstream from the diversion location and at the

Table 3.2-2
Sandies Creek Reservoir Firm Yield Estimates
For Various Guadalupe River Diversion Capacities

Estimate of Firm Yield (acft/yr)				
Guadalupe River Diversion Capacity (cfs)				
63 (48" Pipeline)	141 (72" Pipeline)	251 (96" Pipeline)	393 (120" Pipeline)	786 (two-120" Pipelines)
54,952	58,670	62,648	66,423	74,471



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WATER AVAILABLE FOR DIVERSION FROM GUADALUPE RIVER INTO SANDIES CREEK RESERVOIR

HDR

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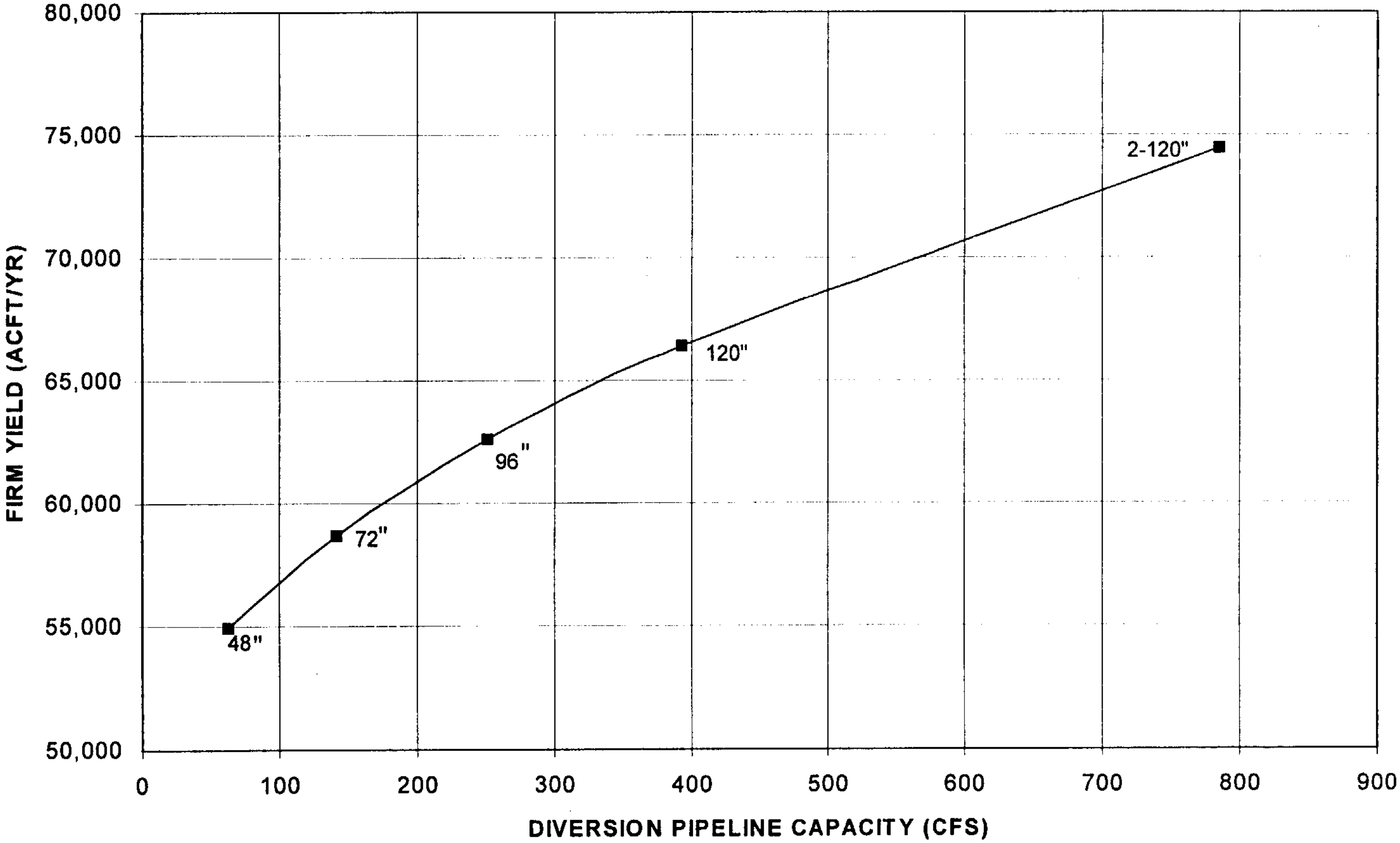
FIGURE 3.2-2

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN



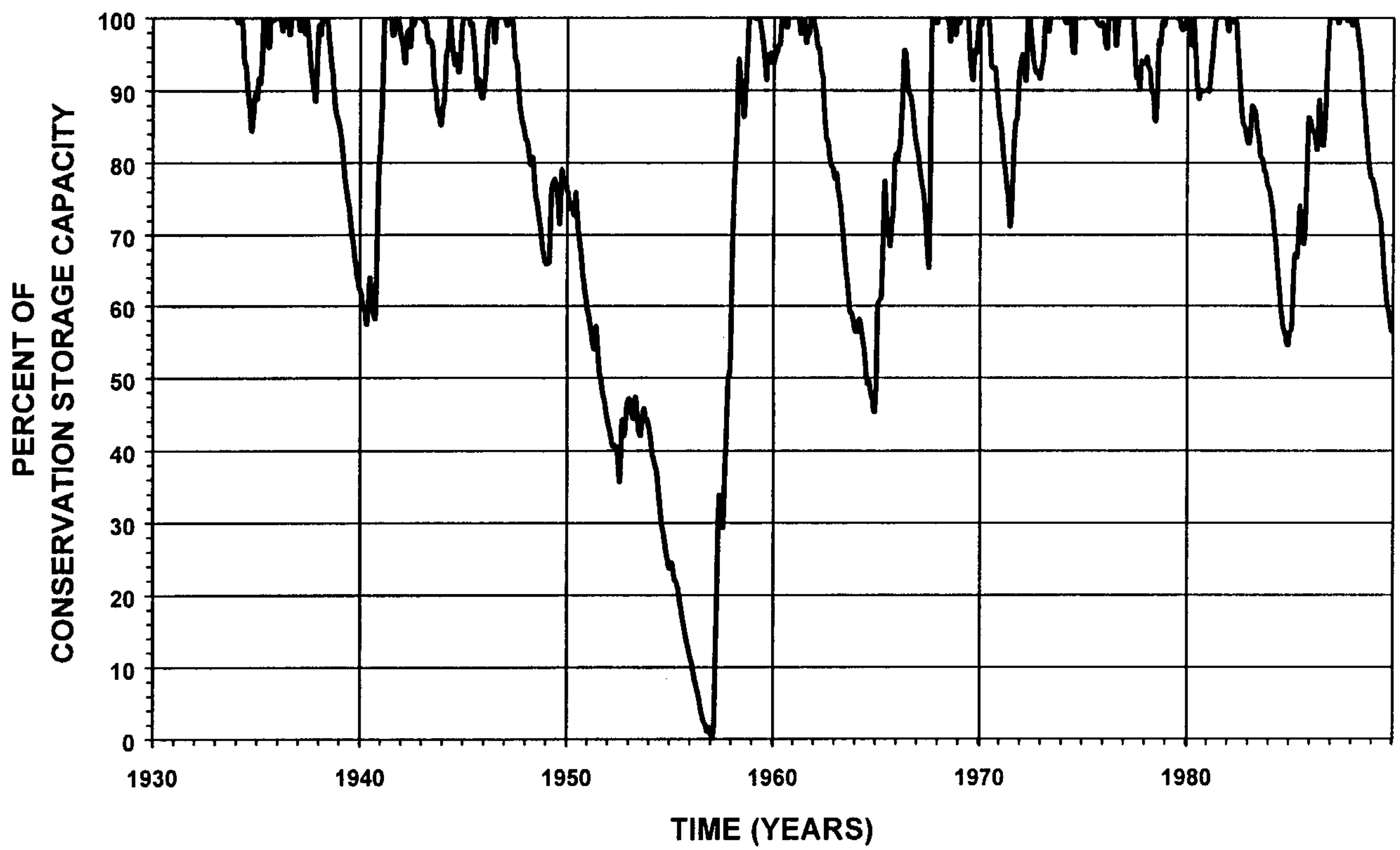
TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

FIRM YIELD
SANDIES CREEK RESERVOIR

FIGURE 3.2-3

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR Engineering, Inc.



TRANS TEXAS WATER PROGRAM /
WEST CENTRAL STUDY AREA

FIRM YIELD STORAGE TRACE
SANDIES CREEK RESERVOIR
ALTERNATIVE G-17

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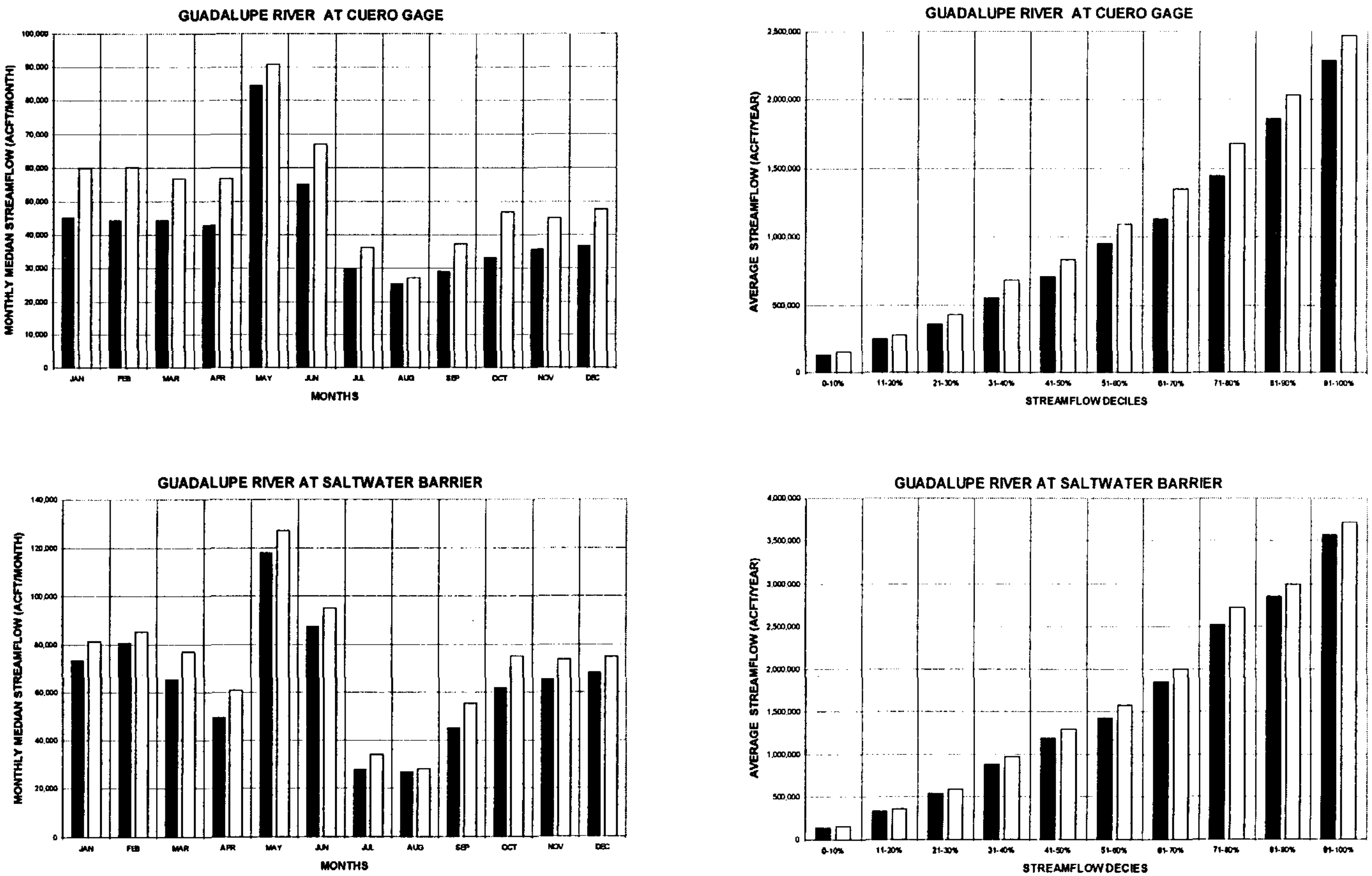
UPDATED EVALUATION OF
POTENTIAL RESERVOIRS IN THE
GUADALUPE RIVER BASIN

FIGURE 3.2-4



LEGEND:

- WITH PROJECT (solid)
- WITHOUT PROJECT (open)

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

CHANGES IN STREAMFLOW SANDIES CREEK RESERVOIR ALTERNATIVE G-17

FIGURE 3.2-5

Saltwater Barrier. Monthly median flows in Sandies Creek below the project location (not illustrated) are affected substantially by the project. Mean annual freshwater inflows to the Guadalupe Estuary, as measured at the Saltwater Barrier, would be reduced about 119,500 acft/yr, or about 7 percent.

3.2.4 Environmental Issues.

The Sandies Creek Reservoir project involves dam construction and inundation of approximately 26,875 acres along a 30-mile reach of Sandies Creek, a tributary of the Guadalupe River (Figure 3.2-1). The proposed reservoir spans portions of Gonzales and DeWitt counties. It is located in the Texas Blackland Prairies ecoregion,[30] in the ecotonal region between the Post Oak Savannah and Blackland Prairie vegetational regions,[31] and within the Texan biotic province.[32]

Soils of the Meguin-Trinity association are found within the floodplains. These soils are somewhat poorly drained, calcareous loamy and clayey soils. They are well suited to range, improved pasture and crops. The Sarnosa-Shiner association is found on uplands. These are nearly level, well-drained, moderately permeable, calcareous loamy soils used for range and wildlife, but also suited to pasture.[33]

The upland forest community type comprises approximately 20 percent of the total woodland acreage within the reservoir boundaries. Dominant overstory species within the upland forest community type include post oak, cedar elm, honey mesquite, and live oak. In the understory and shrub layers, honey mesquite, acacias, cedar elm, and prickly pear (*Opuntia* spp.) occur. Grasses and forb species comprise the herbaceous stratum in this community type.[34]

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30 Omernik, James M., 1986, "Ecoregions of the Conterminous United States", Annals of the Association of American Geographers, 77(1). pp. 118-125.

31 Gould, F.W., 1975, The Grasses of Texas, Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas.

32 Blair, W.F., 1950, "The Biotic Provinces of Texas," Tex. J. Sci. 2:93-117.

33 U.S. Department of Agriculture, Soil Conservation Service (SCS). 1978a. Soil Survey of DeWitt County, Texas. In cooperation with the Texas Agricultural Experiment Station, Texas A&M University, College Station.

34 Espey, Huston & Associates, Inc. (EH&A), 1986, Water Availability Study for the Guadalupe and San Antonio River Basins. Prepared for San Antonio River Authority, Guadalupe-Blanco River Authority, and City of San Antonio. Volumes I and II. EH&A Document No. 85580. February.

Bottomland and riparian forests comprise approximately 80 percent (about 4,306 acres) of the wooded acreage within the proposed reservoir boundaries. A variety of reptiles, amphibians, mammals, and bird species rely on the bottomland/riparian forests for food and cover.[35]

Brushland, which occupies approximately 8,409 acres, is the dominant community type in the wooded upland portions of the proposed reservoir site, and is also present in some lowland areas. This community type occurs primarily as a result of overgrazing and fire suppression, which have allowed woody species to increase in areas that were formerly covered by grasslands or savannah community types. Brushlands are dominated by low trees and shrubs, with a ground cover of forbs and grasses.[36] The thick nature of the brushland vegetation makes this an excellent nesting habitat for a variety of bird species.

The grassland community types represent approximately 9,390 acres within the reservoir site, and include managed pastures, oilfields, and pipeline, utilities, and transportation rights-of-way. The majority of the grassland within the reservoir site is used as grazing land for livestock.[37] Woody species in the grassland habitats are either sparse or absent. Ground cover is occasionally thick, thus providing good cover for a variety of rodent species that in turn provide food for carnivores, such as the coyote, northern harrier, and common barn-owl. A variety of reptiles, mammals, and birds also use grassland habitats for food and cover.[38]

Cropland is limited within the proposed reservoir site, occupying approximately 904 acres and occurring primarily within major floodplains. Principal crops grown in the region include grain sorghum, corn, cotton, wheat, and peanuts.[39]

Wetlands, which occupy approximately 2,789 acres (including 193 acres of riverine habitat) within the Sandies Creek Reservoir site, include riverine habitats; palustrine forested, scrub/shrub, emergent, and open-water wetlands; and limited areas of lacustrine open-water habitat. Forested wetlands (i.e., swamps) are limited to areas within major floodplains.[40]

35Ibid.

36 Ibid.

37U.S. Department of Agriculture, Soil Conservation Service (SCS), 1977, Soil Survey of Bandera County, Texas. In cooperation with Texas Agricultural Experiment Station, Texas A&M University, College Station. April.

38Espey, Huston & Associates, Inc. (EH&A), 1986, Water Availability Study for the Guadalupe and San Antonio River Basins. Prepared for San Antonio River Authority, Guadalupe-Blanco River Authority, and City of San Antonio. Volumes I and II. EH&A Document No. 85580. February.

39Ibid.

40Ibid.

The project area has a much more dendritic creek system than does the Cuero project area. Sandies Creek is the major aquatic habitat in the project area and is smaller than the Guadalupe River. Generally, the channel is no more than 20 to 25 ft wide. Bank slope is more gentle than the Guadalupe River. Vegetation generally reaches to the water's edge, even under low-flow conditions. The channel is more of a shallow V-shape than U-shape. Therefore, as flow increases, the creeks quickly widen out. Several of the tributaries of Sandies Creek are perennial, and have marshy areas associated with them. Gravel bars occur in the channels of several tributaries.[41]

Salt flats occur within the Sandies Creek Reservoir site in poorly drained areas with loamy, highly saline sediments. The climax plant community in these areas is an open grassland composed of salt-tolerant herbaceous species. Dominant species include Gulf cordgrass (*Spartina spartinae*), switchgrass (*Panicum virgatum*), seashore saltgrass (*Distichlis spicata*), alkali sacaton (*Sporobolus airoides*), bushy sea-oxeye (*Borrichia frutescens*), devilweed aster (*Aster spinosus*), and wild buckwheat (*Eriogonum* sp.). Gulf cordgrass and switchgrass decrease as a result of heavy grazing by livestock and continuous burning, leaving bushy sea-oxeye and devilweed aster as the dominant components of the habitat.[42,43] Portions of the salt flats, which retain water for long periods of time due to low permeability and poor drainage, may be considered wetlands by some definitions.

The primary impacts that would result from construction and operation of the Sandies Creek Reservoir include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. The Sandies Creek Reservoir would be permanently inundated to 232 ft-MSL with a surface area of 26,875 acres. Approximately 9,390 acres of grassland, 8,409 acres of brushland, 5,383 acres of woodland, 904 acres of cropland, 2,596 acres of wetlands, and 193 acres of riverine habitat would be converted to open water.

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41 Ibid.

42 U.S. Department of Agriculture, Soil Conservation Service (SCS), 1978a, Soil Survey of DeWitt County, Texas. In cooperation with the Texas Agricultural Experiment Station, Texas A&M University, College Station.

43 Thomas, G.W., 1975, "Texas Plants - An Ecological Summary. *In:* F.W. Gould Texas Plants - A Checklist and Ecological Summary," Texas Agricultural Experiment Station, MP-585/Rev., College Station, Texas.

Indirect effects of reservoir construction may include land use changes in the area surrounding the reservoir and in mitigation areas that may be converted to alternate uses to compensate for losses of terrestrial habitat.

Potential downstream impacts would include modification of the streamflow regime below the dam, and reduced inflows to the Guadalupe Estuary. As a large new reservoir without a current operating permit, Sandies Creek Reservoir would likely be required to meet environmental flow requirements determined by a site-specific study.

A yield of 74,471 acft/year can be obtained with the Consensus Criteria in place. Modeling results indicate that the monthly median streamflow on Sandies Creek below the reservoir is reduced substantially throughout the year relative to without-project conditions. The greatest reductions (approximately 11,000 to 13,500 acft/month) would occur in April, May, and October. Reductions of the monthly median streamflow on the Guadalupe River at Cuero due to the proposed diversion associated with the Sandies Creek Reservoir alternatives would be moderate, with the greatest reduction (approximately 15,000 acft/month) occurring during February.

The criteria for freshwater inflow to bays and estuaries are assumed to be met if the new reservoir criteria are met. Modeling of the monthly median streamflow and average streamflow at the Saltwater Barrier indicate flow reductions that are relatively minor throughout the year and throughout the range of streamflow deciles.

Plant and animal species listed by the USFWS and TPWD as endangered or threatened, and those with candidate status for listing in DeWitt and Gonzales counties are presented in Appendix F. The Texas Natural Heritage Program records include reported occurrences of Texas meadow-rue (*Thalictrum texanum*), a USFWS candidate species for protection, in Gonzales County along the Guadalupe River just upstream of the town of Gonzales,[44] which is located near the Sandies Creek reservoir site.

Those species with potential habitat in the vicinity of the proposed reservoir are listed in Table 3.2-3. Of the species listed this table, three are river dependent: Cagle's map turtle, blue sucker and the Guadalupe bass. The Cagle's map turtle has been observed within the proposed

[44] Texas Natural Heritage Program (TNHP), 1985 and 1994, Unpublished data from element records, Austin, Texas.

Table 3.2-3
Important Species With Habitat Within the Sandies Creek Reservoir Project Vicinity (G-17)

Common Name	Scientific Name	Habitat Preference	Listing Agency	
			USFWS	TPWD
Attwater's Prairie-Chicken	*Tympanuchus cupido attwateri*	Native gulf coastal prairies of the coastal plain; 50% climax grass species composition	E	E
Bald Eagle	*Haliaeetus leucocephalus*	Near large water bodies with nearby resting sites; nests in forested river bottoms	E	E
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin[2]	C1	NL
Texas Horned Lizard	*Phrynosoma cornutum*	Open arid and semi-arid regions with sparse vegetation including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows in soil, or uses rodent burrows, or hides under rocks when inactive.	C2	T
Texas Tortoise	*Gopherus berlandieri*	Open brush with grass understory; open grass and bare ground are avoided; occupies shallow depressions at base of bush or cactus or uses underground burrows; active March-Nov.	NL	T
Timber Rattlesnake	*Crotalus horridus*	Bottomland woodlands[2]	NL	T
Black-spotted Newt	*Notophthalmus meridionalis*	Wet or temporarily wet areas such as arroyos, canals, ditches and shallow depressions; aestivates underground during dry periods[1]	C2	E
Blue Sucker	*Cycleptus elongatus*	Large rivers through the Mississippi Basin; In Texas, major streams southward to the Rio Grande[1]	C2	T
Guadalupe Bass	*Micropterus treculi*	Rivers of the Edwards Plateau including portions of the Brazos, Colorado, Guadalupe, and San Antonio River Basins; also the lower Colorado River and introduced in the Nueces River system[1]	C2	NL
Texas Meadow-rue	*Thalictrum texanum*	Coastal plains and savannah of south east Texas; known in Brazos and Waller Co.s; historic in Harris Co.	C2	NL
Mulenbrock's Umbrella Sedge	*Cyperus grayioides*	Prairie grasslands, moist meadows in Texas, Louisiana, Illinois	C2	NL

[1]Source: TPWD. 1988 Unpublished list. Resource Protection Division. Texas Parks and Wildlife Department. Austin, Texas.
[2]Dixon, J.R., 1987, Amphibians and Reptiles of Texas. Texas A&M Press, College Station, Texas.
Source for all other habitat preference information: Texas Natural Heritage Program, December 1993, unpublished files.

reservoir area.[45] The blue sucker has not been recently reported in the lower Guadalupe River.[46] If the species is present, it would render this reach unsuitable for the construction of an impoundment. A survey of the reservoir site may be required prior to dam construction to determine whether populations of or potential habitat for species of concern occur in the area to be impacted.

Although no cultural resource investigations have been conducted in the proposed Sandies Creek Reservoir, eleven sites were recorded adjacent to the upper reaches of Rocky Creek in Gonzales County. Located as a part of the University of Texas San Antonio Conquista Project,[47] all sites were reported as lithic scatter sites. One site revealed two *Angostura* fragments, suggesting a Paleo-Indian occupation. No other diagnostics were recorded.

One hundred eighty-five recorded cultural resources sites within Gonzales County have been listed by the Texas Archeological Research Laboratory. In addition, 258 sites are recorded in DeWitt County. Within the 26,875-acre study area encompassed by the 232 ft elevation of the proposed reservoir, no cultural resources sites have been recorded. The study area has not been subjected to a systematic cultural resources survey. It is probable that, if the area is surveyed, cultural resources sites will be located, some of which may exhibit the criteria necessary for nomination to the NRHP. A significant portion of the Sandies site is also within the Cuero I Archaeological District, whose boundaries were identified by latitude and longitude coordinates.

The National Register of Historic Places (NRHP) lists six sites in Gonzales County and four sites in DeWitt County. There are no NRHP sites within the proposed reservoir area. The Guide to Official Texas Historical Markers lists 79 markers within Gonzales County and 64 markers within DeWitt County. One marker (Salt Flats) is located within the Sandies Creek Reservoir area. A second marker, located at 250 ft-MSL in elevation, commemorates the town of Westhoff. A single State Historic Inventory Site, the Sandies Creek Bridge, is located within

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45Killebrew, F.C., 1991.,"Habitat Characteristics and Feeding Ecology of Cagle's Map Turtle (*Graptemys caglei*) Within the Proposed Cuero and Lindenau Reservoir Sites," Prepared for Texas Parks and Wildlife Department under interagency contract with the Texas Water Development Board. 15 pp.

46Academy of Natural Sciences (ANS), 1991, "A Review of Chemical and Biological Studies on the Guadalupe River, Texas," 1949-1989. Report No. 91-9. Acad. Nat. Sci. Phil. Philadelphia, PA.

47McGraw, A. Joachim, 1979, A Preliminary Archaeological Survey for the Conquista Project in Gonzales, Atascosa and Live Oak counties, Texas. Center for Archaeological Research, the University of Texas at San Antonio, Survey Report 76.

the Sandies study area. In the town of Westhoff, another Historic Inventory site, the First Baptist Church, is located at the 250 ft-MSL contour. No previously recorded Historic Architectural Buildings Survey (HABS) structures, State Archeological Landmarks, Registered Log Cabins or Natural Landmarks are located within the proposed reservoir area. At least three cemeteries are located within the study site. Laws have been implemented by the Federal and Texas State governments to protect cemeteries. These resources should either be avoided or dealt with appropriately. Special procedures for handling cemeteries, as outlined in Vernon's Annotated Revised Civil Statutes of the State of Texas (Title 26, Article 912a-10 and 912a-11), will have to be followed for the Sandies Creek Reservoir site.

3.2.5 Water Quality and Treatability

[To be completed in subsequent phases of the study.]

3.2.6 Engineering and Costing.

The cost estimate for the dam and reservoir is shown in Table 3.2-4. This estimate is an update of a previous cost estimate performed by EHA.[48] The river intake and pump station for the Phase II cost estimate are sized to deliver up to 47,384 acft/month (785 cfs) through parallel 120-inch diameter pipelines. Financing the project over 25 years at an 8 percent annual interest rate results in an annual expense of $23,120,000. Annual operation and maintenance costs, including power, total $4,130,000. The annual costs, including debt service, and operation and maintenance, total $27,250,000. For an annual firm yield of 74,471 acft, the resulting annual cost of raw water at the reservoir is $366 per acft.

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48 Espey, Huston & Associates, Inc., "Water Availability Study for the Guadalupe and San Antonio River Basins, "Guadalupe-Blanco River Authority, February 1986.

Table 3.2-4
Cost Estimate Summary for Sandies Creek Reservoir (G-17)
(1st quarter 1996 Prices)

Item	Estimated Cost
Capital Costs	
Dam and Reservoir	$86,020,000
Transmission and Pumping (Guadalupe River diversion)	20,280,000
Total Capital Cost	**$106,300,000**
Engineering, Contingencies, and Legal Costs	36,660,000
Land Acquisition	47,610,000
Environmental Studies and Mitigation	38,930,000
Interest During Construction	17,240,000
Total Project Cost	**$246,740,000**
Annual Costs	
Annual Debt Service	$23,120,000
Annual Operation and Maintenance	1,320,000
Annual Power Cost	2,810,000
Total Annual Cost	**$27,250,000**
Firm Yield (acft/yr)	74,471
Annual Cost of Raw Water at the Reservoir	$366/acft

3.2.7 Implementation Issues

An institutional arrangement is needed to implement this project including financing on a regional basis.

Reservoir Alternative (G-17)

1. It will be necessary to obtain these permits:
   a. TNRCC Water Right and Storage permits.
   b. TNRCC Interbasin Transfer Approval.
   c. U.S. Army Corps of Engineers Sections 10 and 404 dredge and fill permits for the reservoir and pipelines.
   d. GLO Sand and Gravel Removal permits.
   e. GLO Easement for use of state-owned land.
   f. Coastal Coordinating Council review.
   g. TPWD Sand, Gravel, and Marl permit
2. Permitting, at a minimum, will require these studies:
   a. Bay and estuary inflow impact.
   b. Habitat mitigation plan.
   c. Environmental studies.
   d. Cultural resource studies.
3. Land will need to be acquired by negotiation or condemnation.
4. Relocations for the reservoir include:
   a. Highways and railroads
   b. Other utilities

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3.3 Guadalupe River Dam No. 7 (G-19)

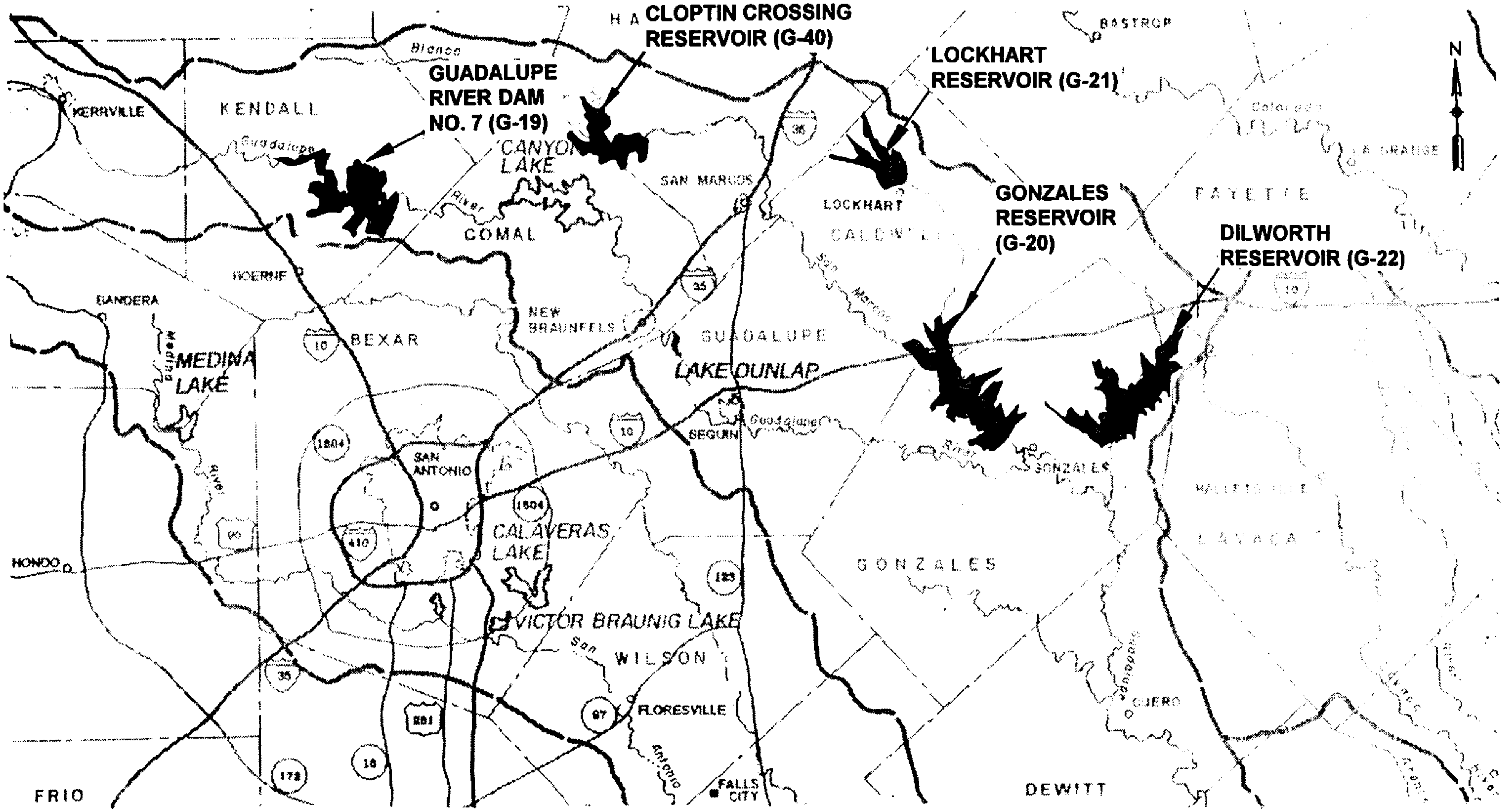
3.3.1 Description of Alternative.

The Guadalupe River Dam No. 7 site was originally proposed in 1953 in the "Initial Plan" of the Guadalupe-Blanco River Authority (GBRA) and was proposed to be located on the Guadalupe River at a location 30 miles west of New Braunfels in Kendall County, as shown in Figure 3.3-1. In a report entitled "Preliminary Report on the Proposed Guadalupe River Dam No. 7 and No. 8," the original purpose of the project was primarily for power development. In 1959, Forrest and Cotton, Inc. studied Dam No. 7 as a water conservation project, located at a site seven river miles upstream from the original study location (drainage area at the upstream location is 1,124 square miles, which is 78 percent of the drainage area of Canyon Lake). The most recent published study of the Guadalupe Dam No. 7 project was performed in October 1981 by Espey, Huston and Associates, Inc. (EHA) in their report entitled "Upper Guadalupe River Dam No. 7," in which the site was again studied with respect to water conservation potential.

The Guadalupe River Dam No. 7, as described by EHA, is a typical rock-filled section with an earthen core and random fill outer shells which would provide a conservation storage capacity of 600,000 acft at elevation 1,242 ft-MSL; at full conservation pool, the surface area would be 12,830 acres; and approximately 31 miles of the Guadalupe River would be inundated by the reservoir. The dam crest is set at a maximum elevation of 1,263 ft-MSL and the spillway consists of a 4,000 to 4,500-feet long section cut into a nearby hill.

3.3.2 Previous (Phase I) Estimates

Yield estimates for Guadalupe Dam No. 7 were determined in the 1981 EHA report honoring numerous combinations of water rights. The final yield estimate for the study was based on honoring all downstream water rights except the GBRA hydropower rights below the Comal River, which were only partly satisfied. EHA estimated the combined yield of Dam No. 7 and Canyon Lake to be 87,100 acft/yr, with the increment of yield attributable to Dam No. 7 being approximately 33,300 acft/yr. The yields first presented in Phase I were not adjusted to reflect Trans-Texas criteria for pass-through, instream needs, and bay and estuary needs. The firm yield of Guadalupe Dam No. 7, subject to Trans-Texas Environmental Criteria for New Reservoirs (Appendix A), was computed to be 28,300 acft/yr in an assessment of water



LEGEND:

BASIN DIVIDE

PROPOSED RESERVOIR

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

0 10 20 Miles

Scale

HDR

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

ALTERNATIVES G-19, G-20, G-21, G-22, G-40

FIGURE 3.3-1

potentially available in the Upper Guadalupe River Basin for Edwards Aquifer recharge enhancement in a study completed by HDR.[49]

3.3.3 Updated (Phase II) Yield Estimate

The firm yield of the proposed Guadalupe River Dam No. 7 was computed for this Phase II study utilizing the Consensus Criteria (Appendix B). The GSA Model was used to estimate daily total streamflow and unappropriated streamflow available at the reservoir site. General assumptions for this application of the GSA Model included:

- springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures
- full utilization of existing water rights
- return flows set to 1989 levels
- full subordination of hydropower rights to 0 cfs at Lake Dunlap

The GSA Model was used to compute total daily streamflow for the Guadalupe River at Comfort (USGS# 08167000) and the Guadalupe River at Spring Branch (USGS# 08167500), as the proposed reservoir site is located between these two gages. These flows represent naturalized flows at the gages, adjusted for upstream water rights and return flows. Inflows at the reservoir site were estimated from the inflows at the gage locations using a linear interpolation routine based upon the drainage areas of the reservoir site and the two gages. Daily streamflows to be passed through the reservoir to meet the requirements of downstream water rights were computed at the Spring Branch gage and adjusted for the difference in drainage area between the gage and the reservoir location.

The firm yield of the Guadalupe River Dam No. 7 was computed using the inflows and pass-through flows computed by the GSA Model, and the modified version of the SIMDLY reservoir operation model. All inflows were passed during months when Canyon Reservoir storage was less than capacity. The streamflow statistics used to determine the Consensus Criteria pass-through requirements are presented in Appendix D. Subject to a uniform seasonal demand pattern, the firm yield was computed as 30,927 acft/yr.

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49 HDR, "Trans-Texas Water Program, West Central Study Area, Phase I Interim Report," Volume 4, San Antonio River Authority, et al., January 1996.

Figure 3.3-2 illustrates the simulated Guadalupe River Dam No. 7 storage fluctuations for the 1934-1989 historical period, subject to the firm yield diversion of 30,927 acft/yr. Simulated reservoir storages remain above the Zone 2 trigger level (80 percent capacity) about 66 percent of the time and above the Zone 3 trigger level (50 percent capacity) about 86 percent of the time over the 1934-1989 historical period. During the 1947-1956 drought period, reservoir levels stayed above the Zone 2 trigger level only about 9 percent of the time, and above the Zone 3 trigger level only about 38 percent of the time. Figure 3.3-3 illustrates the changes in streamflow caused by the reservoir at the project location and at the Saltwater Barrier. Monthly median flows at the project site would be reduced by about 23 percent. Freshwater inflows to the Guadalupe Estuary, as measured at the Saltwater Barrier, would not be significantly affected by the project.

3.3.4 Environmental Issues.

The Guadalupe River Dam No. 7 project involves dam construction and inundation of approximately 12,830 acres along a 31-mile reach of the Guadalupe River. The proposed reservoir is located in the eastern portion of Kendall County within the Central Texas Plateau ecoregion,[50] on the southern edge of the Edwards Plateau vegetational area of Texas,[51] and within the Balconian biotic province.[52]

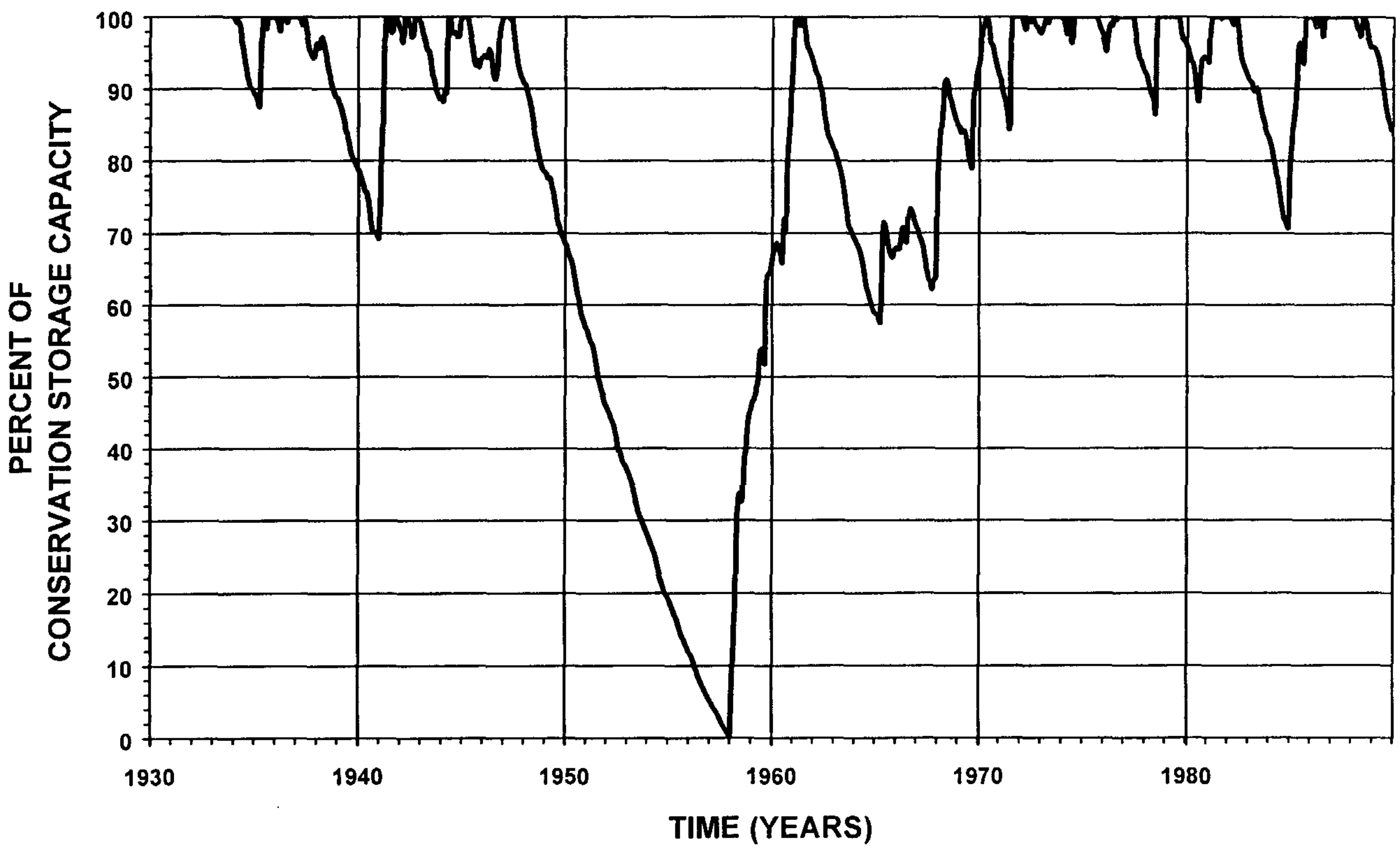
The project area is heavily wooded (41 percent of total land area), with large expanses of brush and scrublands (43%) and small quantities of grassland, cropland, and wetland. The wooded upland areas typically support open to closed stands of plateau oak, Texas oak, shinnery oaks, Ashe juniper, cedar elm, and honey mesquite, with a tall or mid-grass understory. The most important grasses in these upland areas are little bluestem, gramas, curly mesquite, and buffalo grass. The wooded upland areas are primarily undeveloped, with open areas generally used for rangeland.[53]

50Omernik, James M. 1986. Ecoregions of the Conterminous United States. Annals of the Association of American Geographers, 77(1). pp. 118-125.

51 Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas.

52Blair, W.F. 1950. The biotic provinces of Texas. Tex. J. Sci. 2:93-117.

53Espey, Huston & Associates, Inc. (EH&A). 1981. Upper Guadalupe River Basin Water Supply Project, Final Report. Prepared for Upper Guadalupe River Authority and Guadalupe-Blanco River Authority. EH&A Document No. 81137-R1. October.



UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

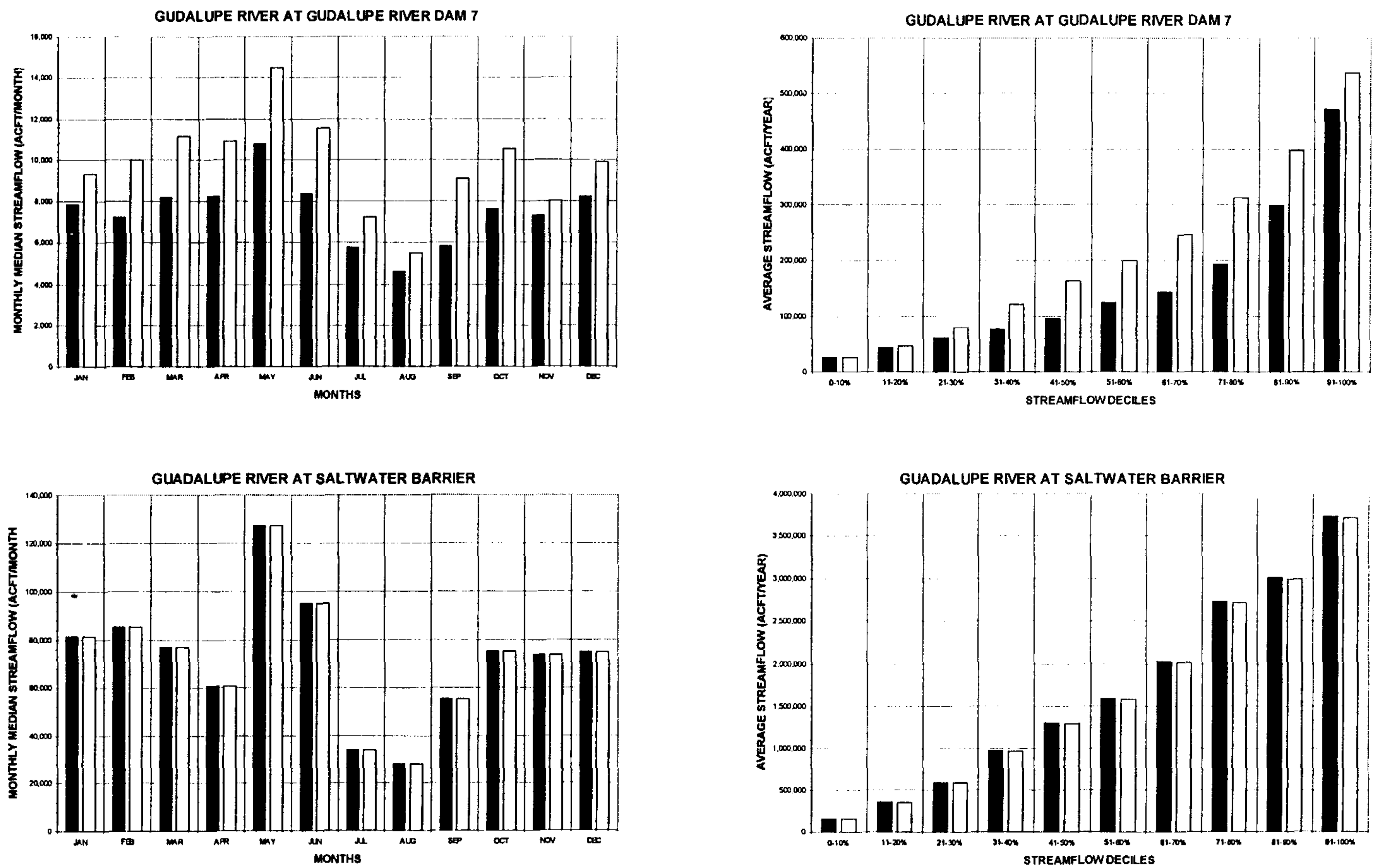
HDR

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

FIRM YIELD STORAGE TRACE GUADALUPE RIVER DAM NO. 7 ALTERNATIVE G-19

FIGURE 3.3-2



LEGEND:

■ WITH PROJECT

□ WITHOUT PROJECT

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

CHANGES IN STREAMFLOW GUADALUPE RIVER DAM NO. 7 ALTERNATIVE G-19

FIGURE 3.3-3

The stream-side vegetation present along the Dam No. 7 site is typical for streams of this size on the Edwards Plateau. These bottomland areas support a gallery forest of baldcypress, pecan, elms, ashes, sycamore, Texas sugarberry, and burr oak. The most important grasses in the bottomland areas are switchgrass and Canada wild-rye. The wooded bottomland areas are typically undeveloped, while open bottomland areas with deep soils are generally used for rangeland and crops.[54]

Soils in the Dam No. 7 reservoir site consist of the well-drained Boerne fine sandy loam in the floodplains, and the gently undulating Eckrant-Comfort and steep Eckrant-Rock outcrop associations on uplands and hills. These associations are composed of shallow, cobbly, stony and mildly alkaline soils. The upland soils are poorly suited to cropland, improved pasturelands, urban uses and recreation due to a stony clay surface layer, large stones, rock outcrops, shallow rooting depth, steep slopes, and very low available water capacity. Thus, rangeland is the most common usage.[55]

Areas which can be classified as wetlands by the U.S. Army Corps of Engineers and/or the U.S. Fish and Wildlife Service occur at the site. Wetlands in the project region consist of the riverine habitats of the Guadalupe River and its tributaries, and associated palustrine habitats generally consisting of fairly narrow bands of wetlands along the watercourses. The majority of the riverine and palustrine wetlands are in the unconsolidated shore or unconsolidated bottom class, although forested wetlands also occur within both the riverine and palustrine classes.

The assemblage of eastern, western, and endemic species and aquatic habitats closely associated with somewhat rugged terrestrial habitats makes the project site both biologically and aesthetically important.[56] Woodland-inhabiting fauna expected to typify the wildlife of the project area include the white-tailed deer, Virginia opossum, eastern cottontail, raccoon, ladder-backed woodpecker, blue jay, cañon wren, cardinal, Texas spiny lizard, and western diamondback rattlesnake, among others.[57]

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[54]Ibid.

[55]U.S. Department of Agriculture, Soil Conservation Service (SCS). 1981. Soil Survey of Kendall County, Texas. In cooperation with Texas Agricultural Experiment Station, Texas A&M University, College Station. March.

[56]Espey, Huston & Associates, Inc. (EH&A). 1981. Upper Guadalupe River Basin Water Supply Project, Final Report. Prepared for Upper Guadalupe River Authority and Guadalupe-Blanco River Authority. EH&A Document No. 81137-R1. October.

[57]Ibid.

The Guadalupe River and its tributary streams are typically deeply incised channels with narrow floodplains, leading to high rates of runoff and flash flood conditions during major storm events. At other times these streams tend to flow relatively shallowly over rock or gravel beds, with high water clarity. The narrow channels are frequently shaded by streamside woodlands. Aquatic vegetation is limited by the scouring of stormwater flows and shading, as well as the low frequency of suitable substrate (muck or mud).[58] The Upper Guadalupe River (Segment 1806) from the upper end of Canyon Lake to the headwaters is designated for contact recreation and considered to have exceptional quality aquatic habitat.[59] Springs and shallow headwaters are numerous in the reservoir site. In addition, the major streams provide series of riffle and pool habitat. Common game fish of importance, when mature, are restricted primarily to the deeper pool areas. Spring and minor headwater habitats may serve as refugia from predators and competition for some aquatic species, including some small fish. Characteristic aquatic-associated species that may occur at the Dam No. 7 site include nutria, water snakes and several species of anurans and waterfowl. The Dam No. 7 site, because of its location on the Guadalupe River, probably receives significant utilization by migratory waterfowl and fish-eating birds.[60]

The primary impacts that would result from construction and operation of the Dam No. 7 Reservoir include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. The Dam No. 7 reservoir site would be permanently inundated to 1,242 ft-MSL with a surface area of 12,830 acres. The area of permanent inundation represents the project area. Approximately 499 acres of riverine habitat would be converted to lacustrine habitat. Other resources of potential concern within the reservoir site include a cemetery, Century Caverns, and Camp Alfazar. Golden Fawn Ranch is located on the proposed reservoir boundary and could be impacted. Indirect effects of reservoir construction may include land use changes in the area

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58Ibid.

59Texas Water Commission (TWC). 1991. Texas Surface Water Quality Standards. Texas Administrative Code, Section 307.

60Espey, Huston & Associates, Inc. (EH&A). 1981. Upper Guadalupe River Basin Water Supply Project, Final Report. Prepared for Upper Guadalupe River Authority and Guadalupe-Blanco River Authority. EH&A Document No. 81137-R1. October.

surrounding the reservoir and in mitigation areas that may be converted to alternate uses to compensate for losses of terrestrial habitat.

Potential downstream impacts would include modification of the streamflow regime below the dam; streamflows below the reservoir would be reduced significantly. Reductions of inflows to the Guadalupe Estuary would be insignificant because inflows passed will typically be controlled by Canyon Reservoir. As a large new reservoir without a current operating permit, Dam No. 7 would likely be required to meet environmental flow requirements determined by a site-specific study.

Plant and animal species listed by the USFWS and TPWD as endangered or threatened in Kendall County, and those with candidate status for listing are presented in the Phase I Study. The Texas Natural Heritage Program records include reported occurrences of the Texas salamander (*Eurycea neotenes*) and the Guadalupe bass (*Micropterus treculi*), both Category 2 candidate species, in the Dam No. 7 reservoir area. In addition, a number of the species listed for Kendall County have habitat requirements or preferences that indicate that they could be present within the reservoir site. A survey of the reservoir site may be required prior to dam construction to determine whether populations of or potential habitat for species of concern occur in the area to be impacted.

The Guadalupe River may be considered a unique and ecologically sensitive area. The Texas Natural Area Survey[61] identified the Guadalupe River from its west boundary to its east boundary in Kendall County as a natural area. The Guadalupe River from Canyon Lake to its headwaters near Kerrville is on the preliminary inventory list of the Heritage Conservation and Recreation Service (HCRS) for possible inclusion in the National Wild and Scenic Rivers Program.[62] The HCRS is within the U.S. Department of the Interior. Although the river is not officially protected by occurring on the inventory list, the HCRS will require interagency consultation for projects which may adversely affect the river.

Habitat types of importance to aquatic organisms of limited range or occurrence within the proposed Dam No. 7 site include springs and shallow headwaters, as well as the riffle/pool

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61 Texas Natural Area Survey. 1973. The natural areas of Texas (preliminary listing). Student Council on Pollution and Environment.

habitat of the Guadalupe River proper. The springs and headwater areas are often important to aquatic species which cannot persist under the competition/predation regime of larger water bodies, or are unable to survive the greater environmental fluctuation there. The Guadalupe bass, a federal Category 2 candidate species, is restricted to the clear, relatively fast-flowing streams of the eastern Edwards Plateau.

The Upper Guadalupe River watershed, situated within the Central Texas cultural area, has rich potential for yielding both historic and prehistoric sites. No complete survey of Dam No. 7 reservoir site has been conducted. Based on the results of previous research performed in the Upper Guadalupe watershed[63,64,65] and on the known history and prehistory of the area, sites reflecting thousands of years of local habitation can be expected to be encountered. The Texas Archeological Research Laboratory lists a total of 78 recorded sites within the 1,274 square mile area that comprises Kendall County, Texas. Six prehistoric sites from the Archaic and Neo-American period, five habitation sites and one pictograph have been located within the designated study area.[66]

That portion of the Guadalupe River which is under consideration for designation as a National Wild and Scenic River has been ranked as outstandingly remarkable in scenic, recreation, and geologic values. The river segment has been recommended for inclusion in the proposed Texas Natural Rivers System. According to the Texas Parks and Wildlife Department, the river is rated as the No. 1 recreation river and the No. 2 scenic river in the state. Portions of the river have also been noted in the Texas Natural Areas Survey. The Survey notes the existence of rare vegetation, two major waterfalls, numerous rapids, and limestone bluffs.

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62 Espey, Huston & Associates, Inc. (EH&A). 1981. Upper Guadalupe River Basin Water Supply Project, Final Report. Prepared for Upper Guadalupe River Authority and Guadalupe-Blanco River Authority. EH&A Document No. 81137-R1. October.

63 Briggs, A.K. 1970. Preliminary Archaeological Survey of Study Area on the Guadalupe River. *Office of the State Archaeologist, Special Reports* 13.

64 Bass, F. A., and T. R. Hester. 1975. An Archaeological Survey of the Upper Cibolo Creek Watershed, Central Texas: Center for Archaeological Research, *Archaeological Survey Report* No. 8.

65 Kelly, T.C. and T.R. Hester. 1976. Archaeological Investigations at Sites in the Upper Cibolo Creek Watershed, Central Texas. Center for Archaeological Research, Archaeological Survey Report No. 17.

66 Espey, Huston & Associates, Inc. (EH&A). 1981. Upper Guadalupe River Basin Water Supply Project, Final Report. Prepared for Upper Guadalupe River Authority and Guadalupe-Blanco River Authority. EH&A Document No. 81137-R1. October.

Interagency consultation would be required for a project (such as the proposed Dam No. 7) which may adversely affect the river.

Cultural resources protection on public lands in Texas is afforded by the Antiquities Code of Texas (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (PL96-515), and the Archaeological and Historic Preservation Act (PL93-291). All areas to be disturbed during construction would first be surveyed by qualified professionals to determine the presence or absence of significant cultural resources.

Implementation of this reservoir alternative is expected to require field surveys to document vegetation/habitat types and cultural resources that may be impacted by the proposed reservoir. Where impacts to potential protected species habitat or significant cultural resources cannot be avoided, additional studies may be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

3.3.5 Water Quality and Treatability.

[To be completed in subsequent phases of the study.]

3.3.6 Engineering and Costing.

The cost estimate for Guadalupe River Dam No. 7 is shown in Table 3.3-1. This estimate is an update of the Phase I cost estimate, which was an update of the cost estimate prepared by EHA in October 1981. Financing the project over 25 years at an 8 percent annual interest rate results in an annual expense of $23,630,000 (Table 3.3-1). Annual operation and maintenance costs total $1,240,000. The total annual costs, including debt service and operation and maintenance, total $24,870,000. For an annual firm yield of 30,927 acft, the resulting annual cost of raw water at the reservoir is $804/acft (Table 3.3-1).

Table 3.3-1
Cost Estimate for Guadalupe River Dam No. 7 and Reservoir (G-19)
(1st quarter 1996 Prices)

Item	Estimated Cost
Capital Costs	
Relocations	$15,030,000
Diversion and Care of Water	9,170,000
Reservoir Clearing	1,520,000
Embankment	28,280,000
Slopes	420,000
Spillway	14,270,000
Grout Curtain	3,320,000
Total Capital Cost	**$72,010,000**
Engineering, Legal, and Contingencies	25,210,000
Environmental Studies and Mitigation	58,660,000
Land Acquisition	77,630,000
Interest During Construction	18,680,000
Total Project Cost	**$252,190,000**
Annual Costs	
Annual Debt Service	23,630,000
Annual Operation and Maintenance	1,240,000
Total Annual Cost	**$24,870,000**
Firm Yield (acft/year)	30,927
Annual Cost of Raw Water at the Reservoir	$804/acft

3.4 Gonzales Reservoir (G-20)

3.4.1 Description of Alternative

The Gonzales Reservoir site was originally proposed by the United States Army Corps of Engineers (COE) in 1950. In the COE's original study entitled "Report on Survey of Guadalupe and San Antonio Rivers and Tributaries, Texas for Flood Control and Allied Purposes," the Gonzales Reservoir site was to provide flood control, water conservation, and development of hydroelectric power. The dam site is located on the San Marcos River about five river miles upstream of its confluence with the Guadalupe River in Gonzales County (refer to Figure 3.3-1 in previous section). At this location, the contributing drainage area is 1,344 square miles.

The Gonzales Reservoir would be impounded by a 15,700-foot long earthen embankment with a top-of-dam elevation of 354 and a maximum dam height of 104 feet. The spillway system would consist of a 480-foot long concrete section with a crest elevation of 309 ft-MSL, and equipped with 12 tainter gates at conservation pool the reservoir would store 560,000 acft at a water surface elevation of 344 ft-MSL. At this elevation, the reservoir would inundate 21,370 acres including approximately 31 miles of the San Marcos River.

3.4.2 Previous (Phase I) Yield Estimate

Phase I yield estimates for Gonzales Reservoir were obtained from a 1959 report entitled "Report on Supplement to the Initial Plan of Development of the Guadalupe-Blanco River Authority" by Forrest and Cotton, Inc. (FC). The critical period for the reservoir is the 1947-1957 drought and the yield at the Gonzales site, ignoring any other potential reservoir projects on the San Marcos River, was estimated at 87,690 acft/yr based on historical springflows. However, FC estimated that the firm yield would be reduced if the flow of San Marcos Springs decreased due to increased pumping of the Edwards Aquifer. It was estimated that if San Marcos springflow decreased to 57,400 acft/yr, the firm yield of Gonzales Reservoir would decrease to 52,470 acft/yr. The yields presented in Phase I were not adjusted to reflect application of Trans-Texas criteria for instream flows and freshwater inflows to bays and estuaries.

3.4.3 Updated (Phase II) Yield Estimate

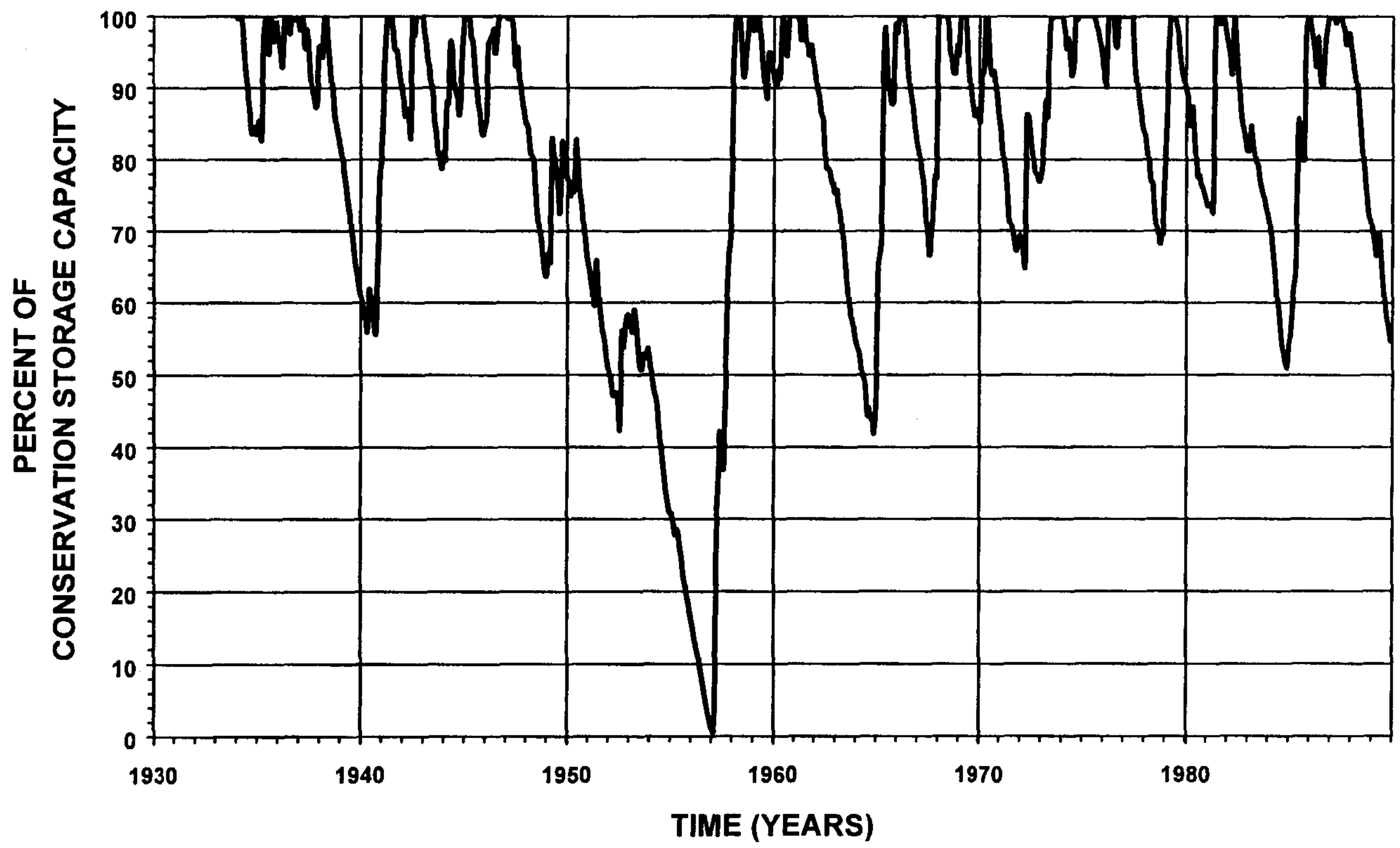
The firm yield of the proposed Gonzales Reservoir was computed for this Phase II study utilizing the Consensus Criteria (Appendix B). The GSA Model was used to estimate daily total streamflow and unappropriated streamflow available at the reservoir site. General assumptions for this application of the GSA Model included:

- springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures
- full utilization of existing water rights)
- return flows set to 1989 levels
- full subordination of hydropower rights to 0 cfs at Lake Dunlap

The GSA Model was used to compute total daily streamflow for the San Marcos River, upstream of its confluence with the Guadalupe River at Gonzales. No long-term gage exists at the reservoir site, so flows from the San Marcos River at Luling (USGS# 08172000), added to the flows from Plum Creek near Luling (USGS# 08173000), were assumed representative of inflows to the proposed reservoir. No adjustment to these flows was made to account for intervening drainage area, because the intervening drainage area represents less that 15 percent of the total drainage area above the reservoir site. These flows represent naturalized flows at the reservoir site, adjusted for upstream water rights and return flows. The GSA Model computes streamflow available for impoundment without causing increased shortages to downstream rights. Daily streamflows to be passed through the reservoir to meet the requirements of downstream water rights and environmental needs also are computed.

The firm yield of the Gonzales Reservoir was computed using the inflows and pass-through flows computed by the GSA Model, and a modified version of the SIMDLY reservoir operation model. The streamflow statistics used to determine the Consensus Criteria pass-through requirements are presented in Appendix D. Subject to a uniform seasonal demand pattern, the firm yield was computed as 75,093 acft/yr.

Figure 3.4-1 illustrates the simulated Gonzales Reservoir storage fluctuations for the 1934-1989 historical period, subject to the firm yield of 75,093 acft/yr. Simulated reservoir storages remain above the Zone 2 trigger level (80 percent capacity) about 61 percent of the time and above the Zone 3 trigger level (50 percent capacity) about 91 percent of the time over the



UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

FIRM YIELD STORAGE TRACE GONZALES RESERVOIR ALTERNATIVE G-20

FIGURE 3.4-1

1934-1989 historical period. During the 1947-1956 drought period, reservoir levels stayed above the Zone 2 trigger level only about 9 percent of the time, and above the Zone 3 trigger level about 57 percent of the time. Figure 3.4-2 illustrates the changes in streamflow caused by the reservoir at the project location and at the Saltwater Barrier. Monthly median flows at the project site would be reduced by about 33 percent. Mean annual freshwater inflows to the Guadalupe Estuary, as measured at the Saltwater Barrier, would be reduced by 103,500 acft/yr, or about 6 percent.

3.4.4 Environmental Issues

The Gonzales Reservoir project involves dam construction and inundation of approximately 21,370 acres along a 31-mile reach of the San Marcos River. The proposed reservoir is located in north-central Gonzales County on the boundary between the Texas Blackland Prairie and the East Central Texas Plains ecoregion[67] in the Post Oak Savannah vegetational area of Texas[68], and the Texas biotic province.[69]

Vegetation types within the proposed Gonzales Reservoir project area on the San Marcos River include grassland and cropland (54 percent), brushland (33 percent), upland and bottomland woodlands (9 percent), wetlands (3 percent), and developed areas (1 percent). Common grassland species include little bluestem, silver bluestem, sand lovegrass, beaked panicum, threeawn, sprangle-grass, tickclover, and various introduced grasses used in pastures and rangeland. Brushlands are typically dominated by honey mesquite, huisache, prickly pear, other small trees and shrubs, and a variety of grasses, including threeawns, lovegrasses, gramas, and bluestems. In the upland woodlands, post oak, blackjack oak, honey mesquite, live oak, and cedar elm are common overstory species. Typical overstory species in the bottomland woodlands include American elm, cedar elm, pecan, green ash, Eastern cottonwood, sycamore, black willow, and Texas sugarberry.[70] Wetlands within the conservation pool consist primarily

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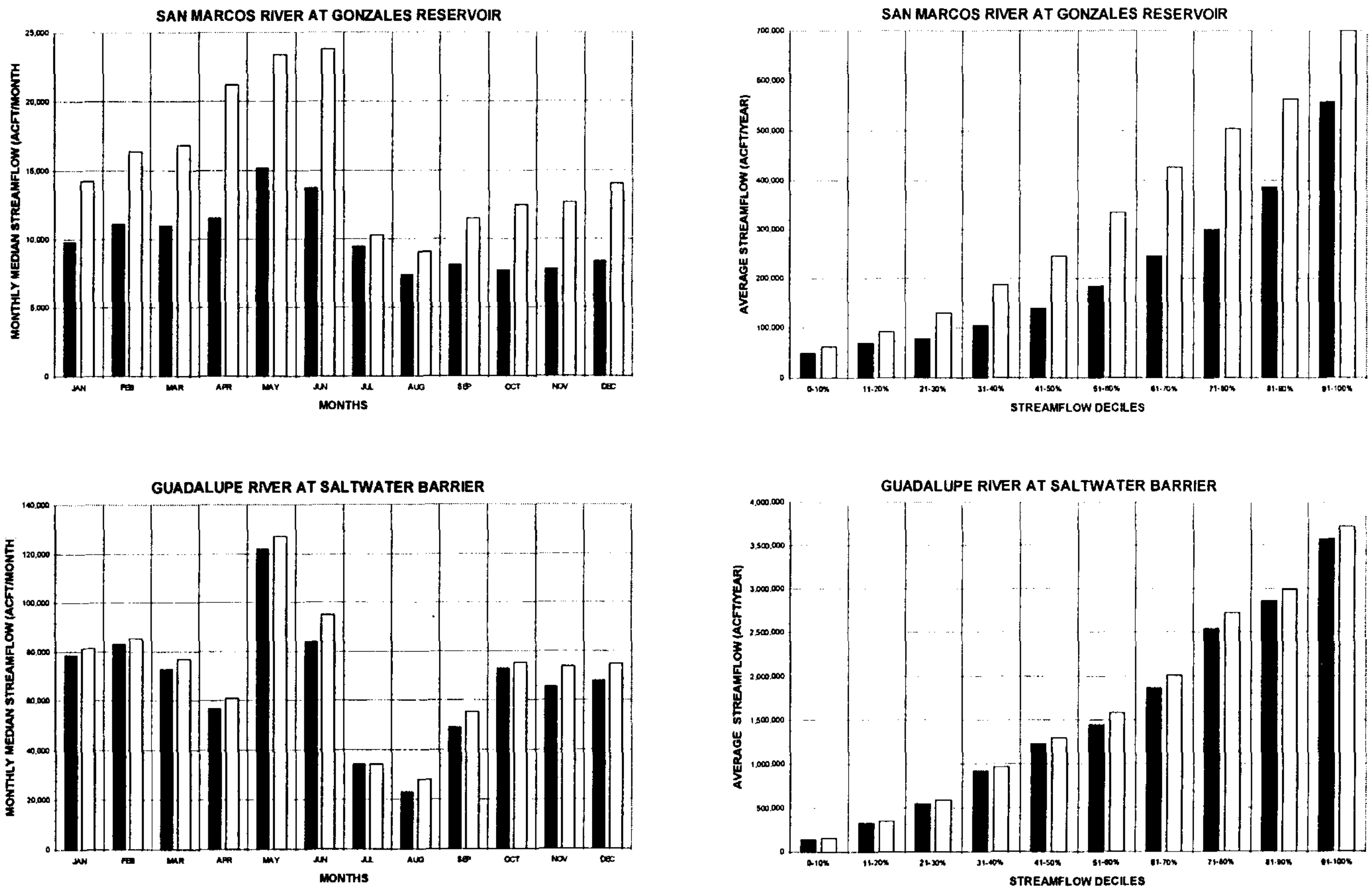
[67] Omernik, James M. 1986. Ecoregions of the Conterminous United States. Annals of the Association of American Geographers, 77(1). pp. 118-125.

[68] Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas.

[69] Blair, W.F. 1950. The biotic provinces of Texas. Tex. J. Sci. 2:93-117.

[70] McMahan, C.A., R.G. Frye, K.L. Brown. 1984. The Vegetation Types of Texas, Including Cropland. Texas Parks and Wildlife Department, Austin, Texas.



LEGEND:

■ WITH PROJECT

□ WITHOUT PROJECT

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

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CHANGES IN STREAMFLOW GONZALES RESERVOIR ALTERNATIVE G-20

FIGURE 3.4-2

of riverine perennial habitat, with small quantities of palustrine emergent, forested and scrub/shrub wetlands, and stockponds.

Within the floodplains, soils are a calcareous black clay of Tinn clay and Bosque clay loam. These soils have the highest fertility in the county, thus making excellent cropland. Gholson and Sunev soils are a fine loamy sand found in uplands with slopes of 1-5 percent and 3-8 percent, respectively.[71]

The primary impacts that would result from construction and operation of the Gonzales Reservoir include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. The Gonzales Reservoir conservation pool would permanently inundate an area of 21,370 acres. Approximately 11,560 acres of grassland and cropland, 7,077 acres of brushland, 2,029 acres of woodland, 188 acres of wetlands, 366 acres of riverine habitat, and 150 acres of developed land would be converted to open water. Indirect effects of reservoir construction may include land use changes in the area surrounding the reservoir and in mitigation areas that may be converted to alternate uses to compensate for losses of terrestrial habitat.

Potential downstream impacts would include modification of the streamflow regime below the dam; streamflows below the reservoir would be reduced significantly. Reduction of inflows to the Guadalupe Estuary would be modest. As a large new reservoir without a current operating permit, Gonzales Reservoir would likely be required to meet environmental flow requirements determined by site-specific studies.

The San Marcos River within the project area is classified by the Texas Parks and Wildlife Department as having potential for scenic river designation. Reservoir construction would also inundate the 179-acre Palmetto State Scenic Park, which contains a unique area of subtropical vegetation.[72]

Plant and animal species listed by the USFWS and TPWD as endangered or threatened, and those with candidate status for listing in Gonzales County are presented in the Appendix F.

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71 U.S. Department of Agriculture, Soil Conservation Service (SCS). 1994. Personal communication with Gonzales County Soil Survey Staff. March.

72 U.S. Bureau of Reclamation. 1978. Special Report on the San Antonio-Guadalupe River Basins Study. November 1978.

The Texas Natural Heritage Program records include reported occurrences within the proposed reservoir of the Cagle's map turtle, a C1 USFWS candidate species and the Guadalupe bass, a C2 candidate for Federal protection. The proposed reservoir site may contain potential habitat for other threatened, endangered and candidate species that have been recorded in the county. A survey of the reservoir site may be required prior to dam construction to determine whether populations of or potential habitat for species of concern occur in the area to be impacted.

Several community facilities and towns within the reservoir site would be affected by the Gonzales Reservoir. The cities of Slayden and Ottine would be fully or partially inundated. Little Hill Church and the Gonzales Warm Springs Rehabilitation Foundation are located within the reservoir boundaries and would be inundated. In addition, the Texas State Elks Association Crippled Children's Hospital is located adjacent to the conservation pool and may be impacted.

Cultural resources known to occur within the Gonzales Reservoir site include the McKeller and Princeville cemeteries. Cultural resources protection on public lands in Texas is afforded by the Antiquities Code of Texas (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (PL96-515), and the Archaeological and Historic Preservation Act (PL93-291). All areas to be disturbed during construction could first be surveyed by qualified professionals to determine the presence or absence of significant cultural resources.

Implementation of this reservoir alternative is expected to require field surveys to document vegetation/habitat types and cultural resources that may be impacted by the proposed reservoir. Where impacts to potential protected species habitat or significant cultural resources cannot be avoided, additional studies may be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

3.4.5 Water Quality and Treatability

[To be completed in subsequent phases of the study.]

3.4.6 Engineering and Costing

The cost estimate for Gonzales Reservoir is shown in Table 3.4-1. This estimate is an update of the Phase I cost estimate which was an update of a previous cost estimate performed by the United States Study Commission in 1960. Financing the project over 25 years at an 8 percent interest rate results in an annual expense of $22,870,000. Annual operation and maintenance costs total $1,130,00. The annual costs, including debt service and operation and maintenance, total $24,000,000. For an annual firm yield of 75,093 acft, the resulting annual cost of raw water at the reservoir is $320/acft.

Table 3.4-1
Cost Estimate for Gonzales Dam and Reservoir (G-20)
(1st quarter 1996 Prices)

Item	Estimated Cost
Capital Costs	
Embankment	$14,000,000
Diversion and Care of Water	340,000
Reservoir Clearing	10,950,000
Spillway	21,450,000
General Items	900,000
Relocations	18,080,000
Total Capital Cost	**$65,720,000**
Engineering, Legal, and Contingencies	23,000,000
Environmental Studies and Mitigation	63,270,000
Land Acquisition	74,020,000
Interest During Construction	18,080,000
Total Project Cost	**$244,090,000**
Annual Costs	
Annual Debt Service	22,870,000
Annual Operation and Maintenance	1,130,000
Total Annual Cost	**$24,000,000**
Firm Yield (acft/yr)	75,093
Annual Cost of Raw Water at the Reservoir	$320/acft

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3.5 Lockhart Reservoir (G-21)

3.5.1 Description of Alternative

The Lockhart dam and reservoir project was first proposed in 1959 by Forrest and Cotton, Inc. (FC) in their report entitled "Report on Supplement to the Initial Plan of Development of the Guadalupe-Blanco River Authority." The City of Lockhart's primary source of municipal water supply is groundwater, and the Lockhart project was proposed to provide additional municipal and industrial water to the local area. The dam site is located at river mile 30.5 on Plum Creek (drainage area of 118 square miles), a tributary of the San Marcos River, just north of Lockhart in Caldwell County (see Figure 3.3-1).

Forest and Cotton developed a preliminary design for the Lockhart project based on a field inspection, as adequate topographic information was not available. The embankment, as proposed, would be approximately 5,900 feet long with a maximum crest height of 73 feet above the streambed (elevation 508 ft-MSL) and would contain 50,000 acft. At this elevation, the reservoir would inundate 2,910 acres including a 5-mile segment of Plum Creek.

3.5.2 Previous (Phase I) Yield Estimate

The Phase I yield estimate of 7,960 acft/yr for Lockhart Reservoir was obtained from the 1959 FC report. The yield presented in Phase I was not adjusted to reflect application of Trans-Texas criteria for instream flows, and freshwater inflows to bays and estuaries.

3.5.3 Updated (Phase II) Yield Estimate

The firm yield of the proposed Lockhart Reservoir was computed for this Phase II study utilizing the Consensus Criteria (Appendix B). The GSA Model was used to estimate daily total streamflow and unappropriated streamflow available at the reservoir site. General assumptions for this application of the GSA Model included:

- springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures
- full utilization of existing water rights
- return flows set to 1989 levels
- full subordination of hydropower rights to 0 cfs at Lake Dunlap

The GSA Model was used to compute total daily streamflow for Plum Creek near Luling (USGS# 08173000). These flows, adjusted to account for intervening drainage area, were assumed representative of inflows to the proposed reservoir. These flows represent naturalized flows at the reservoir site, adjusted for upstream water rights and return flows. The GSA Model computes streamflow available for impoundment without causing increased shortages to downstream rights. Daily streamflows to be passed through the reservoir to meet the requirements of downstream water rights and environmental needs are also computed.

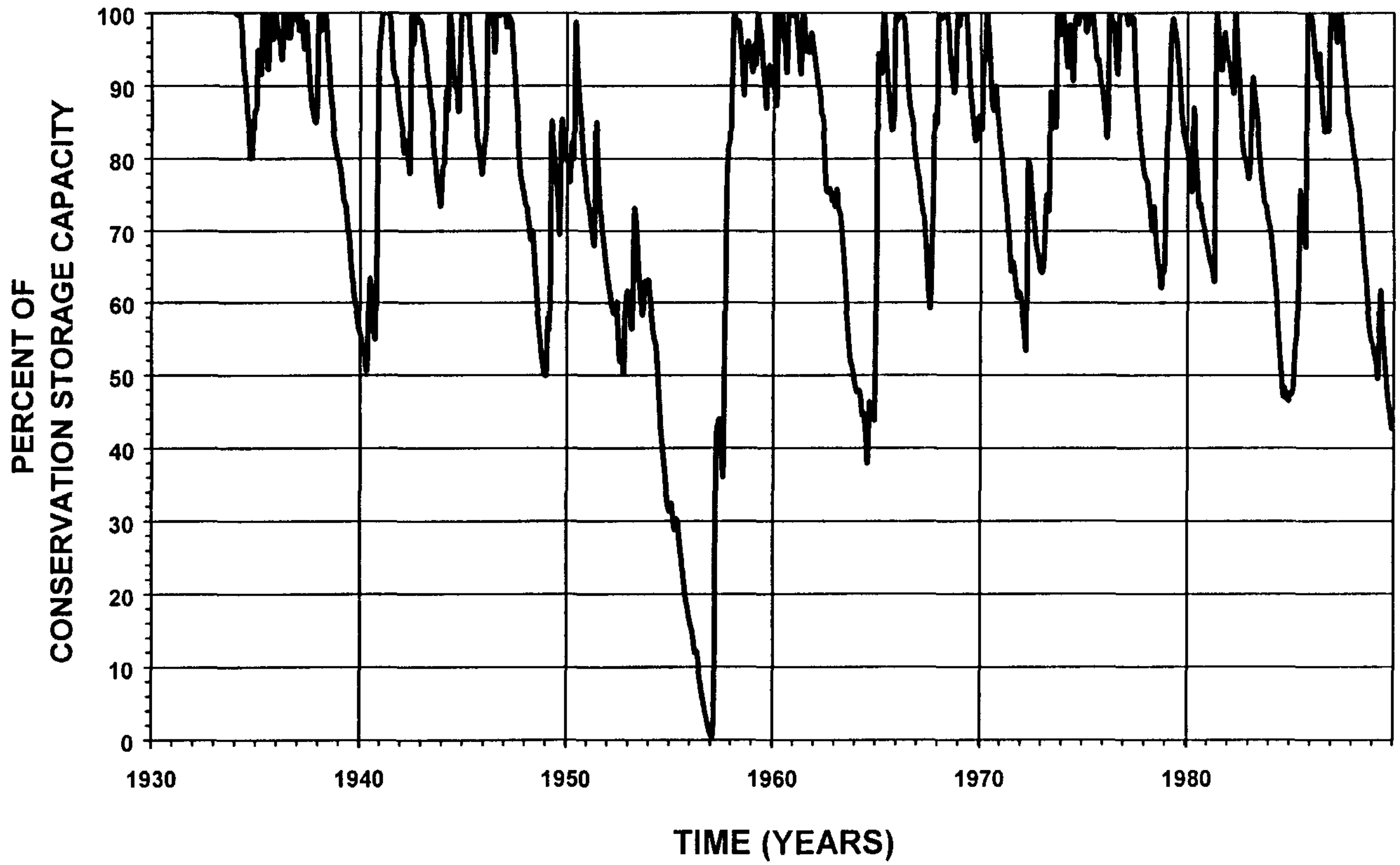
The firm yield of the Lockhart Reservoir was computed using the inflows and pass-through flows computed by the GSA Model, and a modified version of the SIMDLY reservoir operation model. The streamflow statistics used to determine the Consensus Criteria pass-through requirements are presented in Appendix D. Subject to a uniform seasonal demand pattern, the firm yield was computed as 6,339 acft/yr.

Figure 3.5-1 illustrates the simulated Lockhart Reservoir storage fluctuations for the 1934-1989 historical period, subject to the firm yield of 6,339 acft/yr. Simulated reservoir storages remain above the Zone 2 trigger level (80 percent capacity) about 58 percent of the time and above the Zone 3 trigger level (50 percent capacity) about 90 percent of the time over the 1934-1989 historical period. During the 1947-1956 drought period, reservoir levels stayed above the Zone 2 trigger level only about 12 percent of the time, and above the Zone 3 trigger level about 65 percent of the time. Figure 3.5-2 illustrates the changes in streamflow caused by the reservoir at the project location and at the Saltwater Barrier. Monthly median flows at the project would be reduced by about 50 percent. Mean annual freshwater inflows to the Guadalupe Estuary, as measured at the Saltwater Barrier, would be essentially unaffected by the project.

3.5.4 Environmental Issues

The Lockhart Reservoir project involves dam construction and inundation of approximately 2,910 acres along a 5-mile reach of Plum Creek, a tributary of the San Marcos River (Figure 3.3-1). The proposed reservoir site is located in north Caldwell County within the Texas Blackland Prairies ecoregion,[73] in the Blackland Prairie vegetational area of Texas,[74] and in

73 Omernik, James M., 1986, "Ecoregions of the Conterminous United States, "Annals of the Association of American Geographers, 77(1). pp. 118-125.
74 Gould, F.W., 1975, The Grasses of Texas, Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas.



TRANS TEXAS WATER PROGRAM /
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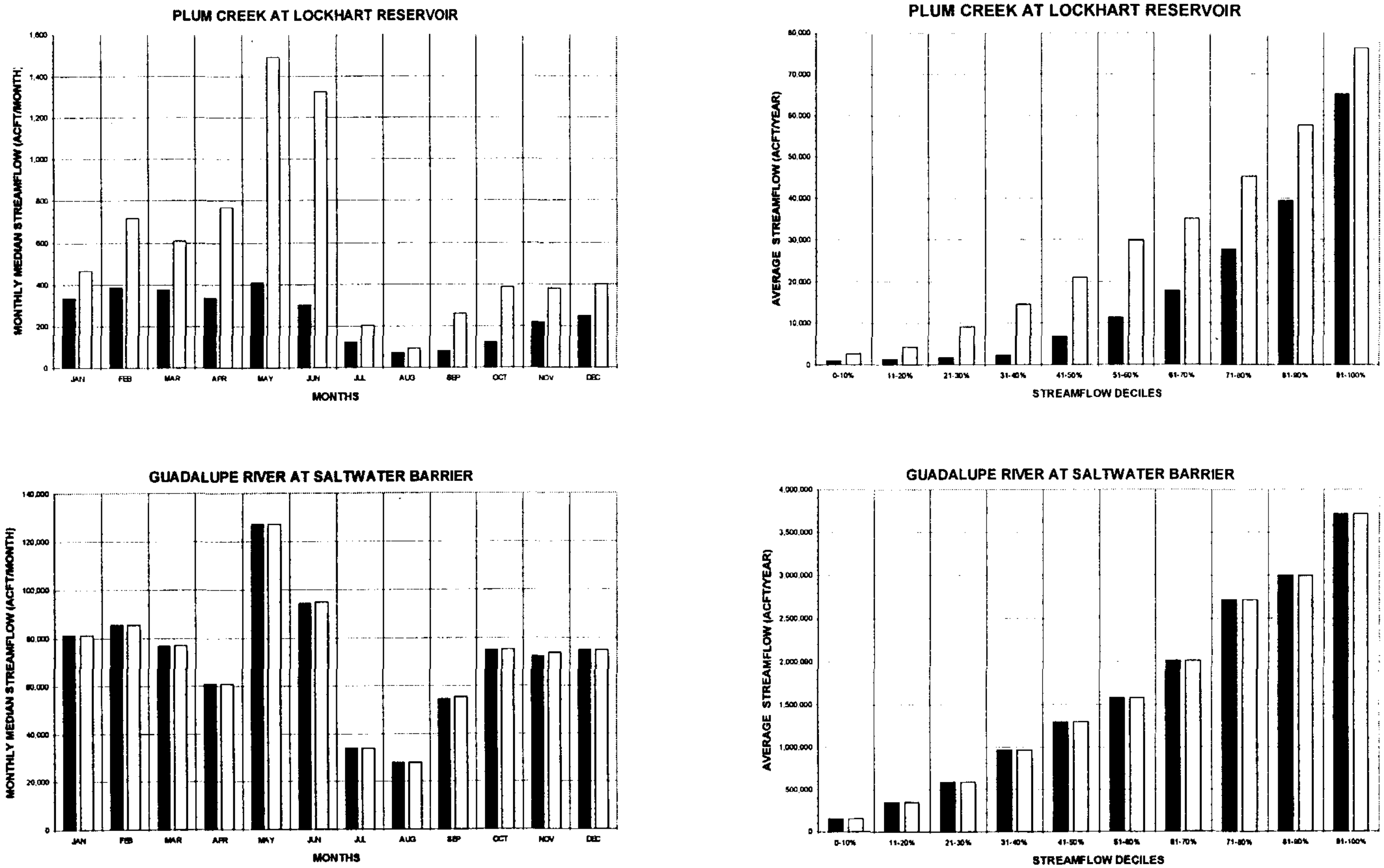
FIRM YIELD STORAGE TRACE
LOCKHART RESERVOIR
ALTERNATIVE G-21

FIGURE 3.5-1

HDR Engineering, Inc.

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN



LEGEND:

■ WITH PROJECT

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UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

CHANGES IN STREAMFLOW LOCKHART RESERVOIR ALTERNATIVE G-21

FIGURE 3.5-2

the Texan biotic province.[75] Vegetation types within the Lockhart Reservoir project area include crops (30 percent), native and introduced grasses (25 percent), brushland and shrubland (38 percent), small quantities of woodlands (4 percent), and intermittent river and palustrine scrub/shrub and forested wetlands (3 percent).

Within the proposed Lockhart Reservoir site, Heiden clays, which are frequently eroded, are found on uplands with slopes ranging from 3 to 8 percent. They are well-drained and frequently used for crops or pasture. Houston black clays are found on smooth uplands. They are moderately well-drained and are used for crops. Trinity clays have formed in calcareous, clayey, alluvial sediments on floodplains along streams where slopes are less than 1 percent. These areas are used predominantly for crops and improved pasture. Frequently flooded Trinity soils are on nearly level floodplains. These soils are flooded several times a year and are used mostly for pasture.[76]

The primary impacts that would result from construction and operation of the Lockhart Reservoir include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. The Lockhart Reservoir would be permanently inundated to 482 ft-MSL with a surface area of 2,910 acres. Approximately 1,600 acres of grassland and cropland, 1,106 acres of brushland and shrubland, 116 acres of woodland, 37 acres of riverine habitat, and 51 acres of wetlands would be converted to open water upon dam construction. Based on available information, no communities or other special resources are located within the reservoir area. Indirect effects of reservoir construction may include land use changes in the area surrounding the reservoir and in mitigation areas that may be converted to alternate uses to compensate for losses of terrestrial habitat.

Potential downstream impacts would include modification of the streamflow regime below the dam; streamflows below the reservoir would be reduced significantly. Reduction of inflows to the Guadalupe Estuary would be insignificant. As a new reservoir without a current permit,

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[75] Blair, W.F., 1950, "The Biotic Provinces of Texas, "Tex. J. Sci. 2:93-117.

[76] U.S. Department of Agriculture, Soil Conservation Service (SCS). 1978b. Soil Survey of Caldwell County, Texas. In cooperation with Texas Agricultural Experiment Station, Texas A&M University, College Station. July.

the Lockhart Reservoir would likely be required to meet environmental flow requirements determined by site-specific studies.

In addition to long-term impacts within the conservation pool, minor changes to existing resources situated between the conservation pool elevation and flood pool elevation could be anticipated due to occasional temporary inundation during flood events.

No protected species have been recorded in the study area, although the area may provide potential habitat to the nine endangered, threatened or candidate species found in Caldwell County. Other protected species may use habitats in the area during migration.

Cultural resources protection on public lands in Texas is afforded by the Antiquities Code of Texas (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (Pl96-515), and the Archeological and Historic Preservation Act (PL93-291). Implementation of this reservoir alternative is expected to require field surveys by qualified professionals to document vegetation/habitat types and cultural resources that may be impacted by the proposed reservoir. Where impacts to potential protected species habitat or significant cultural resources could not be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

3.5.5 Water Quality and Treatability

[To be Completed in subsequent phases of the study.]

3.5.6 Engineering and Costing

The cost estimate for Lockhart Reservoir is shown in Table3.5-1. This estimate is an update of the Phase I estimate, which was and update of a previous cost estimate performed by the United States Study Commission in 1960. Financing the project over 25 years at an 8 percent interest rate results in an annual expense of $3,640,000. Annual operation and maintenance costs total $270,000. The annual costs, including debt service and operation and maintenance, total $3,910,000. For an annual firm yield of 6,339 acft, the resulting annual cost of raw water at the reservoir is $617/acft.

Table 3.5-1
Cost Estimate for Lockhart Dam and Reservoir (G-21)
(1st quarter 1996 Prices)

Item	Estimated Cost
Capital Costs	
Embankment	$8,190,000
Diversion and Care of Water	170,000
Reservoir Clearing	450,000
Spillway	3,860,000
General Items	340,000
Relocations	2,910,000
Total Capital Cost	**$15,920,000**
Engineering, Legal, and Contingencies	5,570,000
Environmental Studies and Mitigation	6,370,000
Land Acquisition	8,150,000
Interest During Construction	2,880,000
Total Project Cost	**$38,890,000**
Annual Costs	
Annual Debt Service	3,640,000
Annual Operation and Maintenance	270,000
Total Annual Cost	**$3,910,000**
Firm Yield (acft/yr)	6,339
Annual Cost of Raw Water at the Reservoir	$617/acft

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3.6 Dilworth Reservoir (G-22)

3.6.1 Description of Alternative

The Dilworth dam and reservoir project was first proposed by the United States Army Corps of Engineers (COE) in 1950. The COE report "Report on Survey of Guadalupe and San Antonio Rivers and Tributaries, Texas for Flood Control and Allied Purposes" presented the Dilworth site as a flood control project. The site was not deemed very effective in a flood control role, however, and the dam and reservoir were not recommended for construction. Until this study, the Dilworth site has not been formally studied for its water conservation potential.

The Dilworth dam site is located at river mile 13.1 on Peach Creek (drainage area of 438 square miles), a tributary of the Guadalupe River, approximately six miles east of the City of Gonzales in Gonzales County (see Figure 3.3-1). The dam design consists of a 15,700-foot earthen embankment with a top-of-dam crest elevation of 307 ft-MSL (maximum dam height of 67 feet). The spillway system would consist of a 700-foot controlled concrete weir section with radial gates at a crest elevation of 280 ft-MSL. Operating under this proposed embankment and spillway configuration, the reservoir would have a conservation pool capacity of 275,000 acft at a water surface elevation of 293 ft-MSL. At this elevation, the reservoir would inundate 15,400 acres along a 13-mile segment of Peach Creek.

3.6.2 Previous (Phase I) Yield Estimate

A yield estimate for Dilworth Reservoir as a water conservation project could not be located, but was estimated for Phase I from data presented by EHA[77] for Cloptin Crossing Reservoir. The EHA yield estimate of 35,000 acft/yr was adjusted for drainage area, storage, depth of runoff, and evaporation, resulting in an estimated yield for Dilworth Reservoir of 27,000 acft/yr. The yield presented in Phase I does not reflect application of Trans-Texas criteria for instream flows, and freshwater inflows to bays and estuaries.

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77 Espey, Huston and Associates, Inc., "Water Availability Study for the Guadalupe and San Antonio River Basins, Volume 1," February 1986.

3.6.3 Updated (Phase II) Yield Estimate

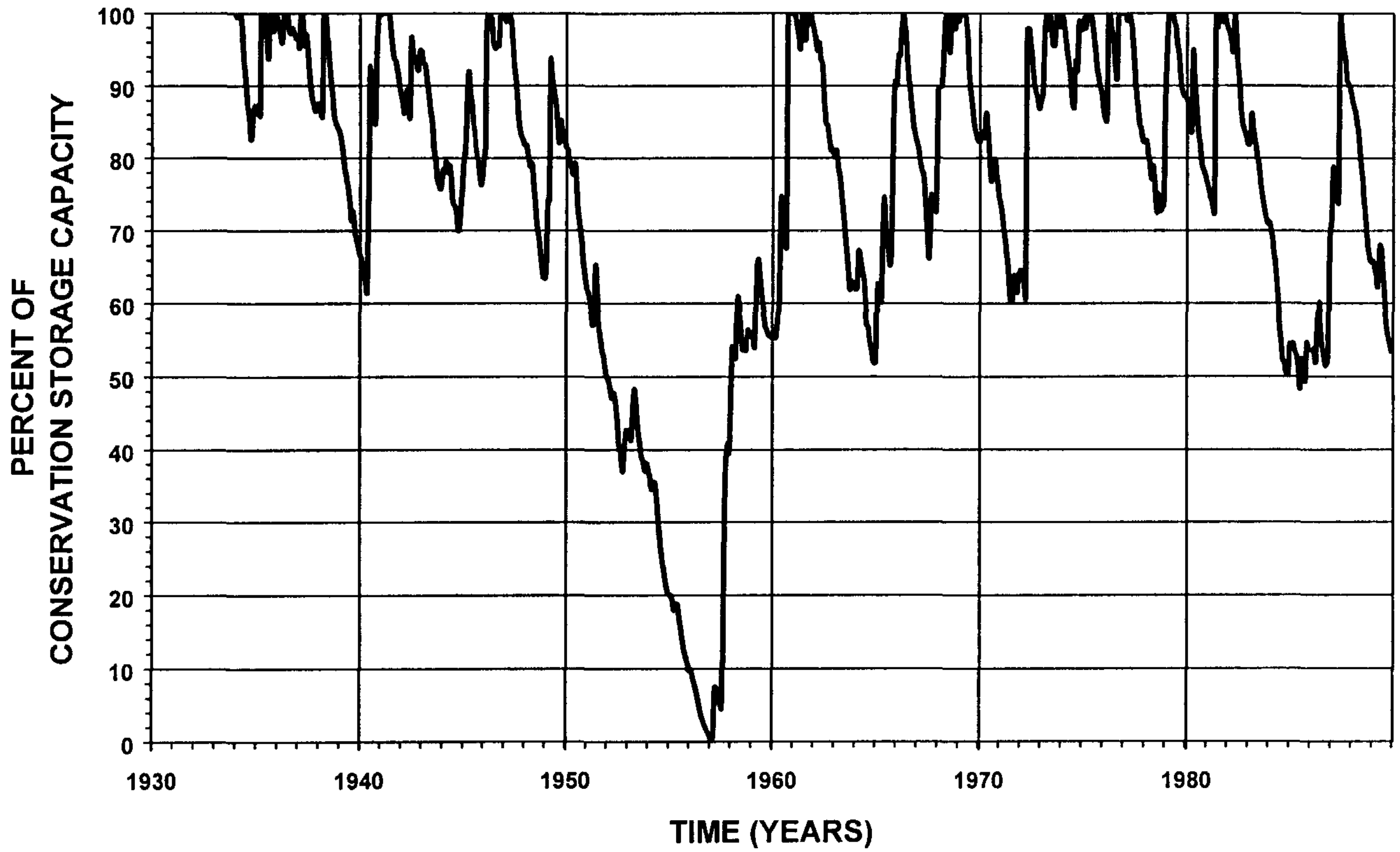
The firm yield of the proposed Dilworth Reservoir was computed for this Phase II study utilizing the Consensus Criteria (Appendix B). The GSA Model was used to estimate daily total streamflow and unappropriated streamflow available at the reservoir site. General assumptions for this application of the GSA Model included:

- springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures
- full utilization of existing water rights
- return flows set to 1989 levels
- full subordination of hydropower rights to 0 cfs at Lake Dunlap

The GSA Model was used to compute total daily streamflow for Peach Creek below Dilworth (USGS# 08174600). These were assumed representative of inflows to the proposed reservoir and are naturalized flows at the reservoir site, adjusted for upstream water rights and return flows.. The GSA Model computes streamflow available for impoundment without causing increased shortages to downstream rights. Daily streamflows to be passed through the reservoir to meet the requirements of downstream water rights and environmental needs are also computed.

The firm yield of the Dilworth Reservoir was computed using the inflows and pass-through flows computed by the GSA Model, and a modified version of the SIMDLY reservoir operation model. The streamflow statistics used to determine the Consensus Criteria pass-through requirements are presented in Appendix D. Subject to a uniform seasonal demand pattern, the firm yield was computed as 18,195 acft/yr.

Figure 3.6-1 illustrates the simulated Dilworth Reservoir storage fluctuations for the 1934-1989 historical period, subject to the firm yield of 18,195 acft/yr. Simulated reservoir storages remain above the Zone 2 trigger level (80 percent capacity) about 52 percent of the time and above the Zone 3 trigger level (50 percent capacity) about 89 percent of the time over the 1934-1989 historical period. During the 1947-1956 drought period, reservoir levels stayed above the Zone 2 trigger level only about 13 percent of the time, and above the Zone 3 trigger level about 42 percent of the time. Figure 3.6-2 illustrates the changes in streamflow caused by the reservoir at the project location and at the Saltwater Barrier. Monthly median flows at the



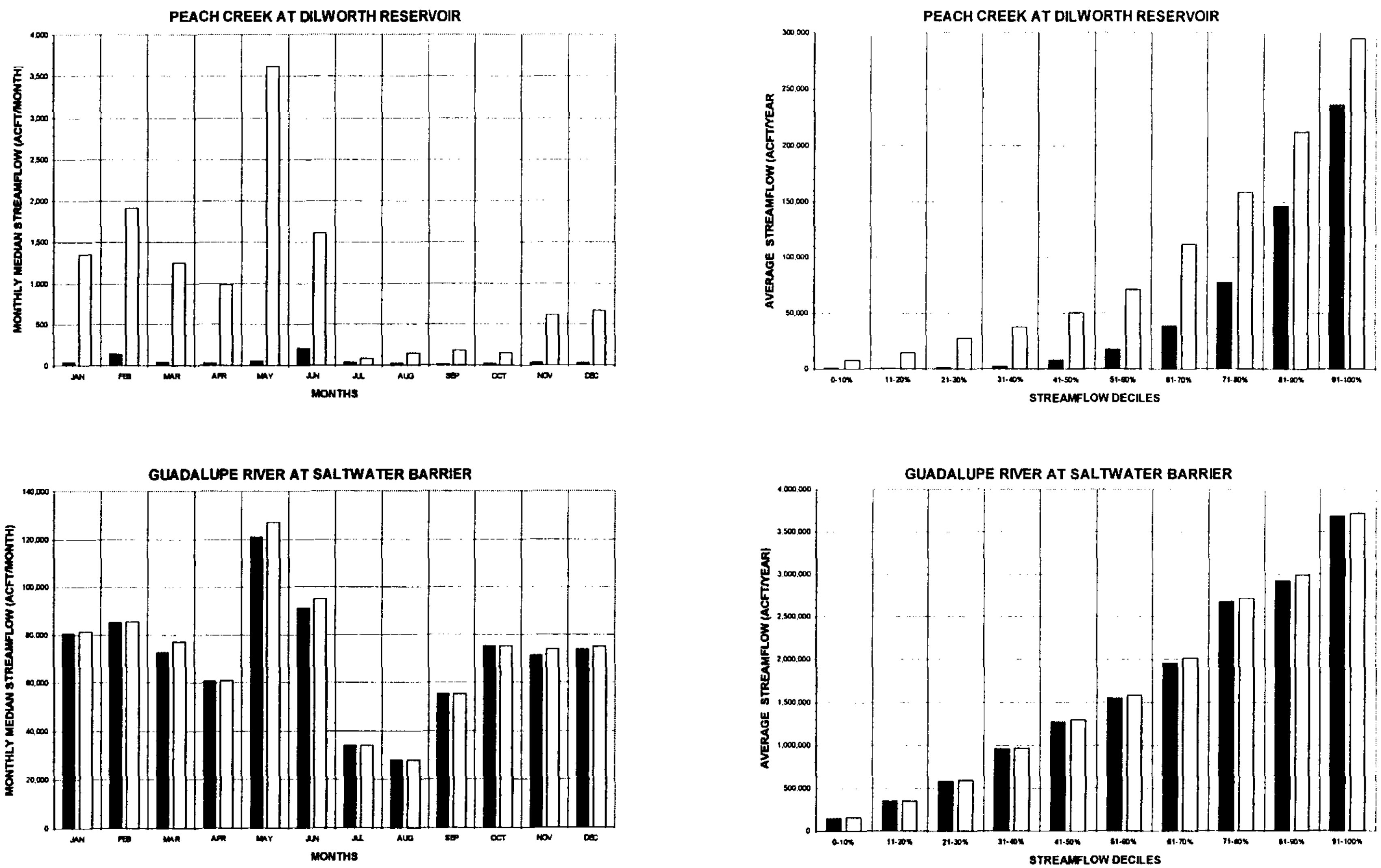
UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

FIRM YIELD STORAGE TRACE DILWORTH RESERVOIR ALTERNATIVE G-22

FIGURE 3.6-1



LEGEND:

■ WITH PROJECT

□ WITHOUT PROJECT

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

CHANGES IN STREAMFLOW DILWORTH RESERVOIR ALTERNATIVE G-22

FIGURE 3.6-2

project would be reduced about 89 percent. Mean annual freshwater inflows to the Guadalupe Estuary, as measured at the Saltwater Barrier, would be affected mildly by the project.

3.6.4 Environmental Issues

The Dilworth Reservoir project involves dam construction and inundation of approximately 15,400 acres along a 13-mile reach of Peach Creek, a tributary of the Guadalupe River. The proposed reservoir is located in northeastern Gonzales County on the boundary between the Texas Blackland Prairies and the East Central Texas Plains ecoregions,[78] in the Pose Oak Savannah region of Texas,[79] and in the Texas biotic province.[80]

Vegetation types within the proposed Dilworth Reservoir project area include bottomland and upland woodlands, shrubland, grassland, cropland, and wetlands. Stream-side vegetation within the proposed reservoir is typical of pecan-elm forests. These forests are found in bottomlands along the Brazos, Colorado, Guadalupe, San Antonio and Frio rivers. They contain, among other species, American elm, cedar elm, cottonwood, sycamore, black willow, yaupon, greenbriar, Johnsongrass, frostweek and western ragweed.[81]

Upland areas are dominated by post oak woods, forest and grassland mosaics. These areas are typically found on sandy soils. Common species include blackjack oak, eastern redcedar, mesquite, black hickory, live oak, hackberry, yaupon, American beautyberry, hawthorn, little bluestem, beaked panicum, three-awn and tickclover.[82]

Within the floodplains, soils are a calcareous black clay classified as Tinn clay and Bosque clay loam. These soils have the highest fertility in the county, thus making excellent cropland. Gholson and Sunev soils are a fine loamy sand found in uplands with slopes of 1 to 5 percent and 3 to 8 percent, respectively.[83]

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78 Omernik, James M. 1986. Ecoregions of the Conterminous United States. Annals of the Association of American Geographers, 77(1). pp. 118-125.
79 Gould, F.W. 1975. The Grasses of Texas. Texas A&M University Press, Texas Agricultural Experiment Station, College Station, Texas.
80 Blair, W.F. 1950. The biotic provinces of Texas. Tex. J. Sci. 2:93-117.
81 McMahan, C.A., R.G. Frye, K.L. Brown. 1984. The Vegetation Types of Texas, Including Cropland, Texas Parks and Wildlife Department, Austin, Texas.
82 Ibid.
83 U.S. Department of Agriculture, Soil Conservation Service (SCS). 1994. Personal communication with Gonzales County Soil Survey Staff. March.

Wetlands within the reservoir site include approximately 1,530 acres of palustrine forested, scrub/shrub, emergent and intermittent riverine wetlands.

The primary impacts that would result from construction and operation of the Dilworth Reservoir include conversion of existing habitats and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing flow regime. The Dilworth Reservoir site would be permanently inundated to 293 ft-MSL with a surface area of 15,400 acres. Approximately 5,049 acres of brushlands, 5,967 acres of grasslands and croplands, 2,754 acres of woodlands, 68 acres of riverine habitat, 1,462 acres of wetlands, and 100 acres of developed land would be converted to open water upon inundation. Several lakes would be inundated by the reservoir, including Post Oak, Laws, Jones, Wood, Mooney, Pogue, Bailey, Lee, Rinehart, and Long. The town of Little New York and St. James Cemetery would also be inundated by the proposed reservoir. Indirect effects of reservoir construction may include land use changes in the area surrounding the reservoir and in mitigation areas that may be converted to alternate uses to compensate for losses of terrestrial habitat.

Potential downstream impacts would include modification of the streamflow regime below the dam; streamflow below the reservoir would be reduced significantly. Reduction of inflows to the Guadalupe Estuary would be minimal. As a new reservoir without a current operating permit, the Dilworth Reservoir would likely be required to meet environmental flow requirements determined by site-specific studies.

No protected species have been recorded on the site, but the area may provide potential habitat for ten threatened, endangered or candidate species that occur in Gonzales County. Other protected species may use habitats in the area during migration. A survey of the reservoir site may be required prior to dam construction to determine whether populations of or potential habitat for species of concern occur in the area to be impacted.

Cultural resources protection on public lands in Texas is afforded by the Antiquities Code of Texas (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (PL96-515), and the Archaeological and Historic Preservation Act (PL93-291). Implementation of this reservoir alternative is expected to require field surveys by qualified professionals to document vegetation/habitat types and cultural resources that may be impacted by the proposed reservoir. Where impacts to potential protected species habitat or significant cultural resources could not be avoided, additional studies would be necessary to evaluate habitat use and/or value, or eligibility for inclusion in the National Register of Historic Places, respectively. Compensation would be required for unavoidable adverse impacts involving net losses of wetlands.

3.6.5 Water Quality and Treatability

[To be completed in subsequent phases of the study.]

3.6.6 Engineering and Costing

The cost estimate for Dilworth Reservoir is shown in Table 3.6-1. This estimate is an update of the Phase I cost estimate, which was an update of a previous cost estimate performed by the United States Study Commission in 1960. Financing the project over 25 years at an 8 percent interest rate results in an annual expense of $10,180,000. Annual operation and maintenance costs total $560,000. The annual costs, including debt service, and operation and maintenance, total $10,740,000. For an annual firm yield of 18,195 acft, the resulting cost of raw water at the reservoir is $590/acft.

Table 3.6-1
Cost Estimate for Dilworth Dam and Reservoir (G-22)
(1st quarter 1996 Prices)

Item	Estimated Cost
Capital Costs	
Relocations	$190,000
Diversion	170,000
Reservoir Clearing	3,870,000
Embankment	11,820,000
Spillway	14,880,000
Outlet Works	1,490,000
Total Capital Cost	**$32,420,000**
Engineering, Legal, and Contingencies	11,350,000
Environmental Studies and Mitigation	24,940,000
Land Acquisition	31,880,000
Interest During Construction	8,050,000
Total Project Cost	**$108,640,000**
Annual Costs	
Annual Debt Service	10,180,000
Annual Operation and Maintenance	560,000
Total Annual Cost	**$10,740,000**
Firm Yield (acft/yr)	18,195
Annual Cost of Raw Water at the Reservoir	$590/acft

3.7 Cloptin Crossing (G-40)

3.7.1 Description of Alternative

The Cloptin Crossing dam and reservoir project was described in detail by the U.S. Army Corps of Engineers (COE) in 1980 as a flood control and water supply project. The COE report "Cloptin Crossing Lake, Phase I General Design Memorandum" presented detailed siting information, and found the project to be economically unfeasible[84]. The 1978 U.S. Bureau of Reclamation (BUREC) report "Summary of Special Report, San Antonio-Guadalupe River Basins Study, Texas Basins Project" presents a summary of the project and a cost estimate.

The Cloptin Crossing site is located at river mile 32.5 on the Blanco River (drainage area of 307 square miles), in Hays and Comal Counties about 2 miles southwest of the town of Wimberley (see Figure 3.3-1). The dam design consists of a 7,520-foot earthen embankment with a top-of-dam crest elevation of 1,023 ft-MSL (maximum dam height of 200 feet). The spillway system would consist of a 760-foot uncontrolled concrete weir section at a crest elevation of 998 ft-MSL. Operating under this proposed embankment and spillway configuration, the reservoir would have a conservation pool capacity of 275,000 acft at a water surface elevation of 980.5 ft-MSL. The reservoir at this elevation would inundate 6,060 acres along a 13-mile segment of the Blanco River.

3.7.2 Previous Yield Estimates

The firm yield estimated by the COE for Cloptin Crossing Reservoir was 40,000 acft/yr, however, it is uncertain whether any water rights or environmental flow needs were considered in the development of this estimate. Preliminary studies performed by HDR for the Edwards Underground Water District[85] reported that Cloptin Crossing Reservoir (with a 275,000 acft conservation storage capacity) could be used to enhance recharge of the Edwards Aquifer by an average of up to 48,275 acft/yr on the long-term (1934-1989) and 40,690 acft/yr during drought (1947-56). Environmental flow needs were not considered in the development of these estimates.

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84 The benefit-cost ratio for the flood protection element was less than 1.0, thus, the project was declared to be unfeasible.

85 HDR, "Guadalupe – San Antonio river Basin Recharge Enhancement Study," EUWD, September 1993.

3.7.3 Updated (Phase II) Yield Estimate

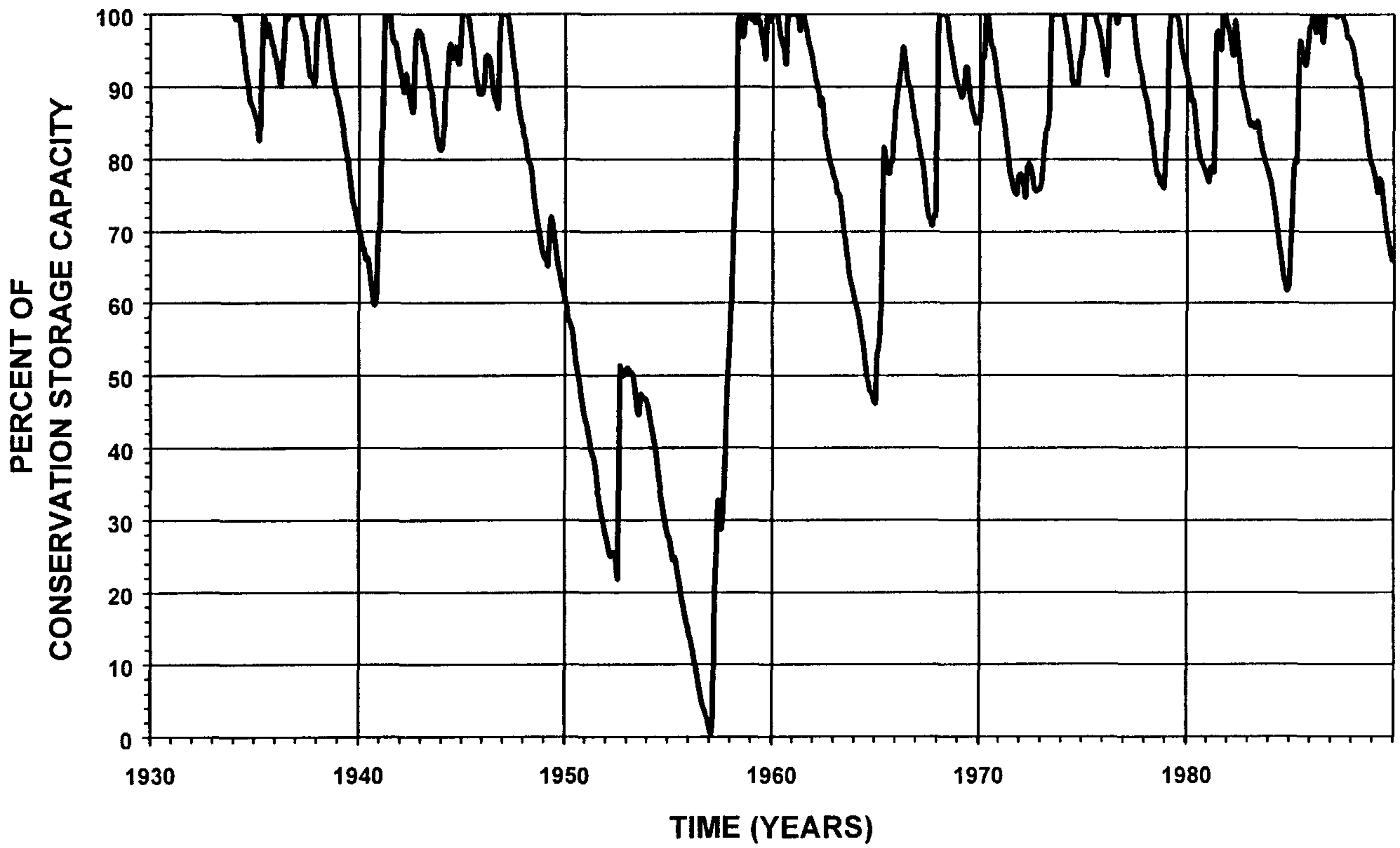
The firm yield of the proposed Cloptin Crossing Reservoir was computed for this Phase II study utilizing the Consensus Criteria (Appendix B). The GSA Model was used to estimate daily total streamflow and unappropriated streamflow available at the reservoir site. General assumptions for this application of the GSA Model included:

- springflows resulting from a fixed Edwards Aquifer pumpage rate of 400,000 acft/yr with existing recharge structures
- full utilization of existing water rights
- return flows set to 1989 levels
- full subordination of hydropower rights to 0 cfs at Lake Dunlap

The GSA Model was used to compute total daily streamflow for the Blanco River at Wimberley (USGS# 08171000). These were assumed representative of inflows to the proposed reservoir. These flows represent naturalized flows at the reservoir site, adjusted for upstream water rights and return flows. The GSA Model computes streamflow available for impoundment without causing increased shortages to downstream rights. Daily streamflows passed through the reservoir site to meet the requirements of downstream water rights and environmental needs are also computed.

The firm yield of the Cloptin Crossing Reservoir was computed using the inflows and pass-through flows computed by the GSA Model, and a modified version of the SIMDLY reservoir operation model. The streamflow statistics used to determine the Consensus Criteria pass-through requirements are presented in Appendix D. Subject to a uniform seasonal demand pattern, the firm yield was computed as 33,163 acft/yr.

Figure 3.7-1 illustrates the simulated Cloptin Crossing Reservoir storage fluctuations for the 1934-1989 historical period, subject to the firm yield of 33,163 acft/yr. Simulated reservoir storages remain above the Zone 2 trigger level (80 percent capacity) about 63 percent of the time and above the Zone 3 trigger level (50 percent capacity) about 87 percent of the time over the 1934-1989 historical period. During the 1947-1956 drought period, reservoir levels stayed above the Zone 2 trigger level only about 3 percent of the time, and above the Zone 3 trigger level about 33 percent of the time. Figure 3.7-2 illustrates the changes in streamflow caused by the reservoir at the project location and at the Saltwater Barrier. Monthly median flows at the



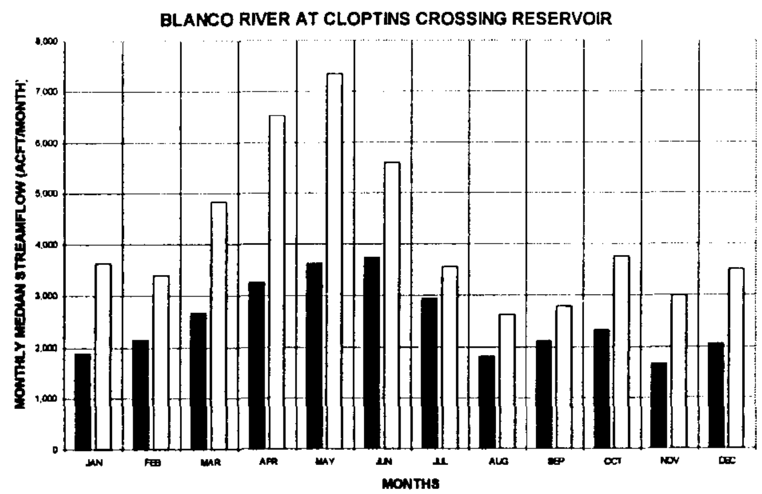
UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

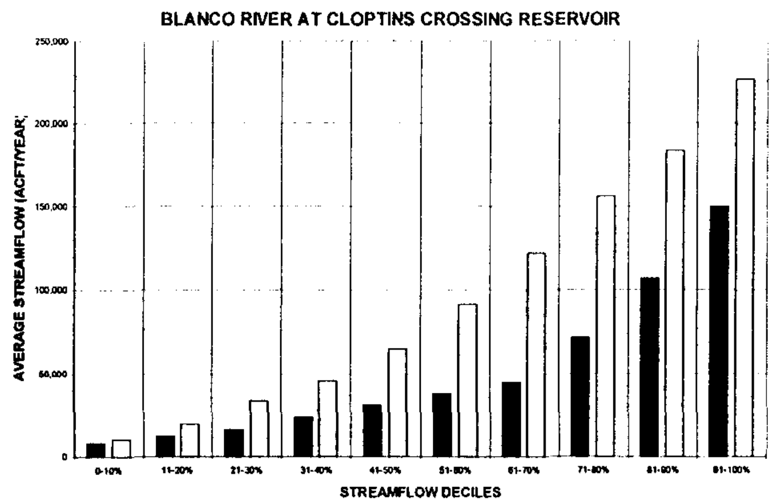
HDR Engineering, Inc.

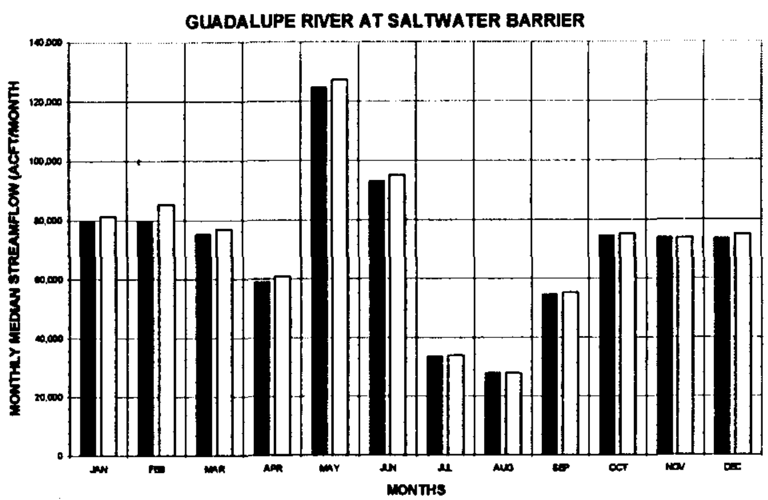
TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

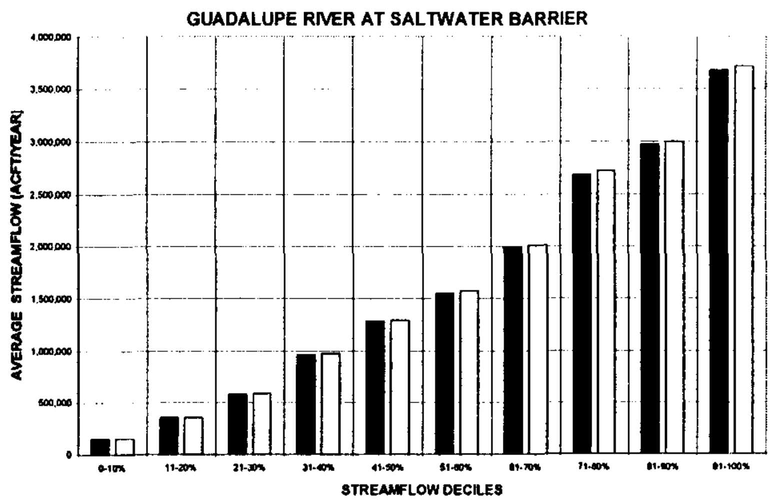
FIRM YIELD STORAGE TRACE CLOPTIN CROSSING RESERVOIR ALTERNATIVE G-40

FIGURE 3.7-1









LEGEND:

■ WITH PROJECT

□ WITHOUT PROJECT

UPDATED EVALUATION OF POTENTIAL RESERVOIRS IN THE GUADALUPE RIVER BASIN

HDR Engineering, Inc.

TRANS TEXAS WATER PROGRAM / WEST CENTRAL STUDY AREA

CHANGES IN STREAMFLOW CLOPTIN CROSSING RESERVOIR ALTERNATIVE G-40

FIGURE 3.7-2

project would be reduced about 38 percent. Mean annual freshwater inflows to the Guadalupe Estuary, as measured at the Saltwater Barrier, would be only mildly affected by the project.

3.7.4 Environmental Issues

The Cloptin Crossing Reservoir project involves dam construction and inundation of approximately 6,060 acres along a 13 mile reach of the Blanco River approximately 2 miles from Wimberley in Hays County (See Figure 3.3-1). The dam centerline would be located approximately one-half mile upstream from Cloptin Crossing.

The proposed reservoir is located on the Edwards Plateau,[86] upstream of the Balcones Fault Zone and Blackland Prairie, and in the Texan biotic province.[87] Vegetation types within the project area on the Blanco River include riparian and upland woodland, park, brush, grassland, and wetland. Edwards Plateau vegetation has historically been grassland or open savannah-type plains with tree and understory species distributed primarily on rocky slopes and in stream bottoms. Throughout the more savannah-type level to rolling uplands of the Edwards Plateau, brush species (particularly Ashe juniper and mesquite) are common invaders, while the steeper canyon slopes have historically supported a dense oak-Ashe juniper thicket. The most important climax grasses of the Plateau include switchgrass (*Panicum virgatum*), several species of bluestems and gramas, Indian grass (*Sorghastrum nutans*), Canada wild-rye (*Elymus canadensis*), curly mesquite (*Hilaria berlangeri*), and buffalograss (*Buchloe dactyloides*). The rough, rocky areas typically support a tall or mid-grass understory and a brush overstory complex consisting primarily of live oak (*Quercus virginiana*), Texas oak (*Q. buckleyi*), shinnery oak (*Q. havardii*), Ashe juniper (*Juniperus ashei*), and mesquite (*Prosopis glandulosa*).

Mesic stream bottom habitats were created as rivers and tributary streams, fed by numerous springs that occur at the base of the Edwards limestone, cut canyons through the plateau and formed isolated, mesic habitats that harbor a variety of plant species exhibiting disjunct distributions or endemism. Because of the many large canyons and rugged terrain, this area is of much botanical interest, and consequently has been visited by many collectors. The

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86 Gould, F.W. 1962. The Grasses of Texas. Texas A&M University Press, Texas Agricultural Experiment Station. College Station, Texas.

87 Blair, W.F. 1950. The Biotic Provinces of Texas. Texas Journal of Science 2:93-117.

ferns, and many of the flowering plants which are common to the area are primarily lithophilous ("rock-loving"), and are represented primarily by various species of lipferns (*Cheilanthes* spp.), cloak-ferns (*Notholaena* spp.), and cliff brakes (*Pellaea* spp.). Columbine (*Aquilegia canadensis*) and endemic species such as anemone *(Anemone edwardsianas)* and wand butterfly-bush (*Buddlega racemosa*) also are present. These plants are sometimes found together with species such as mockorange (*Philadelphus* spp.), American smoke-tree (*Cotinus americana*), spicebush (*Benzoin aestivale*), and the endemic silver bells (*Styrax platanifolia* and *S. texana*) on large boulders and in shaded ravines.

The surface geology of the Cloptin Crossing Reservoir site is Cretaceous Glen Rose Limestone.[88] The soil units that have formed over these limestones are predominantly thin soils from the Brackett-Rock Outcrop-Comfort Complex (undulating), Brackett-Rock-Real Outcrop Complex (steep), Boerne Fine Sandy Loam (1 to 3 percent slopes), Lewisville Silty Clay (0 to 1 percent slopes), Lewisville Silty Clay (1 to 3 percent slopes), Purves Clay, and Oakalla Silty Clay Loam (rarely flooded).[89] The soils within the floodplain range from shallow to deep and are used typically for pastureland, cropland, and wildlife habitat.

Wetlands within the conservation pool include approximately 255 acres of riverine and palustrine habitats. Associated with the channel and banks of the Blanco River, the aquatic habitats are predominantly lower perennial riverine and palustrine that have substrates composed of both bedrock and unconsolidated bottom that are permanently flooded. The smaller drainages feeding the Blanco River are described as intermittent riverine habitats with streambeds that are temporarily flooded. A few small stock ponds are found within the upland area surrounding the project site.

The primary impacts that would result from construction and operation of the Cloptin Crossing Reservoir include conversion of existing habitats, including existing stream habitats, and land uses within the conservation pool to open water, and potential downstream effects due to modification of the existing temperature, water quality, and flow regimes. Permanent inundation of the Cloptin Crossing Reservoir would yield a conservation pool with a surface area

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88 Fisher, W.L. 1983. Geologic Atlas of Texas: San Antonio Sheet. Bureau of Economic Geology. The University of Texas at Austin. Austin, Texas.

89 Batte, C.D. 1984. Soil Survey of Comal and Hays Counties, Texas. United States Department of Agriculture Natural Resource Conservation Service.

of 6,060 acres. Approximately 1,448 acres of grassland, 848 acres of brushland, 1,236 acres of woodland, 81 acres of wetlands, 174 acres of riverine habitat, and 2,273 acres of developed land would be converted to open water. In addition to long-term impacts within the conservation pool, minor changes to existing resources situated between the conservation pool elevation and maximum flood pool elevation are anticipated due to temporary inundation during flood events. Indirect effects of reservoir construction may include land use changes in the area surrounding the reservoir and in mitigation areas that may be converted to alternate uses to compensate for losses of terrestrial habitat.

Potential downstream impacts would include modification of the stream flow regime below the dam, and reduced inflows to the Guadalupe Estuary. At the project site, monthly median flows would decrease from about 17 percent in July to about 50 percent in May. Flows at the Saltwater Barrier are relatively unaffected by the project. As a large new reservoir without a current water rights permit, the Cloptin Crossing Reservoir would likely be required to meet environmental flow requirements determined by site-specific studies.

Although the most current TPWD data files show no reports of any federally or state listed endangered or threatened species, or TOES species of concern within the footprint of the proposed project, few surveys in the area have been conducted and an intensive survey of the project area would be required to assess the habitats within the project area accurately and determine the possibility of any associated threatened or endangered species occurrence. Appendix F, however, contains a complete listing (Phase I and updated Phase II) of the potentially occurring endangered and threatened species and species of concern in Hays County. These may not necessarily be encountered within the project area. The TPWD data files did show a number of important species within two miles of the proposed project site, including Golden-cheeked warbler (*Dendroica chrysoparia*), glass mountains coral-root (*Hexalectris nitida*), Texas amorpha (*Amorpha roemeriana*), and Texas Salamander (*Eurycea neotenes*). Also found within two miles of the proposed project site is the Ashe juniper-Oak series which is considered important nesting and foraging habitat for the federally and state endangered Golden-cheeked warbler and Black-capped vireo (*Vireo atricapillus*).

A search of the database at the Texas Archeological Research Laboratory (TARL) revealed 27 archeological sites recorded from within the general area of the proposed conservation pool. Prior to inundation, it must be determined if any cultural properties are located within the conservation pool by an on-site survey. Once all cultural properties within the conservation pool are identified, they will undergo preliminary assessment to determine the significance and potential for eligibility in the Register of Historic Places. Because the assessment methods used during the survey are limited in their ability to determine significance potential, some sites may have to undergo more extensive test-level investigations before their eligibility can be adequately determined. If cultural resource properties are determined to be eligible, additional work may be required by the State Historic Preservation Officer to protect the site, or to mitigate for unavoidable impacts. Cultural resources protection on public lands in Texas is afforded by the Antiquities Code of Texas (Title 9, Chapter 191, Texas Natural Resource Code of 1977), the National Historic Preservation Act (PL96-515), and the Archeological and Historic Preservation Act (PL93-291).

3.7.5 Water Quality and Treatability

[To be completed in subsequent phases of the study.]

3.7.6 Engineering and Costing

The cost estimate for Cloptin Crossing Reservoir is an update of a previous cost estimate performed by the BUREC. Financing the project over 25 years at an 8 percent interest rate results in an annual expense of $15,030,000. Annual operation and maintenance costs total $760,000. The annual costs, including debt service and operation and maintenance, total $15,790,000. For an annual firm yield of 33,163 acft, the resulting cost of raw water at the reservoir is $476/acft.

Table 3.7-1 Cost Estimate for Cloptin Crossing Dam and Reservoir (G-40) (1st quarter 1996 Prices)	
Item	**Estimated Cost**
Total Capital Cost	**$43,980,000**
Engineering, Legal, and Contingencies	$15,390,000
Environmental Studies and Mitigation	$38,000,000
Land Acquisition	$51,180,000
Interest During Construction	$11,880,000
Total Project Cost	**$160,430,000**
Annual Costs	
Annual Debt Service	15,030,000
Annual Operation and Maintenance	760,000
Total Annual Cost	**$15,790,000**
Firm Yield (acft/yr)	33,163
Annual Cost of Raw Water at the Reservoir	$476/acft

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APPENDIX A

TRANS-TEXAS WATER PROGRAM PHASE I

ENVIRONMENTAL ASSESSMENT

Water Quality

Preliminary water quality impact assessment of affected State waters must include evaluation of water quality standards attainment, chemical and biological compatibility of mixed waters, coastal salt water intrusion, and nutrients for compliance with drinking water standards. The recommended methodology, if any, for each analysis is given as follows:

1. Water Quality Standards Attainment

   A. Chloride, Sulfate, Total Dissolved Solids--Mass balance these constituents under a 7-day, 2-year, low flow (7Q2) condition to insure that the Standards are not violated.

   B. Dissolved Oxygen--If any interbasin transfer scenarios result in a reduction of a river's 7Q2, or if the baseflow is significantly reduced during spring spawning months [defined as the first half of the year when water temperatures are 63°-73°F in TWC Rule 307.7.(b)3. Aquatic Life], then simplified mathematical modeling must be performed to evaluate compliance with the Standard. Basic modeling assumptions are listed below:

      - Summer Analysis
        Headwater--7Q2 flow conditions
        Temperature--average of the three hottest months, plus one standard deviation, from the closest USGS station with water temperature data
        Discharges--full permitted effluent flow and quality
        BOD--compute BODu = $BOD_{5\ day} \times 2.3$
        K_n--nitrification rate = 0.30/day
        K_d--BOD oxidation rate = 0.10/day
        Reaeration--use Texas equation

      - Spring Spawning Analysis
        Same as above, except
        Headwaters--10th percentile monthly low flow conditions
        Temperature--90th percentile monthly high temperature conditions

   C. pH--No recommended method.

   D. Temperature--Mass balance temperature to insure compliance with the maximum temperature criteria, as well as the "rise over ambient" Standard.

   E. Fecal Coliform--No recommended method.

2. Chemical and Biological Compatibility of Waters

A. Formation of precipitates, etc.--No recommended method.

B. Introduction of exotic plants and animals--No recommended method.

3. Salt Water Intrusion

A. Migration of coastal salt wedge and effect of intrusion up tidal rivers--No recommended method.

B. Effect on water supply operations--No recommended method.

C. Effect on freshwater marshes/wetlands--No recommended method.

4. Nutrients

A. Potable water limits--Determine compliance with Drinking Water Standards.

B. Potential for nuisance aquatic vegetation--No recommended method.

<u>Instream Flows</u>

A relatively rapid assessment of instream flow needs to maintain downstream fish and wildlife habitats affected by the TransTexas Water Program can be performed by using the TPWD-modified Tennant's Method (Lyons 1979), which is based on a fixed percentage of median (50th percentile) monthly flows. At any point in a river basin intercepted by the TransTexas Water Program, streamflows must be passed downstream in an amount up to 60% of the median monthly flows from March through September, and 40 % of the median monthly flows from October through February. Streamflows above these monthly flow limits are to be considered available for other beneficial uses and interbasin transfer. Water stored in existing reservoirs will not be allocated to instream uses and released downstream to make up for normal flows below the specified limits.

<u>Freshwater Inflows to Bays and Estuaries</u>

For preliminary planning purposes, the freshwater inflow needs of the bays and estuaries can be conservatively estimated as a function of selected central tendency values. The typical bimodal distribution of monthly rainfall runoff during the historical period is enhanced by requiring the pass through of normal inflows up to the mean (arithmetic average) monthly flow in May-June and September-October, while the minimum maintenance needs are satisfied with inflows up to the median (50th percentile) monthly flow in the remaining months of the year. Water stored in existing reservoirs will not be allocated to bay and estuary uses and released downstream to make up for normal flows below the specified limits.

<u>New Reservoirs</u>

Existing reservoirs that could potentially contribute to the TransTexas Water Program will be evaluated as to the effects on downstream flows and freshwater inflows to bays and estuaries under their existing state and federal permits which authorize their current operations, while any new reservoirs involved in the Program's future water storage and distribution system will be considered to operate such that they pass through impounded streamflows up to the mean (arithmetic average) monthly flow in April-June and August-October, and median (50th percentile) streamflows in the remaining months of the year, as long as reservoir capacity is above 60%. When reservoir capacity is below 60%, the water management operations will recognize drought contingency by passing through up to the median daily flow of the stream observed during the historical drought of record. The analysis will be repeated at 40% and 80% capacity thresholds to demonstrate a range of feasible solutions for operating any new reservoirs.

APPENDIX B

ENVIRONMENTAL WATER NEEDS CRITERIA

OF THE CONSENSUS PLANNING PROCESS

EXECUTIVE SUMMARY

ENVIRONMENTAL WATER NEEDS CRITERIA OF THE CONSENSUS PLANNING PROCESS

In pursuit of the goals of reducing conflict among competing water interests, providing consistent State water policy, and increasing planning and regulatory clarity to State water managers, the draft consensus planning methods reached among the three State water agencies for providing water needs involve trade-offs where neither human nor environmental needs unacceptably "prevail" over the other. The proposed methodology is based on the concept of retaining target flows for environmental purposes and allowing human use of flows greater than the target flows. Each of the new project environmental criteria described below provides for the priority of human needs during dry conditions, but also provides for some sharing of the adverse impact of drought by humans and the environment.

Specific data or project features identified in the final design and permitting process of water supply projects may require consideration of detailed criteria, based on site-specific field studies, which were not applied during the longer-range planning process. The environmental provisions specified below are representative of the basic approach to apportion surface water subject to regulatory actions in the entire water development process (i.e., planning through permitting), but only approximating what may be required for environmental needs in the final permit decision. In addition to passage of environmental flows, adequate flows will be passed through for protection of downstream water rights. In lieu of site-specific studies in the permitting process, the criteria will have the rebuttable presumption of validity. When the results of intensive freshwater inflow or instream flow studies are available and criteria have been established, those criteria will be used in the Water Plan rather than any generic rule.

NEW PROJECT ON-CHANNEL RESERVOIRS

The conservation storage of new, on-channel water supply reservoirs would be divided into three zones with provisions for varying levels of instream flows downstream of on-channel reservoir projects. Zone 1 occurs when reservoir water levels are greater than 80% of storage capacity, and inflows will be passed up to the monthly medians, calculated with naturalized daily stream flow estimates. Also, inflows will be passed to provide one channel flushing flow per season to provide for channel and habitat maintenance. Zone 2 occurs as dry conditions drop reservoir levels to between 50 and 80% of storage capacity. In this zone, inflows would be passed only up to the monthly 25th percentile flow values, calculated with naturalized daily stream flow estimates. In Zone 3, drought conditions worsen, dropping reservoir levels below 50% storage capacity. Inflows would be passed up to the established water quality standard (or 7Q2 value published by the TNRCC) for the downstream segment.

In all zones, instream flow pass-throughs would be targeted to reach the associated estuary system. Flows necessary for the protection of downstream water rights will be added to the appropriate instream flow value determined by the above method. In all cases, no releases will be made from water supply storage to provide environmental flows.

NEW DIRECT DIVERSIONS

Criteria governing direct diversions from a river or stream recommended in the State Water Plan would be based on stream flow conditions just upstream of the diversion point after providing for downstream water rights, and would also be divided into three zones based on hydrologic conditions. Zone 1 occurs when flow is greater than monthly medians; minimum flows passed will be the monthly medians, calculated with naturalized daily stream flow estimates. Zone 2 occurs when flows are greater than the monthly 25th percentile and less than or equal to medians. Minimum flows passed will be the monthly 25th percentile, calculated with naturalized daily stream flow estimates. Zone 3 occurs when stream flow is less than or equal to monthly 25th percentile values. Minimum flows passed will be the larger of: (1) the value necessary to maintain downstream water quality, or (2) a continuous flow threshold to be determined by consensus planning staff (e.g., 15th percentile), that would not allow the diversion by itself to dry up the stream.

NEW DIRECT DIVERSION PROJECTS INTO OFF-CHANNEL STORAGE

In those cases where a recommended water supply project would divert its water from a river or stream into off-channel storage, a combination of the direct diversion and reservoir criteria would apply. The direct diversion criteria will govern the ability to divert water into the off-channel reservoir. The reservoir criteria will address the ability of the project to capture water, as well as define the reservoir's operations to pass environmental flows from its own watershed.

BAY AND ESTUARY CONSIDERATIONS

For most planning purposes, the Zone 1 environmental flow requirements previously described will also provide the target inflows to bays and estuaries (B&E). However, where inflow values that are adequate to meet the beneficial inflow needs as described in Texas Water Code §11.147 have been established, those inflow volumes will be used as the basis for calculating the contributing portions of required water during Zone 1 conditions in new reservoirs or direct diversions for projects located within 200 river miles of the coast, to commence at the mouth of the river. No other special B&E provisions would be made in Zone 2 or Zone 3. These inflow values may be determined by TPWD until that agency and the TNRCC jointly make the determination in accordance with Texas Water Code §11.1491.

AMENDMENTS TO EXISTING PERMITS

Once water supply projects are specifically designed and submitted for permit consideration, a more detailed environmental assessment of its features may be performed. The scope of environmental review and permit consideration of an amendment to an existing water right is limited by law. Because of the many varied conditions around the State, the TNRCC can only provide general guidance as to how the Commission would evaluate applications for water rights and amendments to existing permits. In general, evaluation of impacts to instream or estuarine ecosystems will occur when there is a *significant* change in the point of diversion from downstream to upstream, to an adjoining tributary, to endangered species habitat, or if there is a change of purpose of use from non-consumptive to consumptive. Other changes in place or type of use may have limited or no further environmental review. For further details, refer to A Regulatory Guidance Document for Applications to Divert, Store or Use State Water (June, 1995), published by the TNRCC.

For planning purposes, proposed amendments, such as conversion from non-consumptive to consumptive use (having the effect of a new appropriation) would have the appropriate environmental considerations described for new projects. For other types of amendments where only the intervening river or stream would be affected, the appropriate reservoir or direct diversion instream flow criteria would be applied. Where applicable, environmental flow criteria would only affect that portion of the existing water right subject to change.

ENVIRONMENTAL WATER NEEDS CRITERIA OF THE CONSENSUS PLANNING PROCESS

OVERVIEW

In pursuit of the goals of reducing conflict among competing water interests, providing consistent State water policy, and increasing planning and regulatory clarity to State water managers, the draft consensus proposals reached among the Texas Water Development Board, the Texas Natural Resource Conservation Commission, and the Texas Parks and Wildlife Department on planning methods for providing water needs necessarily involve trade-offs where neither human nor environmental needs unacceptably "prevail" over the other. The challenge facing the technical and policy staff of the three agencies was to craft methods that seek to optimize the provision of environmental flows while minimizing impact on water supply capability.

A guiding desire was to develop a procedure for the Water Plan process that would improve the current method of providing instream flows for environmental purposes with one that will ensure the long-term maintenance of the water-based environment that is so important to Texans, realizing that dry conditions are a natural part of Texas. This process leaves water in the rivers up to an environmental target flow amount and allows human use of flows larger than the target rate. The agencies sought the advice of national experts on how to quantify instream environmental flow targets in a planning process. Their recommendation was that site specific studies should be required, but the instream environment that developed over time should be maintained if river flow rates are normal. The procedure developed uses median flows calculated from naturalized daily streamflow estimates. These estimates are calculated by removing human impacts on the measured flows to represent normal flows, with different operating procedures as river flow conditions change from normal to dry and finally to drought to balance human and environmental uses.

Inter-agency staff have modeled and evaluated well over 100 different scenarios with a variety of alternative management options and in diverse locations and site conditions around the State. We feel the draft proposals listed below produce an acceptable balance between human and environmental needs, and employing straightforward policy considerations and planning methods that are intuitive, consistent, and equitable in their approach. Each of the new project criteria described below provides for the priority of human needs during dry and drought conditions, but at the same time provides for some sharing of the adverse impact of drought by humans and the environment.

It should be emphasized that specific features that are identified in the final project design may require application of detailed criteria during the permitting process which were not applied during the long-range planning process. The environmental provisions specified below are representative of the basic approach to apportion surface water subject to regulatory action in the water planning process, and only approximating what may be required for environmental needs in the ultimate regulatory decision. In lieu of site-specific studies in the permitting process, the criteria will have the rebuttable presumption of validity.

For planning purposes, the environmental pass-through requirements for all zones will be added to flows that provide for downstream water rights. The protection of downstream water rights will be presented by using the full recorded amount of the existing water right and the higher of current reported use or future projected consumptive use (never larger than the full recorded amount of the right) for each downstream right. This range of available water will be noted so that sponsors of surface water development projects will be aware that certain actions on their part may be needed to produce the projected water supply. This approach will ensure that the full permitted rights are recognized during the planning process while identifying areas where significant amounts of appropriated water are presently not being used and potentially available to meet future water needs through marketing, subordination agreements, or other regulatory means.

NEW PROJECT ON-CHANNEL RESERVOIRS

As illustrated in Figure 1, the conservation storage of new-project, on-channel water supply reservoirs would be divided into three zones for environmental instream flow provision as follows:

Zone 1

In Zone 1 of the reservoir, when the reservoir water level is greater than 80% of storage capacity, inflows will be passed up to the monthly medians that are calculated with naturalized daily streamflow estimates.*

Also when the reservoir level is within Zone 1, inflows will be passed to provide one channel flushing flow event per three-month calendar season to provide for channel and habitat maintenance. The default planning criteria allow for a flushing flow event with a 72-hour duration and a peak discharge equal to the site's daily maximum flow with a 1.5-year recurrence interval calculated using an annual historical series of naturalized daily streamflow estimates. During these events, the reservoir will pass-through the higher of: (a) peak flow values, or (b) the sum of environmental pass-throughs, plus flows for protection of downstream water rights. Thus, the flushing flow is not to be stacked on other flow requirements. These environmental criteria should not and are not intended to provide any increase in flooding or cause over-banking below a new reservoir.

* Naturalized streamflow is the estimated amount of water that would have been present in a watercourse with no direct man-made impacts in the watershed. It is calculated by taking values of historically measured streamflow, adding amounts of estimated man-made losses from the upstream watershed caused by diversion and lake evaporation, then subtracting amounts of estimated man-made gains to the upstream watershed caused by return flows.

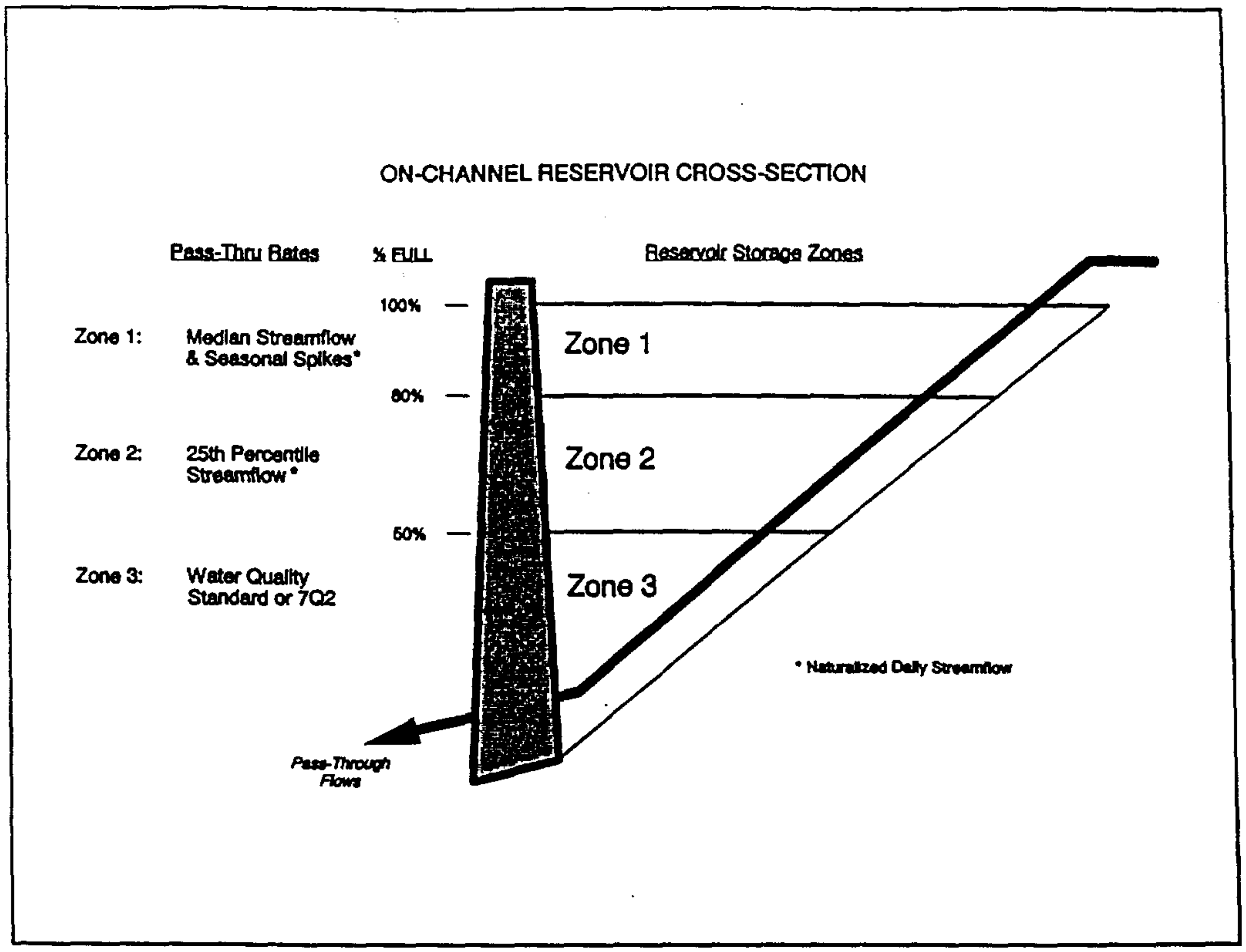

FIGURE 1
NEW PROJECT, ON-CHANNEL RESERVOIR CRITERIA
FOR PASSING ENVIRONMENTAL FLOWS

Zone 2

As dry conditions develop and the reservoir water level declines into Zone 2 between 50 and 80% storage capacity, inflows passed would be reduced and provided only up to the monthly 25th percentile flow values that are calculated with naturalized daily streamflow estimates.

Zone 3

As more severe drought conditions develop and the reservoir level declines into Zone 3 below 50% storage capacity, environmental pass-throughs would be reduced, and flows would be passed up to a target of the established water quality standard for the downstream segment. In lieu of any established water quality standard, the 7Q2 low flow value, as published in the TNRCC's Water Quality Standards, would be used as the default criterion for Zone 3 pass-throughs. If in Zones 1 and 2, the value necessary to maintain downstream water quality is higher than the medians or 25th percentiles then the value necessary to maintain downstream water quality will be used instead of the other target flow values.

All Reservoir Zones

In all zones, it is the intent of these planning criteria that flows passed for instream purposes would also reflect the needs of the associated bay and estuary system. In addition to passage of environmental flows, adequate flows will be passed through for protection of downstream water rights. In all zones, water that can be captured by reservoirs in excess of the environmental provisions is available for water supply storage, and no water will be released from storage to meet environmental targets when inflows are below these limits. However, most future reservoir projects and direct diversions are anticipated to be designed solely for water supply rather than flood control, meaning that most floods can't be captured by the reservoir, but will spill downstream. These spills increase the amount of water available for instream flow maintenance and estuarine needs than would be provided by the environmental criteria alone.

NEW PROJECT DIRECT DIVERSIONS

As illustrated in Figure 2, the criteria for direct diversions from a river or stream that are recommended in the Water Plan, would be based on streamflow conditions just upstream of the diversion point, and would also be divided into three zones as follows:

Zone 1

Zone 1 occurs when actual streamflow is greater than monthly medians calculated with naturalized daily streamflow estimates. When streamflow is within Zone 1, minimum flows passed will be the monthly medians that are calculated with naturalized daily streamflow estimates.

Zone 2

Zone 2 occurs when actual streamflow is less than or equal to medians, but greater than monthly 25th percentile values. When streamflow is within Zone 2, minimum flows passed will be the monthly 25th percentile values that are calculated with naturalized daily streamflow estimates.

Zone 3

Zone 3 occurs when actual streamflow is less than or equal to monthly 25th percentile values. When streamflow is within Zone 3, minimum flows passed will be the larger of: (1) the value necessary to maintain downstream water quality or (2) a continuous flow threshold to be determined by consensus planning staff (e.g., 15th percentile flow) that will not allow the diversion by itself, to dry up the stream.

For perennial river/stream segments where a water quality standard has been established for a stream segment, that value will be used as the pass-by target. Where such a standard has not yet been established, the default planning criterion is the 7Q2 value as published in the TNRCC's Water Quality Standards. For Zones 1 and 2, if the value necessary to maintain downstream water quality is higher than the medians or 25th percentiles, this value necessary to maintain downstream water quality will be used instead of the other values.

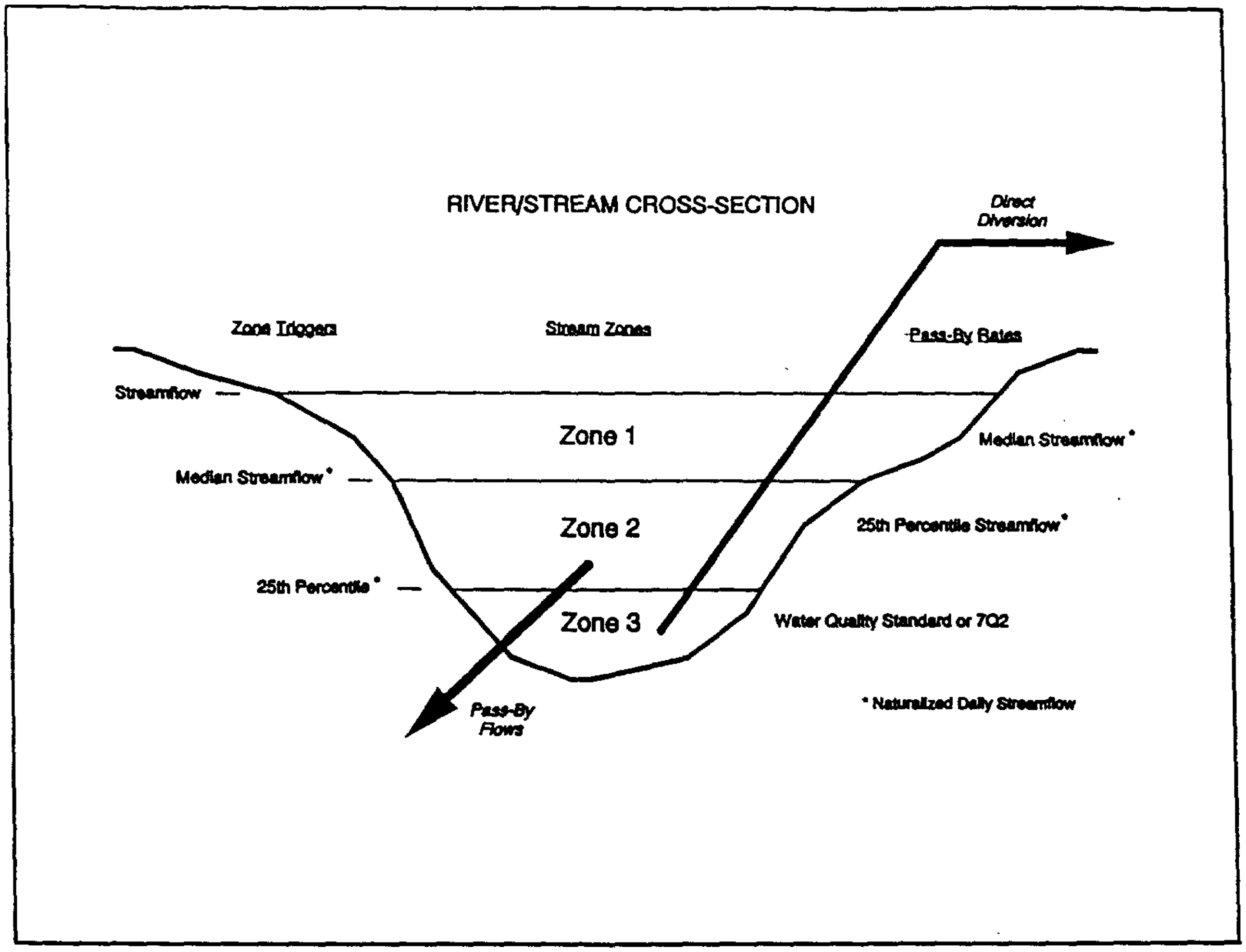

FIGURE 2
NEW PROJECT, DIRECT DIVERSION CRITERIA
FOR PASSING ENVIRONMENTAL FLOWS

All Zones

The trigger values above are calculated with naturalized daily streamflow estimates. In addition to passage of environmental flows, adequate flows will be passed through for protection of downstream water rights. The above procedure, because it provides a specific quantity of flow for environmental use for each zone, does not have smooth transitions between zones for diversion restrictions, and the agencies agree that the procedure should be investigated to see if it is possible to make smoother transitions.

NEW DIRECT DIVERSIONS INTO LARGE OFF-CHANNEL STORAGE

As illustrated in Figure 3, in those cases where a large water supply project would divert its water from a river or stream into off-channel storage, a combination of the direct diversion and reservoir criteria would apply.

The direct diversion criteria will govern the ability to divert water into the off-channel project. The reservoir criteria will address the ability of the reservoir to capture water from its own watershed, as well as define the reservoir's multi-stage operations to pass-through environmental flows, as well as flows for protection of downstream water rights.

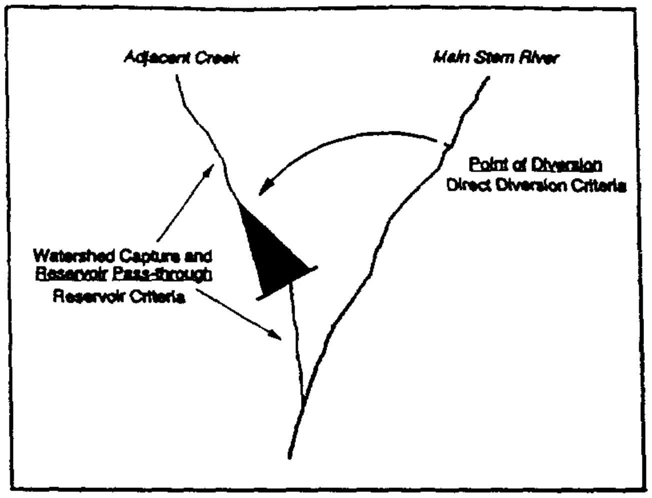

FIGURE 3
COMBINED CRITERIA FOR DIVERSION INTO OFF-CHANNEL RESERVOIR

BAY AND ESTUARY CONSIDERATIONS

As a planning place-holder value, the Zone 1 reservoir pass-throughs or direct diversion pass-bys described previously will also provide freshwater inflow to the bays and estuaries. However where inflow values adequate to meet the beneficial inflow needs as described in Texas Water Code §11.147 have been established, those inflow volumes will be used for projects within 200 river miles of the coast, commencing from the mouth of the river, as the basis for calculating the relative contributions of fresh water from the associated rivers and coastal basins during times of Zone 1 conditions. No other special provisions would be made for B&E purposes in Zone 2 or 3 conditions for either new reservoirs or large direct diversions. These inflow values may be determined by TPWD until that agency and the TNRCC jointly make the determination in accordance with Texas Water Code §11.1491.

The target flows in Zone 1 of the reservoir operating procedure should be established to provide the beneficial flows as defined in §11.147(a) of the Texas Water Code, i.e. the "salinity, nutrient, and sediment loading regime adequate to maintain an ecologically sound environment in the receiving bay and estuary system that is necessary for the maintenance of productivity of economically important and ecologically characteristic sport or commercial fish and shellfish species and estuarine life upon which such fish and shellfish are dependent."

In practical terms, that means it is not necessarily MinQ or MaxQ produced by the optimization model, but a point along that curve between these values that provides some margin of safety (comfort) in providing sufficient flows in Zone 1 to maintain average historic productivity on the fisheries. The fresh water inflow target is one that has been validated by comparing the seasonal distribution of salinity regimes with the density distribution of selected estuarine flora and fauna.

B&E pass-through requirements for a new water development project will be based on a pro-rata share of that location's contribution of flow to the estuary in question. Once the target amount of water reaches an estuary during a month, no additional flows need to be provided for bay and estuary purposes during that month. For the remainder of the month, environmental flows revert to the instream criteria.

RESULTS OF INFLOW AND INSTREAM STUDIES - USE OF STATE DETERMINATIONS

When the results of intensive fresh water inflow or instream flow studies are available and criteria have been established in the regulatory process, those criteria will be used in the Water Plan rather than any generic rule. The instream flow requirements for the Colorado River have been approved by TNRCC through the regulatory process. When established criteria are available and agreed to by TPWD and TNRCC, bay and estuary inflow requirements would be apportioned to each new project identified in the plan according to its proportional share (based on contribution hydrology), and as provided for by TNRCC's A Regulatory Guidance Document for Applications to Divert, Store or Use State Water (June, 1995). Where possible, this process seeks to restore seasonal flow patterns and minimize cumulative impacts from water development projects.

In order to facilitate the timely completion of the (joint) determination of the inflow conditions necessary for the (remaining) bays and estuaries, TPWD and TNRCC, per §11.1491 of the Texas Water Code, will each designate an employee to share equally in the oversight of the program to review the studies prepared by the TWDB and TPWD under Section 16.058 (bay and estuary inflow studies) to determine inflow conditions necessary for the bays and estuaries. The three agencies will continue to work together as they have in development of the Guadalupe Estuary (San Antonio Bay system) target flows to meet the bay and estuary studies completion deadlines, and that provides a salinity, nutrient, and sediment loading regime at or above the identified needs.

AMENDMENTS TO EXISTING PERMITS

Once projects are specifically designed and submitted for permit consideration, a more straightforward and factual environmental assessment of its features may then be performed. The scope of environmental review and corresponding permit considerations relating to an amendment of an existing water right is limited by law, and is set forth in more detail in the TNRCC's A Regulatory Guidance Document for Application to Divert, Store or Use State Water (June, 1995).

An environmental assessment and any corresponding permit conditions relating to an application for an amendment are limited to addressing any new or additional environmental impacts which may result from granting the amendment, and where such impacts would be beyond that which are possible under the full, legal operation of the existing water right prior to its amendment. Because of the many varied conditions around the State, the TNRCC Regulatory Guidance Document can only provide general procedures in many instances as to how the Commission would evaluate applications for water rights permits and amendments to existing permits. A summarization and categorization of the TNRCC's general guidance for determining potential adverse impact to the environment is as follows for types of possible water right amendments likely to be considered in the consensus planning process:

Type of Amendment	Scope of Environmental Review	Basis for Environmental Reservation
Interbasin Transfer with no change in *permitted* purpose of use, appropriative amount, point of diversion, and rate of diversion.	No additional environmental impacts considered with respect to the originating basin. Consideration of potential changes in water quality and/or migration of nuisance species, and excessive freshwater inflows to maintain proper salinity levels for B&E's may be made for receiving basin. A social, economic, and environmental impact statement may be required to be submitted.	Not applicable for originating basin.
Significant change in point of diversion from downstream to upstream, to adjoining tributary, or to endangered species habitat	Evaluation of impacts to intervening instream or site-affected environmental resources.	Case-by-case basis where level of significance evaluated as per Regulatory Guidance Document.
Change of purpose of use from non-consumptive to consumptive use	Evaluation of impacts to instream and B&E environmental resources.	Three-zone planning criteria described previously.
Change in purpose of use where there is no increase in the consumption of water from that legally authorized in the existing water right.	No environmental review.	not applicable.

For consensus planning purposes, possible water rights amendments, such as conversion from non-consumptive to consumptive use (having the effect of a new appropriation) would have the appropriate *instream and B&E* considerations described above for new projects applied in our planning assessment. For other types of amendments where only the intervening river or stream segment would be affected, the appropriate reservoir or direct diversion *instream* criteria would then be applied, in lieu of a detailed, site-specific study.

Where applicable, the "environmental planning criteria" would only affect that portion of the existing water right subject to change. Also, where regional or local planning efforts may specify higher environmental goals than that provided for by existing minimum legal or regulatory requirements, such alternate goals can be requested by the applicant and can be ultimately provided for in the permit language.

APPENDIX C

PHASE I MODELING PARAMETERS

CUERO AND SANDIES CREEK (LINDENAU) RESERVOIRS

Guadalupe - San Antonio Basin Modeling Parameters
Cuero Reservoir - Alternative G-16
Scenario 1

Analysis Point: Guadalupe River at Cuero (USGS Gage 1758)

Minimum Flow Requirements:

Month	Inflow Passage Requirement at Reservoir (acft/mo)	Inflow Passage Requirement at Reservoir (cfs)	Bay & Estuary Inflow Requirement at Saltwater Barrier (acft/mo)	Bay & Estuary Inflow Requirement at Saltwater Barrier (cfs)
Jan	67,956	1,127	N/A	N/A
Feb	64,256	1,066	N/A	N/A
Mar	68,534	1,137	N/A	N/A
Apr	103,868	1,723	N/A	N/A
May	157,739	2,616	N/A	N/A
Jun	146,608	2,431	N/A	N/A
Jul	51,371	852	N/A	N/A
Aug	52,110	864	N/A	N/A
Sep	82,987	1,376	N/A	N/A
Oct	91,596	1,519	N/A	N/A
Nov	53,055	880	N/A	N/A
Dec	56,337	934	N/A	N/A
Drought Median[1]	10,461	173	N/A	N/A

Flow Requirements Based On:	Trans-Texas Environmental Criteria
Edwards Aquifer Pumpage:	400,000 acft/yr
Return Flows:	
Surface Water Sources:	1988 Actual
Groundwater Sources:	1988 Actual
Water Rights:	
Canyon Lake:	74,100 acft/yr
Hydro Requirement at Lake Dunlap:	0 cfs
Applewhite Reservoir:	Included
Other Rights:	Full Authorized Amounts
Steam-electric Diversions:	
Braunig Lake (consumptive use):	12,000 acft/yr (full permitted amount)
Braunig Lake (river diversion):	12,000 acft/yr (full permitted amount as needed)
Calaveras Lake (consumptive use):	37,000 acft/yr (full permitted amount)
Calaveras Lake (river diversion):	60,000 acft/yr (full permitted amount as needed)
Coleto Creek Reservoir (consumptive use):	12,500 acft/yr (full permitted amount)
Coleto Creek Reservoir (river diversion):	20,000 acft/yr (full permitted amount as needed)

Reservoir Firm Yield Estimates

Reservoir Capacity Threshold for Implementation of Drought Contingency Operations[2]	Estimate of Firm Yield (acft/yr)
40%	117,000
60%	163,000
80%	187,000

Notes:
1) Median monthly natural flow during the January, 1954 to December, 1956 historical period.
2) The capacity threshold is the percentage of reservoir conservation storage that triggers a change from normal to drought contingency operations under the Trans-Texas Environmental Criteria for new reservoirs. Drought contingency operations provide for the release of inflows up to the median monthly natural flow during the January, 1954 to December, 1956 historical period.

Guadalupe - San Antonio Basin Modeling Parameters
Lindenau Reservoir - Alternative G-17
Scenario 1

Analysis Point: Sandies Creek near Westhoff (USGS Gage 1750)

Minimum Flow Requirements:

Month	Inflow Passage Requirement at Reservoir[1] (Sandies Creek) (acft/mo)	(cfs)	Instream Flow Requirement at Guadalupe River Diversion Location[2] (acft/mo)	(cfs)	Bay & Estuary Inflow Requirement at Saltwater Barrier for River Diversion[3] (acft/mo)	(cfs)
Jan	1,391	23	29,067	482	119,235	1,977
Feb	1,996	33	27,952	464	111,426	1,848
Mar	1,372	23	41,402	687	118,399	1,964
Apr	9,946	165	43,546	722	108,476	1,799
May	13,883	230	61,261	1,016	260,311	4,317
Jun	14,245	236	51,054	847	252,135	4,182
Jul	1,138	19	32,065	532	86,267	1,431
Aug	2,288	38	25,915	430	71,697	1,189
Sep	13,840	230	34,423	571	177,444	2,943
Oct	7,281	121	23,705	393	172,249	2,857
Nov	1,518	25	22,278	369	92,774	1,539
Dec	1,372	23	23,299	386	103,130	1,710
Drought Median[4]	837	14	N/A	N/A	N/A	N/A

Flow Requirements Based On:	Trans-Texas Environmental Criteria
Edwards Aquifer Pumpage:	400,000 acft/yr
Return Flows:	
Surface Water Sources:	1988 Actual
Groundwater Sources:	1988 Actual
Water Rights:	
Canyon Lake:	74,100 acft/yr
Hydro Requirement at Lake Dunlap:	0 cfs
Applewhite Reservoir:	Included
Other Rights:	Full Authorized Amounts
Steam-electric Diversions:	
Braunig Lake (consumptive use):	12,000 acft/yr (full permitted amount)
Braunig Lake (river diversion):	12,000 acft/yr (full permitted amount as needed)
Calaveras Lake (consumptive use):	37,000 acft/yr (full permitted amount)
Calaveras Lake (river diversion):	60,000 acft/yr (full permitted amount as needed)
Coleto Creek Reservoir (consumptive use):	12,500 acft/yr (full permitted amount)
Coleto Creek Reservoir (river diversion):	20,000 acft/yr (full permitted amount as needed)

Reservoir Firm Yield Estimates[5]

Reservoir Capacity Threshold for Implementation of Drought Contingency Operations[6]	Estimate of Firm Yield (acft/yr)
40%	43,800
60%	45,200
80%	48,700

Notes:
1) Inflow passage requirement at reservoir site on Sandies Creek applied only to inflows from the Sandies Creek watershed.
2) Instream flow requirement for Guadalupe River diversion at Cuero (USGS Gage 1758) only applied to determine water potentially available for diversion into Lindenau Reservoir assuming full control of the Sandies Creek watershed.
3) Bay & Estuary inflow requirement at Saltwater Barrier only applied to determine water potentially available for diversion from the Guadalupe River at Cuero (USGS Gage 1758) into Lindenau Reservoir assuming full control of the Sandies Creek watershed.
4) Median monthly natural flow during the January, 1954 to December, 1956 historical period.
5) Firm yield estimates include inflows from the Sandies Creek watershed and diversion from the Guadalupe River at Cuero (USGS Gage 1758). Water potentially available for diversion from the Guadalupe River at Cuero was limited to 80 percent of the estimated monthly water available to account for daily streamflow variations. Monthly diversions from the Guadalupe River were also subjected to a maximum diversion rate of 40,000 acft per month.
6) The capacity threshold is the percentage of reservoir conservation storage that triggers a change from normal to drought contingency operations under the Trans-Texas Environmental Criteria for new reservoirs. Drought contingency operations provide for the release of inflows up to the median monthly natural flow during the January, 1954 to December, 1956 historical period.

APPENDIX D

NATURALIZED DAILY STREAMFLOW STATISTICS

Proposed Reservoir	Naturalized Daily Streamflow Statistics for Consensus Criteria Pass-Through Requirements Median Flows (acft/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cuero Reservoir (G-16)	1,872	2,014	2,013	2,067	2,461	2,222	1,676	1,310	1,445	1,622	1,688	1,748
Sandies Creek Reservoir (G-17)	33	39	34	32	40	34	19	14	21	23	28	30
Guadalupe River Dam No. 7 (G-19)	219	236	228	221	251	200	142	118	151	192	209	224
Gonzales Reservoir (G-20)	447	492	465	531	612	540	399	336	362	369	383	422
Lockhart Reservoir (G-21)	28	36	29	24	32	24	10	4	8	11	16	20
Dilworth Reservoir(G-22)	20	24	20	10	26	16	2	1	1	1	7	10
Cloptin Crossing Reservoir (G-40)	105	121	137	161	167	161	107	65	81	96	93	105

Proposed Reservoir	Naturalized Daily Streamflow Statistics for Consensus Criteria Pass-Through Requirements 25th Percentile Flows (acft/day)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cuero Reservoir (G-16)	1,171	1,272	1,227	1,205	1,331	1,198	946	692	835	962	1,063	1,127
Sandies Creek Reservoir (G-17)	21	22	21	16	15	14	6	2	8	10	14	18
Guadalupe River Dam No. 7 (G-19)	129	130	124	126	112	90	61	38	66	88	104	121
Gonzales Reservoir (G-20)	284	313	288	270	321	297	229	203	217	227	239	270
Lockhart Reservoir (G-21)	14	16	13	11	11	8	3	1	2	4	8	10
Dilworth Reservoir(G-22)	1	4	1	1	2	1	1	1	1	1	1	1
Cloptin Crossing Reservoir (G-40)	52	59	58	63	74	77	44	34	37	40	43	44

Naturalized Daily Streamflow Statistics for Consensus Criteria Pass-Through Requirements 7Q2 Flows (acft/day)	
Cuero Reservoir (G-16)	1,041
Sandies Creek Reservoir (G-17)	7
Guadalupe River Dam No. 7 (G-19)	63
Gonzales Reservoir (G-20)	249
Lockhart Reservoir (G-21)	2
Dilworth Reservoir(G-22)	1
Cloptin Crossing Reservoir (G-40)	40

APPENDIX E

SUMMARY OF ENVIRONMENTAL CONSIDERATIONS

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SUMMARY OF ENVIRONMENTAL CONSIDERATIONS

	Cuero Reservoir (G-16)	Sandies Creek Reservoir (G-17)	Guadalupe River Dam No. 7 (G-19)	Gonzales Reservoir (G-20)	Lockhart Reservoir (G-21)	Dilworth Reservoir (G-22)	Cloptin Crossing (G-40)
Yield (acft/yr)	145,448	74,471	30,927	75,093	6,339	18,195	33,163
Conservation Pool (ac)	41,500	26,875	12,830	21,370	2,910	15,400	6,060
100-Year Flood Pool (ac)	57,500	30,906	14,755	24,980	5,700	20,700	7,730[2]
Habitat Impacted (ac)							
Developed	260	0	0	150	0	100	2,273
Grasslands	13,796	9,390	873	11,560	727	5,967	1,448
Crops	6,691	904	624	0	873	0	0
Shrublands	0	0	1,745	0	728	0	0
Brushlands	6,991	8,409	3,741	7,077	378	5,049	848
Park	0		0	0	0	0	0
Woodlands	11,360	5,383	5,236	2,029	116	2,754	1,236
Wetlands	1,464	2,596	112	188	51	1,462	81
Riverine Habitat	938	193	499	366	37	68	174
Total Area Affected (ac)	41,500	26,875	12,830	21,370	2,910	15,400	6,060
Lotic to Lentic Habitat	1,044	193	499	366	0	68	174
Inundated Area	41,500	26,875	12,830	21,370	2,910	15,400	6,060
Long-Term Impacts	41,500	26,875	12,830	21,370	2,910	15,400	6,060
Protected Species[1]	yes	yes	yes	yes	no	no	no
Protected Species Habitat[1]	yes	yes	yes	yes	yes	yes	yes
Cultural Resources[1]	yes	yes	yes	yes	yes	yes	yes

[1]A more detailed explanation appears in the report section text.

[2]Cited in BUREC report as "top of flood control capacity."

APPENDIX F

PROTECTED, ENDANGERED, AND THREATENED SPECIES

Table No.	
1.	Caldwell
2.	Comal
3.	De Witt
4.	Gonzales
5.	Guadalupe
6.	Hays (Phase II Updated)
6a.	Hays (Phase I)
7	Kendall

Table 1 - Caldwell

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Agency TPWD	Potential Occurrence in County
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby resting sites; nesting in riparian forests near water; nests in riparian areas of the Coastal Plains	E	E	migratory/ nesting
Black-capped Vireo	*Vireo atricapillus*	Semi-open broad-leaved shrublands, oak-juniper woodlands with distinctive patchy, two-layered shrub - tree aspect	E	E	migratory
Golden-cheeked Warbler	*Dendroica chrsoparia*	Woodlands with oaks and mature juniper	E	E	[1] possible
Interior Least Tern	*Sterna antillarum athalassos*	Nesting on sandbars of large rivers, dispersal	E	E	migratory
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*	Open coastal areas	T	T	migratory
Peregrine Falcon, American	*Falco peregrinus anatum*	Open coastal areas	E	E	migratory
Swallow-tailed Kite, American	*Elanoides forficatus*	Varied, moist open land with tall trees for nesting	T	T	endemic
Wood Stork	*Mycteria americana*	Post-breeding; in wetlands of the coastal plain, major waterways, and lower Mississippi valley	E[3]	T	dispersal
White-faced Ibis	*Plegadis chihi*	Freshwater marshes	C2	T	endemic
Whooping Crane	*Grus americana*	Coastal wetlands; Matagorda and Aransas Islands	E	E	migrating
Zone-tailed Hawk	*Buteo albonotatus*	Canyons and wooded river bottoms in Southwest U.S.A.	NL	T	migrating
Siren, Lesser, Rio Grande	*Siren intermedia texana*	Wet or temporally wet areas, arroyos,canals,ditches and shallow depressions; requires moisture to remain	C2	E	endemic
Texas Horned Lizard	*Phrynosoma cornutum*	Open arid and semi-arid regions with sparse vegetation; grass, cactus, scattered brush; soil may vary from sandy to rocky, burrows in soil, rodent burrow, or hides under rocks	C2	T	endemic
Timber Rattlesnake	*Crotalus horridus*	Bottomland woodlands, reclusive in dense thickets	NL	T	endemic
Blue Sucker	*Cycleptus elongatus*	Large rivers throught the Mississippi Basin; In Texas, major streams southward to the Rio Grande	C2	T	[1] possible
Bracted Twistflower	*Streptanthus bracteatus*	In shallow, well drained gravely clays and clay loams over limestone in oak-juniper woods, wooded slopes, canyon bottoms and sandy river margins	C2	NL	endemic

Table 2 - Comal

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Agency TPWD	Potential Occurrence in County
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby roosting/resting sites	E	E	wintering / transient
Peregrine Falcon, American	*Falco peregrinus anatum*	Open coastal areas	E	E	migratory
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*	Open coastal areas	T	T	migratory
Swallow-tailed Kite, American	*Elanoides forficatus*	Varied, open land with tall trees for nesting	3C	T	endemic
White-tailed Hawk	*Buteo albicaudatus*	Grasslands and coastal prairies	NL	T	endemic
Zone-tailed Hawk	*Buteo albonotatus*	Semi-aird canyon edges of Southwest U.S.	NL	T	historic nesting
Black-capped Vireo	*Vireo atricapillus*	Semi-open broad-leaved shrublands	E	E	nesting/migrant
Golden-cheeked Warbler	*Dendroica chrsoparia*	Woodlands with oaks and old juniper	E	E	nesting/migrant
Interior Least Tern	*Sterna antillarum athalassos*	Large river sandbars	E	E	migratory
Whistling - duck, Fulvous	*Dendrocygna bicolor*	Ponds and freshwater marshes	C2	NL	endemic
White-faced Ibis	*Plegadis chihi*	Freshwater marshes	C2	T	endemic
Whooping Crane	*Grus americana*	Coastal wetlands; Matagorda & Aransas islands	E	E	migrating
Wood Stork	*Mycteria americana*	Post-breeding; in wetlands of the coastal plain, major waterways, and lower Mississippi valley	E	T	dispersal
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	3C	NL	resident
Texas Horned Lizard	*Phrynosoma cornutum*	Open arid and semi-arid regions with sparse vegetation; grass, cactus, scattered brush; soil may vary from sandy to rocky, burrows in soil, rodent burrow, or hides under rocks	C2	T	endemic
Texas Garter Snake	*Thamnophis sirtalis annectans*	Varied, especially moist habitats	C2	NL	endemic
Timber Rattlesnake	*Crotalus horridus*	Bottomland hardwoods	NL	T	' possible
Texas Mock-Orange	*Philadelphus texensis*	On limestone bluffs and among boulders on the Edwards Plateau	C2	NL	endemic

Table 3 - De Witt

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Agency TPWD	Potential Occurrence in County
Attwater's Prairie-Chicken	*Tympanuchus cupido attwateri*	Native gulf coastal prairies of the coastal plain; 50% climax grass species composition	E	E	endemic
Bald Eagle	*Haliaeetus leucocephalus*	Near large water bodies with near by resting sites, nesting in forested river bottoms	E	E	wintering\ transient
Brown Pelican	*Pelecanus occidentalis*	Ocean, salt bays, and coastal areas	E	E	endemic
Peregrine Falcon, American	*Falco peregrinus anatum*	Open coastal areas	E	E	migratory
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*	Open coastal areas	T	T	migratory
Reddish Egret	*Egretta rufescens*	Coastal wetland islands	C2	T	endemic
Swallow-Tailed Kite, American	*Elanoides forficatus*	Varied; open land, nesting in forested river bottoms	3C	T	migratory
White-tailed Hawk	*Buteo albicaudatus*	Grasslands and coastal prairies	NL	T	endemic
White-faced Ibis	*Plegadis chihi*	Freshwater marshes	C2	T	endemic
Whooping Crane	*Grus americana*	Coastal wetlands; Matagorda and Aransas Islands	E	E	migrating
Wood Stork	*Mycteria americana*	Post-breeding; in wetlands of the coastal plain, major waterways, and lower Mississippi valley	E[2]	T	[1] dispersal
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	C1	NL	[3] endemic
Texas Horned Lizard	*Phrynosoma cornutum*	Open arid and semi-arid regions with sparse vegetation including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky, burrows in soil or hides under rocks	C2	T	endemic
Texas Tortoise	*Gopherus berlandieri*	Open brush with grass understory; open grass and bare ground are avoided; occupies shallow depressions at base of bush or cactus, underground burrows, under objects; active March-Nov.	NL	T	[1] probable
Timber Rattlesnake	*Crotalus horridus*	Bottomland woodlands	NL	T	[3] endemic
Black-spotted Newt	*Notophthalmus meridionalis*	Wet or temporarily wet areas; arroyos, canals, ditches; aestivates underground during dry periods	C2	E	[1] probable

Table 4 - Gonzales

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Agency TPWD	Potential Occurrence in County
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby resting sites; nesting in riparian forests near water	E	E	migratory
Golden-cheeked Warbler	*Dendroica chrsoparia*	Woodlands with oaks and old juniper	E	E	[1] possible
Interior Least Tern	*Sterna antillarum athalassos*	Large river sandbars	E	E	migratory
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*	Open coastal areas	T	T	migratory
Peregrine Falcon, American	*Falco peregrinus anatum*	Open coastal areas	E	E	migratory
Reddish Egret	*Egretta rufescens*	Coastal wetland islands	C2	T	endemic
Swallow-Tailed Kite, American	*Elanoides forficatus*	Open forested areas	3C	T	migratory
White-tailed Hawk	*Buteo albicaudatus*	Grasslands and coastal prairies	NL	T	endemic
White-faced Ibis	*Plegadis chihi*	Freshwater marshes	C2	T	migratory
Whooping Crane	*Grus americana*	Coastal wetlands; Matagorda & Aransas islands	E	E	migrating
Wood Stork	*Mycteria americana*	Post-breeding; in wetlands of the coastal plain, major waterways, and lower Mississippi valley	E[2]	T	dispersal
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	C1	NL	[3] endemic
Texas Tortoise	*Gopherus berlandieri*	Open brush with grass understory; open grass and bare ground are avoided; occupies shallow depressions at base of bush or cactus, underground burrows, under objects; active March-Nov.	NL	T	probable
Siren, Lesser, Rio Grande	*Siren intermedia texana*	Wet or temporally wet areas, arroyos,canals,ditches and shallow depressions; requires moisture to remain	C2	E	endemic
Texas Horned Lizard	*Phrynosoma cornutum*	Open arid and semi-arid regions with sparse vegetation including grass, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky, burrows in soil, rodent burrow, or hides under rocks when inactive	C2	T	endemic
Timber Rattlesnake	*Crotalus horridus*	Bottomland woodlands, dense thickets	NL	T	[3] endemic
Blue Sucker	*Cycleptus elongatus*	Large rivers throught the Mississippi Basin; In Texas, major streams southward to the Rio Grande	C2	T	[1] possible
Guadalupe Bass	*Micropterus treculi*	Rivers of the Edwards Plateau including portions of the Brazos, Colorado, Guadalupe, and San Antonio River Basins; also the lower Colorado River and introduced in the Nueces River system	C2	NL	[1] possible

Table 5 - Guadalupe

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Agency TPWD	Potential Occurrence in County
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby roosting/resting sites	E	E	wintering / transient
Peregrine Falcon, American	*Falco peregrinus anatum*	Open coastal areas	E	E	migratory
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*	Open coastal areas	T	T	migratory
Swallow-tailed Kite, American	*Elanoides forficatus*	Varied, open land with tall trees for nesting	3C	T	resident
Black-capped Vireo	*Vireo atricapilius*	Semi-open broad-leaved shrublands	E	E	nesting/migrant [1]
Golden-cheeked Warbler	*Dendroica chrysoparia*	Woodlands with oaks and old juniper	E	E	nesting/migrant
Interior Least Tern	*Sterna antillarum athalassos*	Large river sandbars	E	E	migratory
White-faced Ibis	*Plegadis chihi*	Freshwater marshes	C2	T	resident
Whooping Crane	*Grus americana*	Coastal wetlands; Matagorda & Aransas islands	E	E	migrating transient
Wood Stork	*Mycteria americana*	Coastal wetlands	E**	T	dispersal
Texas Horned Lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands	C2	T	resident
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	3C	NL	resident
Texas Garter Snake	*Thamnophis sirtalis annectans*	Varied, especially moist habitats	C2	NL	resident
Timber Rattlesnake	*Crotalus horridus*	Bottomland hardwoods	NL	T	potential
Blue Sucker	*Cycleptus elongatus*	Rivers crossing eastern Edwards Plateau to coast	C2	T	resident
Guadalupe Bass	*Micropterus terculi*	Streams of eastern Edwards Plateau	C2	NL	resident
Fountain Darter	*Etheostoma fonticola*	San Marcos River to confluence with Blanco River; associated with San Marcos Salamander in quite, clear water	E	E	resident
San Marcos Gambusia	*Gambusia georgei*	San Marcos River to confluence with Blanco River, large clear spring-fed river	E	E	resident, possibly extinct
Big Red Sage	*Salvia penstemonoides*	Moist rich ledges, rocky level creek floodplain; reintroduced through native plant nursey trade	C2	NL	historic endemic

Table 6 - Hays (Phase II Updated)

Endangered and Threatened Species and Species of Concern For Hays County, Texas.

Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
MAMMALS:						
Cave Myotis	*Myotis velifer*	Cave-dwelling; may also roost in rock crevices, old-buildings, and bridges	NL[1,5]	NL[6]	NL[8]	endemic
AVES:						
Zone-tailed Hawk	*Buteo albonotatus*	Arid scrub, pine-oak woodland; mountains of Trans-Pecos and western Edwards Plateau	NL[1,5]	T[9]	T[8]	transient
Mountain Plover	*Charadrius montanus*	Western plains; shortgrass prairies; Western Panhandle and Trans-Pecos	C[5]	NL[6,9]	NL[8]	transient
Golden-cheeked Warbler	*Dendroica chrysoparia*	Woodlands with oak and mature juniper	E[1]	E[9]	T[8]	migratory
Peregrine Falcon	*Falco peregrinus*	Open coastal areas	E (S/A)[1]	NL[6,9]	NL[8]	transient

[1] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed vertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[2] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed invertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[3] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[4] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed Non-flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[5] Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division. U.S. Department of the Interior. Notice of Review.
[6] Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. County lists of Texas' special species. (Bastrop, Bell, Burleson, Burnet, Colorado, Fayette, Hays, Lee, Llano, Milam, Travis, Washington and Williamson Counties revised Jan. 13, 1997)
[7] Texas Organization for Endangered Species. August 1993. Endangered, threatened and watch lists of Texas plants. TOES Publication 9, third revision.
[8] Texas Organization for Endangered Species. January 1988. Endangered, threatened and watch lists of vertebrates of Texas. TOES Publication 6.
[9] Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. Species with Federal or Texas State Endangered or Threatened Status. Dec. 1996
[10] Texas Organization for Endangered Species. Sept. 1988. Invertebrates of Special Concern TOES Publication 7.

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V - Category V TOES Plant Watch List

Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
American Peregrine Falcon	*Falco peregrinus anatum*	Open Coastal areas	E[1]	E[9]	E[8]	migratory
Arctic Peregrine Falcon	*Falco peregrinus tundris*	Open Coastal Plain	E (S/A)[1]	T[9]	T[8]	migratory
Whooping Crane	*Grus americana*	Coastal wetlands, Matagorda and Aransas Islands	E[1]	E[9]	E[8]	transient
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby roosting and nesting sites	T[1]	T[9]	E[8]	migratory
Wood Stork	*Mycteria americana*	Coastal wetlands, dispersal	NL[1,5]	T[9]	T[8]	endemic
Brown Pelican	*Pelecanus occidentalis*	Ocean, salt bays, and coastal areas	E[1]	E[9]	E[8]	transient
White-faced Ibis	*Plegadis chihi*	Bays, marshes, lakes, ponds; Coastal Plains, inland in eastern Texas	NL[1,5]	T[9]	T[8]	transient
Interior Least Tern	*Sterna*	Nesting on large river sandbars	E[1]	E[9]	E[8]	transient

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[2] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed invertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[3] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

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[5] Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division, U.S. Department of the Interior. Notice of Review.

[6] Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. County lists of Texas' special species. (Bastrop, Bell, Burleson, Burnet, Colorado, Fayette, Hays, Lee, Llano, Milam, Travis, Washington and Williamson Counties revised Jan. 13, 1997)

[7] Texas Organization for Endangered Species. August 1993. Endangered, threatened and watch lists of Texas plants. TOES Publication 9, third revision.

[8] Texas Organization for Endangered Species. January 1988. Endangered, threatened and watch lists of vertebrates of Texas. TOES Publication 6.

[9] Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. Species with Federal or Texas State Endangered or Threatened Status. Dec. 1996

[10] Texas Organization for Endangered Species. Sept. 1988. Invertebrates of Special Concern TOES Publication 7.

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V - Category V TOES Plant Watch List

Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
	antillarum athalassas					
Black-capped Vireo	*Vireo atricapillus*	Semi-open broad-leaved shrublands, oak-juniper woodlands with distinctive patchy, two-layered shrub-tree aspect	E[1]	E[9]	T[8]	migratory
REPTILES:						
Timber Rattlesnake	*Crotalus horridus*	Bottomland hardwoods	NL[1,5]	T[9]	NL[8]	endemic
Texas Garter Snake	*Thamnophis sirtalus annectens*	Wet to moist microhabitats are conducive to the species occurrence, but is not necessarily restricted to them; hibernates underground or in or under surface cover; breeds March to August	NL[1,5]	NL[6]	WL[8]	endemic
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	C[5]	NL[6,9]	NL[8]	endemic

[1] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed vertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[2] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed invertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[3] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[4] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed Non-flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[5] Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division, U.S. Department of the Interior. Notice of Review.
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Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
Spot-tailed Earless Lizard	*Holbrookia lacerata*	Rocky desert flats, areas with sparse vegetation or mesquite-prickly pear associations, and the uplands of the Edwards Plateau	NL[1,5]	NL[6,9]	NL[8]	endemic
Keeled Earless Lizard	*Holbrookia propinqua*	Prefers sandy environments, common on sand dunes and barrier beaches within its range	NL[1,5]	NL[6,9]	NL[8]	endemic
Texas Horned Lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands, open desert and grasslands	NL[1,5]	T[9]	T[8]	endemic
AMPHIBIANS:						
San Marcos Salamander	*Eurycea nana*	Spring flows, submerged vegetation	T[1]	T[6]	T[8]	endemic
Blanco River Springs Salamander	*Eurycea pterophila*	Subterranean aquatic karst and springs	NL[1,5]	NL[6,9]	NL[8]	endemic
Blanco Blind	*Eurycea robusta*	Subterranean aquatic karst	NL[1,5]	E[6]	NL[8]	endemic

1 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed vertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
2 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed invertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
3 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
4 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed Non-flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
5 Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division, U.S. Department of the Interior. Notice of Review.
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Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
Salamander						
Edwards Plateau Spring Salamander	*Eurycea* sp 7	Subterranean aquatic karst and springs	NL[1,5]	NL[6,9]	NL[8]	endemic
Texas Blind Salamander	*Typhlomolge rathbuni*	Subterranean streams of the Purgatory Creek system	E[1]	E[6]	T[8]	endemic
FISH:						
Blue Sucker	*Cycleptus elongatus*	Larger rivers throughout the Mississippi Basin; In Texas, major streams southward to the Rio Grande	NL[1,5]	T[9]	NL[8]	endemic
Fountain Darter	*Ethestoma fonticola*	San Marcos River to confluence with Blanco River; associated with San Marcos Salamander in quiet, clear water	E[1]	E[9]	E[8]	endemic
San Marcos	*Gambusia*	San Marcos River to confluence with Blanco	E[1]	E[9]	E[8]	endemic

[1] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed vertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[2] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed invertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[3] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[4] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed Non-flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[5] Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division. U.S. Department of the Interior. Notice of Review.

[6] Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. County lists of Texas' special species. (Bastrop, Bell, Burleson, Burnet, Colorado, Fayette, Hays, Lee, Llano, Milam, Travis, Washington and Williamson Counties revised Jan. 13, 1997)

[7] Texas Organization for Endangered Species. August 1993. Endangered, threatened and watch lists of Texas plants. TOES Publication 9, third revision.

[8] Texas Organization for Endangered Species. January 1988. Endangered, threatened and watch lists of vertebrates of Texas. TOES Publication 6.

[9] Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. Species with Federal or Texas State Endangered or Threatened Status. Dec. 1996

[10] Texas Organization for Endangered Species. Sept. 1988. Invertebrates of Special Concern TOES Publication 7.

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Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
Gambusia	*georgei*	River, large clear spring-fed river				
Guadalupe Bass	*Micropterus treculi*	Clear flowing streams of eastern Edwards Plateau	NL[1,5]	NL[6,9]	WL[8]	endemic
INVERTEBRATES:						
Flint's Net-Spinning Caddisfly	*Cheumatopsyche flinti*	Honey Creek, Hays County, Texas	NL[2,5]	NL[6,9]	SOC[10]	endemic
Edwards Aquifer Diving Beetle	*Haideoporus texanus*	Springs of the Edwards Aquifer	NL[2,5]	NL[6,9]	SOC[10]	endemic
Comal Springs Riffle Beetle	*Heterelmis comalensis*	Headwater springs to the Comal River	PE[5]	PE[6]	NL[6,10]	endemic
Texas Cave Shrimp	*Palaemonetes antrorum*	Edwards Aquifer and Ezell's Cave, Hays County, Texas	NL[2,5]	NL[6,9]	SOC[10]	endemic
San Marcos Saddle-Case Caddisfly	*Protoptila arca*	San Marcos River	NL[2,5]	NL[6,9]	SOC[10]	endemic
Ezell's Cave	*Stygobromus*	Ezell's Cave, Hays County, Texas	NL[2,5]	NL[6,9]	SOC[10]	endemic

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[3] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[4] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed Non-flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
[5] Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division, U.S. Department of the Interior. Notice of Review.
[6] Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. County lists of Texas' special species. (Bastrop, Bell, Burleson, Burnet, Colorado, Fayette, Hays, Lee, Llano, Milam, Travis, Washington and Williamson Counties revised Jan. 13, 1997)
[7] Texas Organization for Endangered Species. August 1993. Endangered, threatened and watch lists of Texas plants. TOES Publication 9, third revision.
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Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
Amphipod	*flagellatus*					
MOLLUSKS						
Horseshoe Liptooth	*Polygyra hippocrepis*	Waters of Hays County, Texas	NL[2,5]	NL[6,9]	NL[6,10]	endemic
PLANTS:						
Hill Country Wild-mercury	*Argythamnia aphoroides*	Shallow to moderately deep clays and clay loams over limestone, in grasslands associated with plateau live oak woodlands, mostly on rolling uplands	NL[3,5]	NL[6,9]	V[7]	endemic
Glass Mountains Coral-root	*Hexalectris nitida*	Beneath oaks or in cedar - oak groves on the Edwards Plateau	NL[3,5]	NL[6,9]	NL[6,7]	endemic
Warnock's Coral-root	*Hexalectris warnockii*	Among rocks in shaded canyons on the Edwards Plateau	NL[3,5]	NL[6,9]	NL[6,7]	endemic

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[2] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed invertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[3] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[4] U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed Non-flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.

[5] Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division, U.S. Department of the Interior. Notice of Review.

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Common Name	Scientific Name	Habitat Preference	USFWS Listing	TPWD Listing	TOES Listing	Potential Occurrence
Canyon Mock-orange	*Philadelphus ernestii*	Edwards Plateau, solution pitted outcrops of Cretaceous limestone on caprock along mesic canyons, usually in shade of mixed canyon woodlands	NL[3,5]	NL[6,9]	V[7]	endemic
Texas Wild Rice	*Zizania texana*	Known only from the San Marcos River (Hays County) where it occurs in clear flowing water from springs of constant cool temperature.	E[3]	E[9]	E[7]	endemic

1 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed vertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
2 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed invertebrate animal species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
3 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
4 U.S. Fish and Wildlife Service Division of Endangered Species. U.S. listed Non-flowering plant species index by lead region and status as of January 31,1997. U.S. Fish and Wildlife Endangered Species Home Page.
5 Federal Register. February 28, 1996. 50 CFR Part 17. Review of plant and animal taxa that are candidates for listing as endangered or threatened species. Fish and Wildlife Service Division, U.S. Department of the Interior. Notice of Review.
6 Texas Biological and Conservation Data System. Texas Parks and Wildlife Department, Endangered Resources Branch. County lists of Texas' special species. (Bastrop, Bell, Burleson, Burnet, Colorado, Fayette, Hays, Lee, Llano, Milam, Travis, Washington and Williamson Counties revised Jan. 13, 1997)
7 Texas Organization for Endangered Species. August 1993. Endangered, threatened and watch lists of Texas plants. TOES Publication 9, third revision.
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Table 6a - Hays (Phase I)

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Agency TPWD	Potential Occurrence in County
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby roosting/resting sites	E	E	wintering / transient
Peregrine Falcon, American	*Falco peregrinus anatum*	Open coastal areas	E	E	migratory
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*	Open coastal areas	T	T	migratory
Swallow-tailed Kite, American	*Elanoides forficatus*	Varied, open land with tall trees for nesting	3C	T	resident
Zone-tailed Hawk	*Buteo albonotatus*	semi-aird canyon edges of Southwest U.S.	NL	T	historic nesting [1]
Black-capped Vireo	*Vireo atricapillus*	Semi-open broad-leaved shrublands	E	E	nesting/migrant
Golden-cheeked Warbler	*Dendroica chrysoparia*	Woodlands with oaks and old juniper	E	E	nesting/migrant
Interior Least Tern	*Sterna antillarum athalassos*	Large river sandbars	E	E	migratory
White-faced Ibis	*Plegadis chihi*	Freshwater marshes	C2	T	resident
Whooping Crane	*Grus americana*	Coastal wetlands; Matagorda & Aransas islands	E	E	migrating transient
Wood Stork	*Mycteria americana*	Coastal wetlands	E**	T	dispersal
Texas Horned Lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands	C2	T	resident
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	3C	NL	resident
Texas Garter Snake	*Thamnophis sirtalis annectans*	Varied, especially moist habitats	C2	NL	resident
Timber Rattlesnake	*Crotalus horridus*	Bottomland hardwoods	NL	T	not confirmed **
Blue Sucker	*Cycleptus elongatus*	Rivers crossing eastern Edwards Plateau to coast	C2	T	resident
Guadalupe Bass	*Micropterus treculi*	Streams of eastern Edwards Plateau	C2	NL	resident
Fountain Darter	*Etheostoma fonticola*	San Marcos River to confluence with Blanco River; associated with San Marcos Salamander in quite, clear water	E	E	resident
San Marcos Gambusia	*Gambusia georgei*	San Marcos River to confluence with Blanco River, large clear spring-fed river	E	E	resident, possibly extinct
Canyon Mock - Orange	*Philadelphus ernestii*	Edwards Plateau	C2	NL	resident
Hill Country Wild-Mercury	*Argythamnia aphoroides*	Shallow to moderately deep clays and clay loams over limestone in grasslands associated with plateau live oak, on rolling uplands	C2	NL	resident [1]

Table 7 - Kendall

Common Name	Scientific Name	Habitat Preference	Listing USFWS	Agency TPWD	Potential Occurrence in County
Bald Eagle	*Haliaeetus leucocephalus*	Large bodies of water with nearby roosting/resting sites	E	E	wintering / transient
Golden Eagle	*Aquila chrysaetos*	wild expanses of open country, whether of mountains, plains or canyons	NL	T	potential
Fulvous Whistling Duck	*Dendrocygna bicolor*	grassy freshwater marshes and ponds	NL	T	migrant
Peregrine Falcon, American	*Falco peregrinus anatum*	Open coastal areas	E	E	migratory
Peregrine Falcon, Arctic	*Falco peregrinus tundrius*	Open coastal areas	T	T	migratory
Swallow-tailed Kite, American	*Elanoides forficatus*	Varied, open land with tall trees for nesting	3C	T	potential
Zone-tailed Hawk	*Buteo albonotatus*	semi-aird canyon edges of Southwest U.S.	NL	T	'potential
Black-capped Vireo	*Vireo atricapillus*	Semi-open broad-leaved shrublands	E	E	nesting/migrant
Golden-cheeked Warbler	*Dendroica chrysoparia*	Woodlands with oaks and old juniper	E	E	nesting/migrant
Interior Least Tern	*Sterna antillarum athalassos*	Large river sandbars	E	E	migratory
White-faced Ibis	*Plegadis chihi*	Freshwater marshes	C2	T	resident
Whooping Crane	*Grus americana*	Coastal wetlands; Matagorda and Aransas Islands	E	E	migrating transient
Wood Stork	*Mycteria americana*	Coastal wetlands	E**	T	dispersal
Texas Horned Lizard	*Phrynosoma cornutum*	Varied, sparsely vegetated uplands	C2	T	resident
Cagle's Map Turtle	*Graptemys caglei*	Waters of the Guadalupe River Basin	3C	NL	resident
Baird's Rat Snake	*Elaphe bairdii*	rocky, wooded canyons and forested uplands	NL	T	endemic
Mexican Milk snake	*Lampropeltis triangulum annulata*	variety, from sand dunes to cultivated fields	NL	T	endemic
Texas Garter Snake	*Thamnophis sirtalis annectans*	Varied, especially moist habitats	C2	NL	resident
Timber Rattlesnake	*Crotalus horridus*	Bottomland hardwoods	NL	T	' periphery of range
Blue Sucker	*Cycleptus elongatus*	Rivers crossing eastern Edwards Plateau to coast	C2	T	resident
Guadalupe Bass	*Micropterus treculi*	Streams of eastern Edwards Plateau	C2	NL	resident
Big Red Sage	*Salvia penstemonoides*	Moist rich ledges, rocky level creek floodplain	C2	S1S2	endemic
Canyon Mock - Orange	*Philadelphus ernestii*	Edwards Plateau	C2	NL	endemic
Edge Falls Anemone	*Anemone edwardsiana var. petraea*	Shallow to moderately deep clays and clay loams over limestone in grasslands associated with plateau live oak, on rolling uplands	C2	S1	endemic
Glass Mountains Coral-root	*Hexalectris nitida*	Along rocks in shaded canyons	C2	S2	endemic
Hill Country Wild Mercury	*Argythamnia aphoroides*	Edwards Plateau	C2	NL	historic