Section 3
Reservoir Sites Recommended for Protection

3.1 Designated Unique Reservoir Sites

Application of the matrix screening process considering approximately 150 potential reservoir sites resulted in the identification of 19 sites that appear most suitable for protection or acquisition by the State of Texas to ensure availability for future water supply development. Pursuant to actions of the Texas Legislature, three of these sites have been designated as being of unique value for the construction of a dam and reservoir. The three sites designated as unique are: Allens Creek on Allens Creek near the confluence with the Brazos River in Austin County; Columbia on Mud Creek, a tributary of the Angelina River, in Cherokee and Smith Counties; and Post on the North Fork of the Double Mountain Fork of the Brazos River in Garza County. As these three sites have already received some degree of protection from the State, detailed study has been focused upon development and compilation of technical information about the other 16 reservoir sites that emerged from the matrix screening process. Such information is summarized by reservoir site in Section 3.4 and general assumptions regarding water supply modeling and cost estimates are presented in Sections 3.2 and 3.3, respectively.

3.2 Assumptions for Water Supply Modeling

The general hydrologic assumptions and procedures used in the technical evaluations of the 16 reservoir sites selected for detailed study are described below. Exceptions to these assumptions and procedures are explained in the documentation provided for each potential reservoir site in Section 3.4.

1. The latest applicable Water Availability Model (WAM) from the Texas Commission on Environmental Quality (TCEQ) is used to simulate operation of each reservoir with no return flows not specifically referenced in a surface water right. This is corresponds to TCEQ WAM Run 3 assumptions. Any necessary modifications of TCEQ WAM basic data (e.g., naturalized flows, net evaporation) or uses of alternative modeling tools (e.g., Corpus Christi Water Supply Model) are described in Section 3.4.

2. Unless already permitted, each potential reservoir is modeled at the most junior priority date in the applicable TCEQ WAM, and other unpermitted reservoirs are excluded. An abbreviated series of sensitivity analyses to assess the effects of the relative priority of various Sulphur River Basin reservoirs upon the firm yields of one another is included as Appendix A.
3. Firm yields are calculated for a minimum of four reservoir conservation storage capacities, including that from the most recent previous analysis, to generally assess optimum development of the site. If a reservoir is already permitted or an application has been filed, only the conservation capacity in the permit or application is considered.
4. Environmental flow requirements are modeled using Consensus Criteria for Environmental Flow Needs (CCEFN), except for those reservoirs already permitted or that have applications pending at the TCEQ. For those reservoirs with a permit or pending application, the environmental flow criteria stated in the permit or application have been used in the yield analyses. For the recommended conservation storage capacity only, firm yield also has been evaluated without environmental flow passage requirements in order to assess the potential yield commitment to environmental flow needs.
5. For off-channel reservoirs dependent upon pumped storage from a nearby stream or existing reservoir, the maximum pumping rate recommended in the most recent previous study is used for all simulations.

3.3 Assumptions for Cost Estimates

The general assumptions and procedures used to develop cost estimates for the 16 reservoir sites selected for detailed study are described below. Exceptions to these assumptions and procedures are explained in the documentation provided for each potential reservoir site in Section 3.4.

1. General Cost Considerations – Costs are estimated for each reservoir at its recommended conservation capacity and reported in 2005 dollars.
2. Capital Costs — Dam and spillway costs are based on configuration and dimensions in the most recent study available. Costs for dams and spillways, relocations, and

resolution of facility conflicts are calculated using comparable unit costs to the extent reasonable. The Texas Natural Resources Information System (TNRIS) provided technical support with identification of potential relocations and facility conflicts including roadways, railroads, active oil and gas wells, product transmission pipelines, power transmission lines, and state lands.

3. Other Project Costs — Contingencies, engineering, and legal fees associated with reservoir development are estimated at 35 percent of capital costs. Land acquisition costs are calculated using the median land value for 2005 as published on the Texas A&M University Real Estate Center website for the Land Market Area in which the reservoir site is located. Environmental and archaeological studies, as well as mitigation and recovery costs, are estimated as 100 percent of the land acquisition cost. Interest during construction is computed using a 6 percent annual interest rate on total borrowed funds, less a 4 percent rate of return on investment of unspent funds.
4. Annual Costs — Debt service is calculated using a six percent annual interest rate over a 40 year amortization period. Annual operations and maintenance of dams and spillways is estimated to be 1.5 percent of the total construction cost for the dam and spillway. Pumping energy costs, where appropriate for off-channel reservoirs, is calculated using horsepower and a purchase cost of $0.06/kW-hr, which is consistent with Senate Bill 1 cost estimate requirements. Recent data indicates that current energy costs can be higher.
5. Unit Cost of Water — Unit cost of raw water at the reservoir is computed by dividing total annual cost (including debt service, operations and maintenance, and applicable pumping energy) by the firm yield of the potential reservoir. Thus, it represents unit cost at full reservoir development.

3.4 Proposed Reservoir Sites Recommended for Protection

Technical evaluations, comprised of project description, firm yield, cost estimate, and environmental considerations are included for each of the 16 reservoir sites selected for detailed study in this section. These technical evaluations are supplemented by special contributions from the Texas Natural Resource Information System (TNRIS), Texas Parks and Wildlife Department (TPWD), and Texas Water Development Board (TWDB).

TNRIS staff members researched and assembled extensive geodatabases in order to map and tabulate conflicts with existing facilities location within or near each reservoir site. Such conflicts are mapped in the following sub-sections and include: primary Interstate or U.S. highways, secondary state or Farm to Market roads, railroads, power transmission lines, product transmission pipelines, active oil and gas wells, recorded water wells, and state parks or forests.

The TPWD GIS Lab prepared a landcover / land use database and summary map for each of the 16 reservoirs selected for technical evaluation in this study. Using imagery representative of conditions during the 1999 to 2003 period, TPWD prepared landcover classifications and mapping considered sufficient for planning level evaluation of reservoir sites. Landcover classifications used include: open water, swamp, marsh, seasonally flooded shrubland, bottomland hardwood forest, upland deciduous forest, evergreen forest, broad-leaf evergreen forest, shrubland, grassland, agricultural land, and urban / developed land. Procedures and technical assumptions are summarized in Appendix C and a map of existing landcover is provided for each reservoir in the following sub-sections. Summary landcover information for all 16 reservoir sites recommended for protection and/or acquisition is included in Section 4.2.

TWDB staff members prepared a memorandum summarizing a Cultural Resource Assessment for this Reservoir Site Protection Study that is included as Appendix B. Though resolution of conflicts regarding cultural resources within reservoir sites can be quite significant with respect to time and costs associated with excavations and recovery, detailed information regarding specific locations of such resources is often unknown and, even when known, is necessarily protected. In order to provide some insight with respect to the potential occurrence of sensitive cultural resources within 19 reservoir sites having or recommended for unique status, TWDB staff has tabulated county-level frequency of occurrence for the 27 counties potentially affected and grouped results into four regions. Reservoir sites within the northeast region have the greatest likelihood of occurrence of sensitive cultural resources and include the following: Columbia, Fastrill, Lower Bois d'Arc Creek, Marvin Nichols IA, George Parkhouse I, George Parkhouse II, and Ralph Hall.

3.4.1 Bedias Reservoir

3.4.1.1 Description

Bedias Reservoir is a proposed reservoir on Bedias Creek, a tributary of the Trinity River in the Trinity River Basin, that is being considered jointly by the Trinity River Authority and the San Jacinto River Authority as a potential water supply project. As illustrated in Figure 3.4.1-1, the proposed reservoir is located in Madison, Grimes, and Walker counties about 3.5 miles west of the U.S. Hwy. 75 crossing of Bedias Creek. The addition of conveyance facilities will allow diversion of a portion of the created supply into the West Fork of the San Jacinto River for use by the San Jacinto River Authority. Bedias Reservoir would help to meet the demands of Montgomery County, which will exceed available groundwater and Lake Conroe supplies beginning in the year 2020. The projected needs within 50 miles of the proposed reservoir site by 2060 are 284,552 acft/yr. The nearest major demand center is the greater Houston area, which is located approximately 85 miles southeast of the project site.

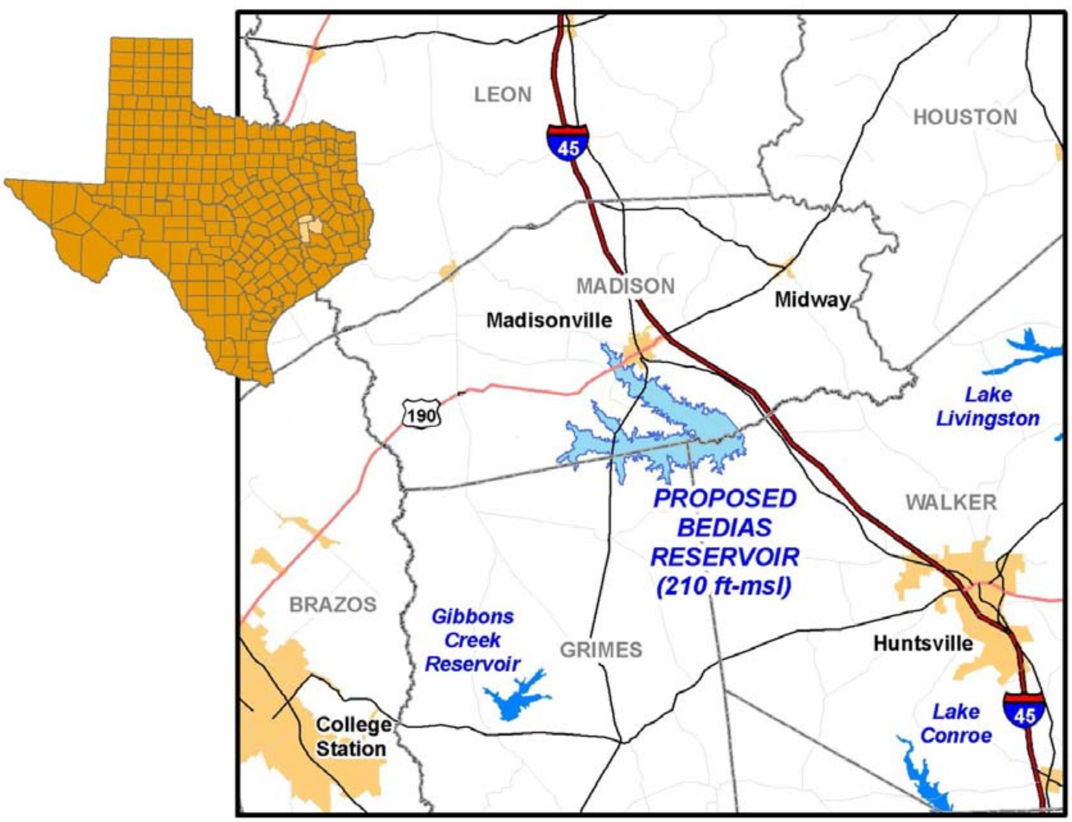

Figure 3.4.1-1. Location Map of Bedias Reservoir

Bedias Reservoir was previously studied by the Bureau of Reclamation (USBR) as part of a federal water supply plan investigating viable alternatives to meet municipal water needs for the year 2000 (Burns and McDonnell, 1989). Subsequently, the proposed reservoir and an associated water transfer project were recommended as a water management strategy in the 2001 Region H Water Plan as well as the 2002 Texas State Water Plan (TWDB, 2002). In the 2006 Region H Water Plan, the Bedias Reservoir and transfer project were replaced with a shared interbasin transfer project from the Trinity River Basin to Lake Houston. The Bedias project is currently included in the Trinity River Basin Master Plan (Trinity River Authority of Texas, 2003).

For the reservoir location evaluated in this study, the upstream drainage area of the project is approximately 395 square miles. At a normal pool elevation of 210 ft-msl, the reservoir would have a conservation capacity of 192,700 acft and would inundate 10,000 acres.

3.4.1.2 Reservoir Yield Analysis

Detailed information regarding the proposed location and conservation storage capacity of Bedias Reservoir was not available from the recent Region H planning study. It is not clear that this reservoir was actually modeled as part of the planning process, even though a recommended conservation pool level of 230 feet msl is stated in the Region H Plan. Therefore, for purposes of this reservoir siting investigation, information pertaining to the reservoir obtained from the previous Burns and McDonnell report (1989) has been used. Of the four potential reservoir sites that were investigated by the Burns and McDonnell study, the Bedias 10-mile site, with a conservation pool level of 210 feet msl and a maximum storage capacity of 192,700 acft, was recommended as the most feasible reservoir location. This site is approximately 10 miles upstream of FM 247 (3.5 miles west of U.S. Highway 75) and has been used as the basis for the current yield analysis.

The firm yield of Bedias Reservoir has been calculated using the Trinity River Basin water availability model (WAM) (dated July 16, 2004) using Run 3 assumptions, as obtained from the Texas Commission on Environmental Quality (TCEQ). The WAM simulations were performed using the Water Rights Analysis Package program (WRAP, executable dated 5/24/2004). A new control point was added on Bedias Creek at the reservoir site. The location is the same as the existing primary control point 8BEMA in the WAM. The naturalized flows and adjusted net evaporation for this primary control point were used in this study of the yield analysis of Bedias Reservoir.

The Bedias Reservoir elevation-area-capacity relationship is presented in Table 3.4.1-1 and shown in Figure 3.4.1-2. The elevation-area-capacity data in Table 3.4.1-1 were developed in the previous USBR's water supply plan investigating using U.S. Geological Survey topographic maps. Figure 3.4.1-3 shows the reservoir inundation at 10-foot contours.

Table 3.4.1-1.
Elevation-Area-Capacity Relationship for Bedias Reservoir

Elevation (ft-msl)	***Area (acres)***	***Capacity (acft)***
160.0	0	0
180.0	3,750	52,500
200.0	7,600	105,500
210.0	10,000	192,700
220.0	18,200	337,000
230.0	23,000	541,400
235.0	26,800	665,700
240.0	30,500	808,100

For purposes of this yield study, it is assumed that Bedias Reservoir will be subject to environmental flow passage requirements based Consensus Criteria for Environmental Flow Needs (CCEFN). These minimum environmental flow requirements are summarized in Table 3.4.1-2. The reservoir has to pass the lesser of the inflow and the values of Table 3.4.1-2 depending on storage in the reservoir, i.e., the median flow when the storage is greater than 80 percent of the conservation storage capacity, the 25-percentile flow when the storage is greater than 50 percent of the conservation storage capacity, and the 7Q2 flow when the when the storage is less than 50 percent of the conservation storage capacity.

Table 3.4.1-2.
Consensus Criteria for Environmental Flow Needs for Bedias Reservoir

		Jan	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*
Median	acft/mo	1,853	2,394	1,719	1,142	1,640	421	43	5	23	23	253	861
	cfs	30.1	42.7	27.9	19.2	26.7	7.1	0.7	0.1	0.4	0.4	4.3	14.0
25th	acft/mo	412	735	730	379	388	68	5	0	0	0	16	79
	cfs	6.7	13.1	11.9	6.4	6.3	1.1	0.1	0.0	0.0	0.0	0.3	1.3
7Q2	acft/mo	6	6	6	6	6	6	6	6	6	6	6	6
	cfs	0.1											
Note: The 7Q2 value is used when the 7Q2 value exceeds the value of the median and/or quartile.													

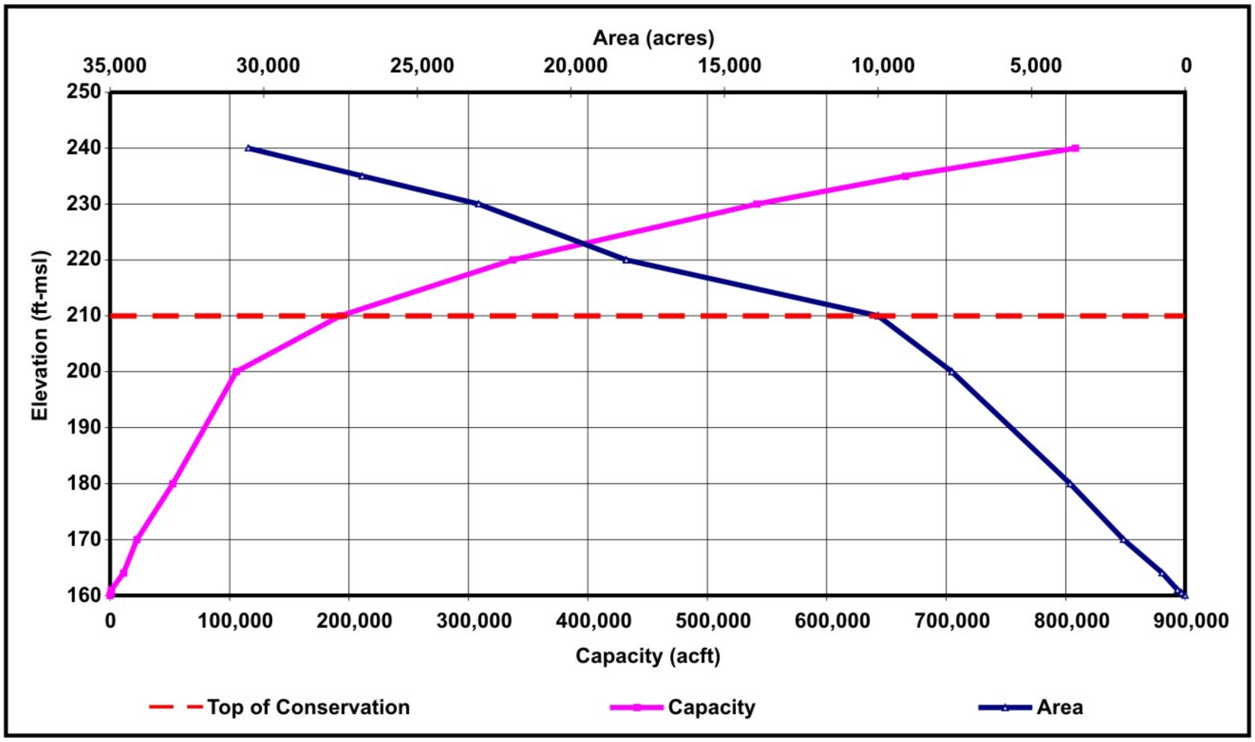

Figure 3.4.1-2. Elevation-Area-Capacity Relationship for Bedias Reservoir

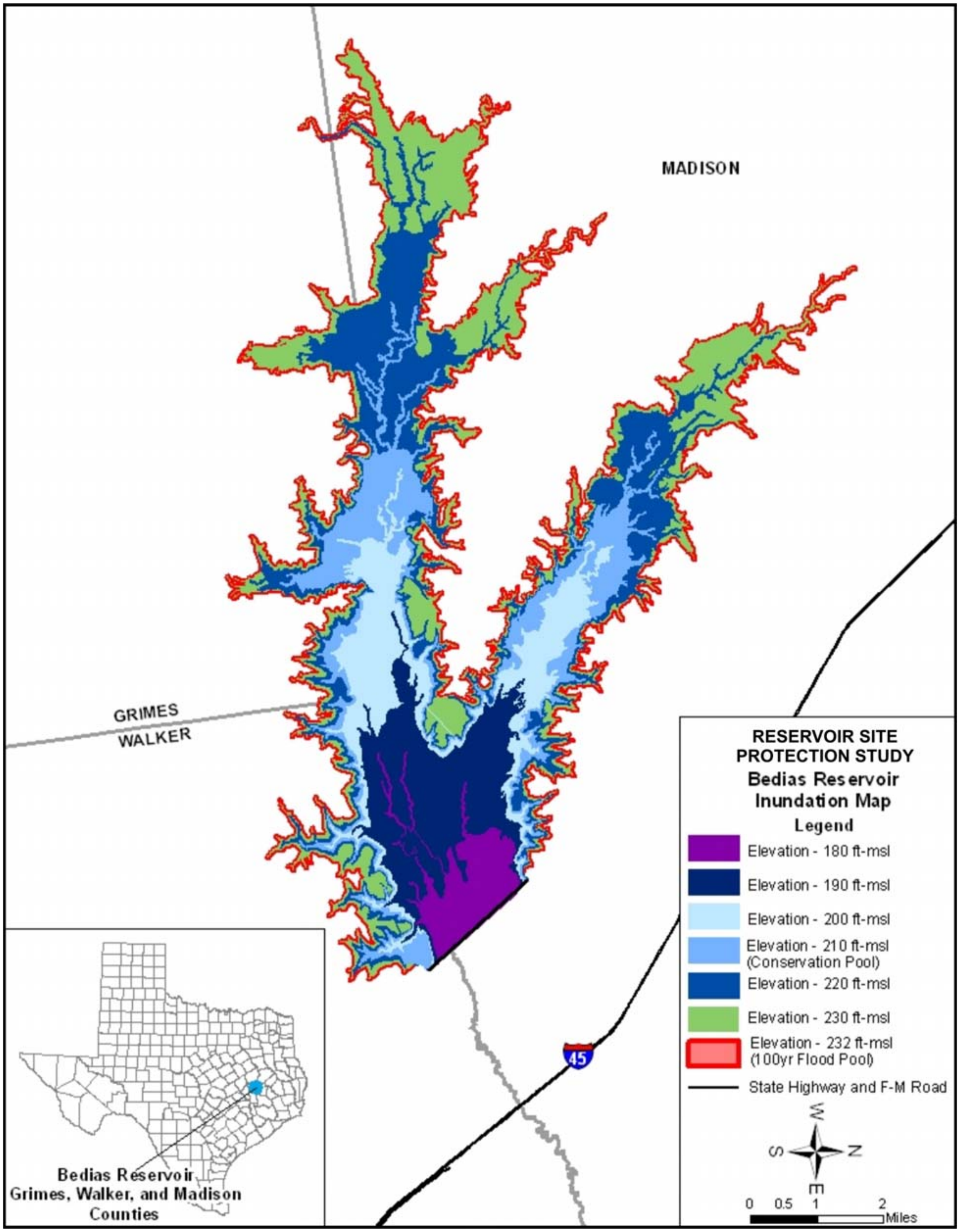

Figure 3.4.1-3. Inundation Map for Bedias Reservoir

As stated in Certificate of Adjudication No. 4248, Lake Livingston, even though senior in priority, will be subordinated to Bedias Reservoir when and if Bedias Reservoir is issued a water right by the TCEQ. The Lake Livingston subordination to Bedias Reservoir is recognized and modeled in this yield study.

WAM simulations were made to determine firm yield using conservation pool elevations of 200, 210, 220, 230, and 240 ft-msl, assuming stand alone reservoir operations and no minimum reserve content. Results of these simulations are summarized in Table 3.4.1-3 and Figure 3.4.1-4. At the conservation pool level of 210 ft-msl, or 192,700 acft of conservation storage capacity, the firm yield is 75,430 acft/yr. Application of CCEFN reduces the firm yield of the reservoir by 150 acft/yr. The firm annual yield determined in the Bedias Project Investigation (Burns and McDonnell, 1989) was 78,500 acft/yr for the same conservation pool level.

At the conservation pool elevation of 210 ft-msl, the reservoir would be full about 19 percent of the time and would be below 50 percent of the conservation storage capacity about 18 percent of the months simulated from January 1940 to December 1996. Figure 3.4.1-5 presents the storage trace for Bedias Reservoir as simulated with the WAM assuming a conservation storage capacity of 192,700 acft (elevation 210 ft-msl) and an annual firm yield diversion of 75,430 acft. The corresponding storage frequency curve for the reservoir is also shown in Figure 3.4.1-5.

Table 3.4.1-3.
Firm Yield vs. Conservation Storage for Bedias Reservoir

Pool Elevation (ft-msl)	Storage (acft)	Environmental Bypass Criteria	Firm Yield (acft/yr)	Critical Period
200.0	105,500	CCEFN	57,220	6/50-1/58
210.0*	192,700	CCEFN	75,430	6/50-1/58
		None	75,580	6/50-1/58
220.0	337,000	CCEFN	91,100	6/50-1/58
230.0	541,400	CCEFN	108,400	6/50-1/58
240.0	808,100	CCEFN	115,900	6/50-1/58
*Proposed conservation storage.				

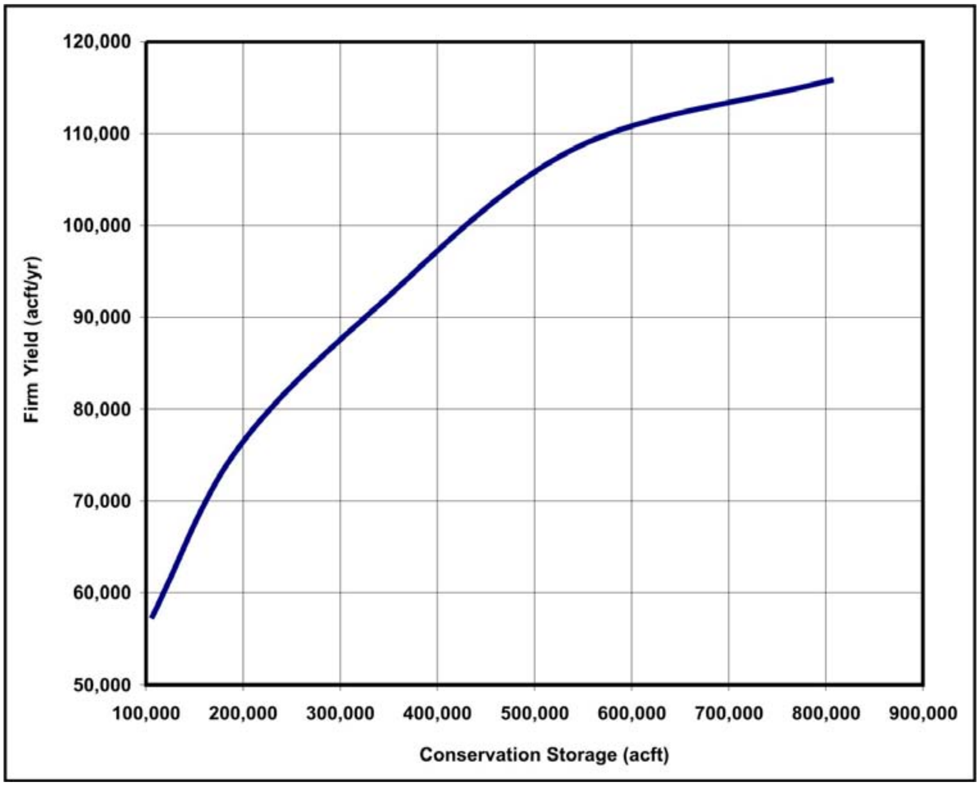

Figure 3.4.1-4. Firm Yield vs. Conservation Storage for Bedias Reservoir

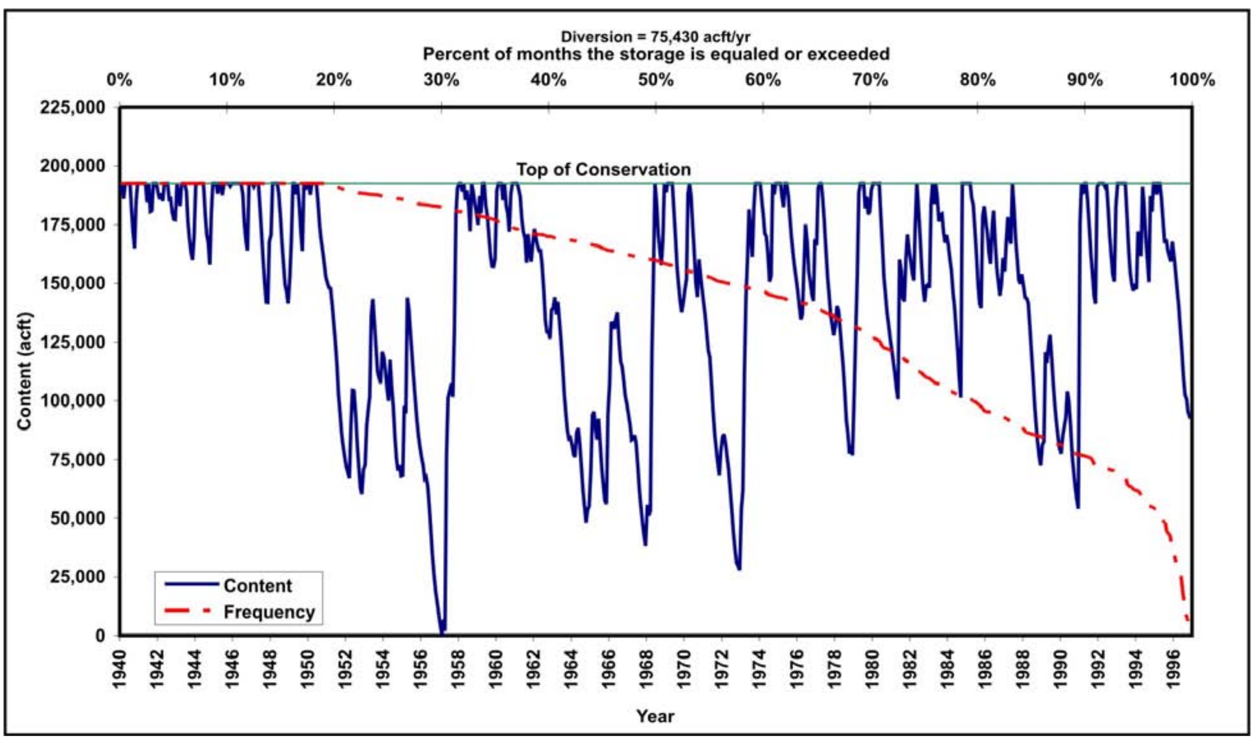

Figure 3.4.1-5. Simulated Storage in Bedias Reservoir
(Conservation Elevation = 210 ft-msl, Diversion = 75,430 acft/yr)

3.4.1.3 Reservoir Costs

The costs for Bedias Reservoir Dam assume a zoned earthen embankment with a maximum height of 70 feet. The spillway will consist of 8 tainter gates, each being 40 feet wide by 30 feet high. The length of the dam is estimated at 13,100 feet (Burns and McDonnell, 1989).

The conflicts identified at the site include pipelines, electrical distribution, phone lines, cemeteries, and a dike. A list of the potential conflicts is provided in Table 3.4.1-4. The conflict costs represent less than 4 percent of the total construction cost of the reservoir project. Figure 3.4.1-6 shows the conflicts as mapped by TNRIS.

Table 3.4.1-4.
List of Potential Conflicts for Bedias Reservoir

Description	*Unit*	*Quantity*
Pipelines	Mile	3.7
Electrical Distribution & Phone Lines	Mile	0.9
Cemeteries	Each	1.0
Dikes:		
Embankment	C.Y.	4,255
Soil Cement Facing	C.Y.	700

Table 3.4.1-5 summarizes the estimated capital costs for the Bedias Reservoir Project, including construction costs, engineering, permitting, and mitigation. Unit costs for the dam and reservoir are based on the cost assumptions used in this study. The total estimated cost of the project is $239.8 million (2005 prices). Assuming an annual yield of 75,430 acft/yr, raw water from the project will cost approximately $232 per acre-foot ($0.71 per 1,000 gallons) during the debt service period.

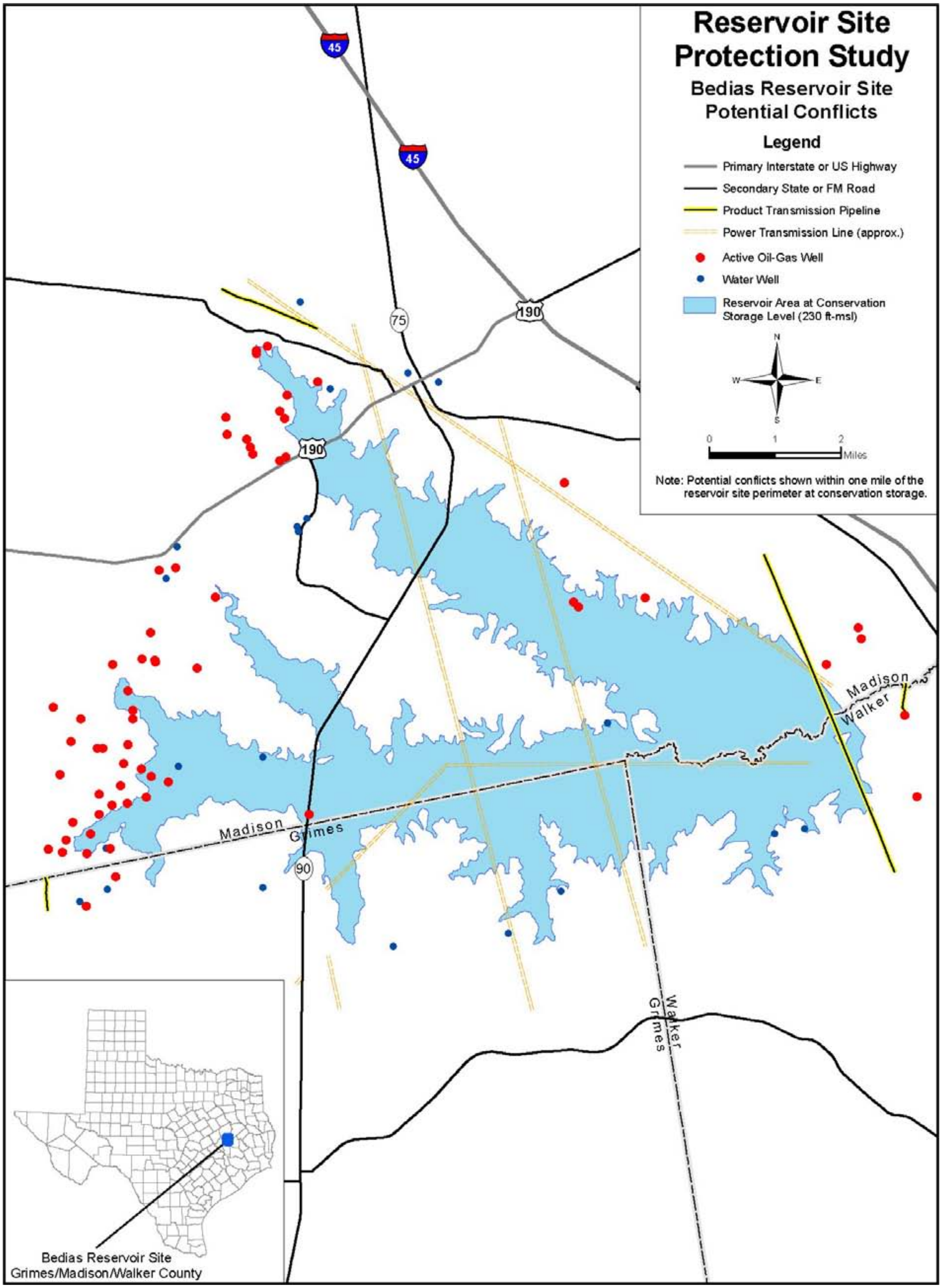

Figure 3.4.1-6. Potential Major Conflicts for Bedias Reservoir

Table 3.4.1-5.
Cost Estimate — Bedias Reservoir @ Elevation 210 ft-msl
(page 1 of 2)

	UNIT	*QUANTITY*	*UNIT COST*	*COST*
MOBILIZATION (5%)	LS	1		**$3,801,877**
EMBANKMENT:				
DIVERSION & CARE OF WATER	LS	1	$1,267,476.17	$1,267,476
CLEARING AND GRUBBING	AC	75	$2,000.00	$150,000
EXCAVATION, STRIPPING	CY	100,550	$2.00	$201,100
COMPACTED FILL	CY	2,513,761	$2.50	$6,284,403
DRAINAGE BLANKET	CY	226,238	$35.00	$7,918,330
RIP RAP	CY	93,009	$172.50	$16,044,053
BEDDING	CY	35,192	$35.00	$1,231,720
ROADWAY	LF	14,737	$150.00	$2,210,550
GRASSING	AC	25	$4,500.00	$112,500
FOUNDATION TREATMENT	CY	698,667	$2.50	$1,746,668
SUBTOTAL - EMBANKMENT CONSTRUCTION				**$37,166,799**
SPILLWAY:				
CLEARING & GRUBBING	AC	14	$4,000.00	$56,000
CARE OF WATER-CONSTRUCTION	LS	1	$844,984.11	$844,984
LINE DRILLING	SF	10,362	$12.84	$133,087
PERF. PIPE DRAINS	LF	1,398	$38.87	$54,339
REINFORCED CONCRETE	CY	51,810	$400.00	$20,724,000
MISCELLANEOUS STEEL	LB	167,712	$3.21	$538,356
TAINTER GATES & ANCHORAGE	LB	872,352	$2.20	$1,919,174
HOISTS & MACHINERY	LB	204,864	$7.94	$1,626,620
SLUICE GATES & OPERATORS	LS	1	$60,839.00	$60,839
BRIDGE	LF	377	$1,300.00	$490,100
CRANE	LS	1	$667,537.45	$667,537
ELECTRICAL FACILITIES	LS	1	$79,428.51	$79,429
STANDBY POWER UNIT	LS	1	$55,768.95	$55,769
POWER LINE TO SITE	LS	1	$40,559.24	$40,559
RIP RAP	CY	6,912	$172.50	$1,192,320
BEDDING	CY	2,368	$35.00	$82,880
SUBTOTAL - SPILLWAY CONSTRUCTION				**$28,565,994**
OUTLET WORKS:				
EXCAVATION & BACKFILL	CY	153,670	$2.50	$384,175
LINE DRILLING	SF	2,480	$12.84	$31,843
REINFORCED CONCRETE	CY	13,344	$400.00	$5,337,600
RIP RAP	CY	2,767	$172.50	$477,308
BEDDING	CY	922	$35.00	$32,270
ACCESS BRIDGE	LF	300	$1,300.00	$390,000
MISCELLANEOUS STEEL	LB	114,237	$3.21	$366,701
FLOOD GATES	LS	1	$1,233,676.80	$1,233,677
WATER OUTLET PIPE	LF	270	$456.29	$123,199
WATER SUPPLY GATES	LS	1	$163,926.92	$163,927
LOW FLOW RELEASE GATES	LS	1	$506,990.47	$506,990

Table 3.4.1-5.
Cost Estimate — Bedias Reservoir @ Elevation 210 ft-msl
(page 2 of 2)

		UNIT	*QUANTITY*	*UNIT COST*	*COST*
CONTROL HOUSE		LS	1	$483,330.91	$483,331
MISCELLANEOUS ITEMS		LS	1	$773,721.53	$773,722
SUBTOTAL - OUTLET WORKS CONSTRUCTION					**$10,304,742**
SUBTOTAL - DAM CONSTRUCTION					**$76,037,534**
UNLISTED ITEMS AT 10% OF CONSTRUCTION COSTS					$7,603,753
CLEARING RESERVOIR		AC	2,843	$1,000.00	$2,843,000
PERMANENT OPERATING FACILITIES		LS	1	$1,267,476.17	$1,267,476
SUBTOTAL - DAM & RESERVOIR CONSTRUCTION					**$91,553,640**
ENGINEERING & CONTINGENCIES (35% DAM & RESERVOIR)					**$32,043,774**
TOTAL - DAM & RESERVOIR CONSTRUCTION					**$123,597,414**
CONFLICTS (RELOCATIONS):					
PIPELINES		LF	19,536	$256.06	$5,002,306
ELEC. DISTR. & PHONE LINES		LF	4,752	$16.00	$76,032
CEMETERIES		EA	1	$506.99	$507
DIKES:	EMBANKMENT	CY	4,255	$2.50	$10,638
	SOIL CEMENT FACING	CY	700	$65.00	$45,500
					$5,134,982
ENGINEERING & CONTINGENCIES (35% CONFLICTS)					**$1,797,244**
LAND PURCHASE COSTS		AC	11,495	3,288.0	**$37,795,560**
ENVIRONMENTAL STUDIES & MITIGATION COSTS (100% LAND COSTS)					**$37,795,560**
CONSTRUCTION TOTAL					**$206,120,761**
INTEREST DURING CONSTRUCTION					**$33,686,832**
TOTAL COST					**$239,807,593**
ANNUAL COSTS					
DEBT SERVICE (6% FOR 40 YEARS)					**$15,937,981**
OPERATION & MAINTENANCE (1.5% OF DAM & SPILLWAY COSTS)					**$1,373,305**
TOTAL ANNUAL COSTS					**$17,311,286**
FIRM YIELD (ACRE-FEET PER ANNUM)					75,430
UNIT COST OF WATER (DURING AMORTIZATION)					
	PER ACRE-FOOT				$232
	PER 1,000 GALLONS				$0.71

Units: AC = Acre; CY = Cubic Yard; EA = Each; LB = Pound; LF = Linear Foot; LS = Lump Sum; SF = Square Foot; and SY = Square Yard.

3.4.1.4 Environmental Considerations

Bedias Reservoir is not located on an ecologically significant stream segment as identified by the Texas Parks and Wildlife Department (TPWD). It also has not been identified as an ecologically unique stream segment by the Region H Planning Group.

Real estate and recreational development will increase some property values and generate additional recreational income to the area; however, development of the lakeshore area also will bring congestion to a previously rural area, noise, and some unavoidable air pollution. On the other hand, residents in the area will likely welcome the additional camping, boating, and fishing activities that the reservoir would provide (Brown and Root and Turner Collie and Braden, Inc., 2001).

Bedias Reservoir will inundate 10,000 acres of land at conservation storage capacity. Table 3.4.1-6 and Figure 3.4.1-7 summarize existing landcover for the Bedias Reservoir site as determined by TPWD using methods described in Appendix C. Existing landcover within this reservoir site is dominated by upland deciduous forest (39 percent) and grassland (38 percent) with some bottomland hardwood forest (5 percent). Marsh, swamp, and open water total less than 2.3 percent of the reservoir area.

Table 3.4.1-6.
Acreage and Percent Landcover for Bedias Reservoir

Landcover Classification	*Acreage*[1]	*Percent*
Bottomland Hardwood Forest	443	5.2%
Marsh	190	2.2%
Seasonally Flooded Shrubland	14	0.2%
Evergreen Forest	96	1.1%
Broad Leaf Evergreen Forest	700	8.1%
Upland Deciduous Forest	3,387	39.4%
Grassland	3,287	38.2%
Shrubland	440	5.1%
Agricultural Land	45	0.5%
Open Water	4	0.0%
Total	8,606	100.0%

[1] Acreage based on approximate GIS coverage rather than calculated elevation-area-capacity relationship.

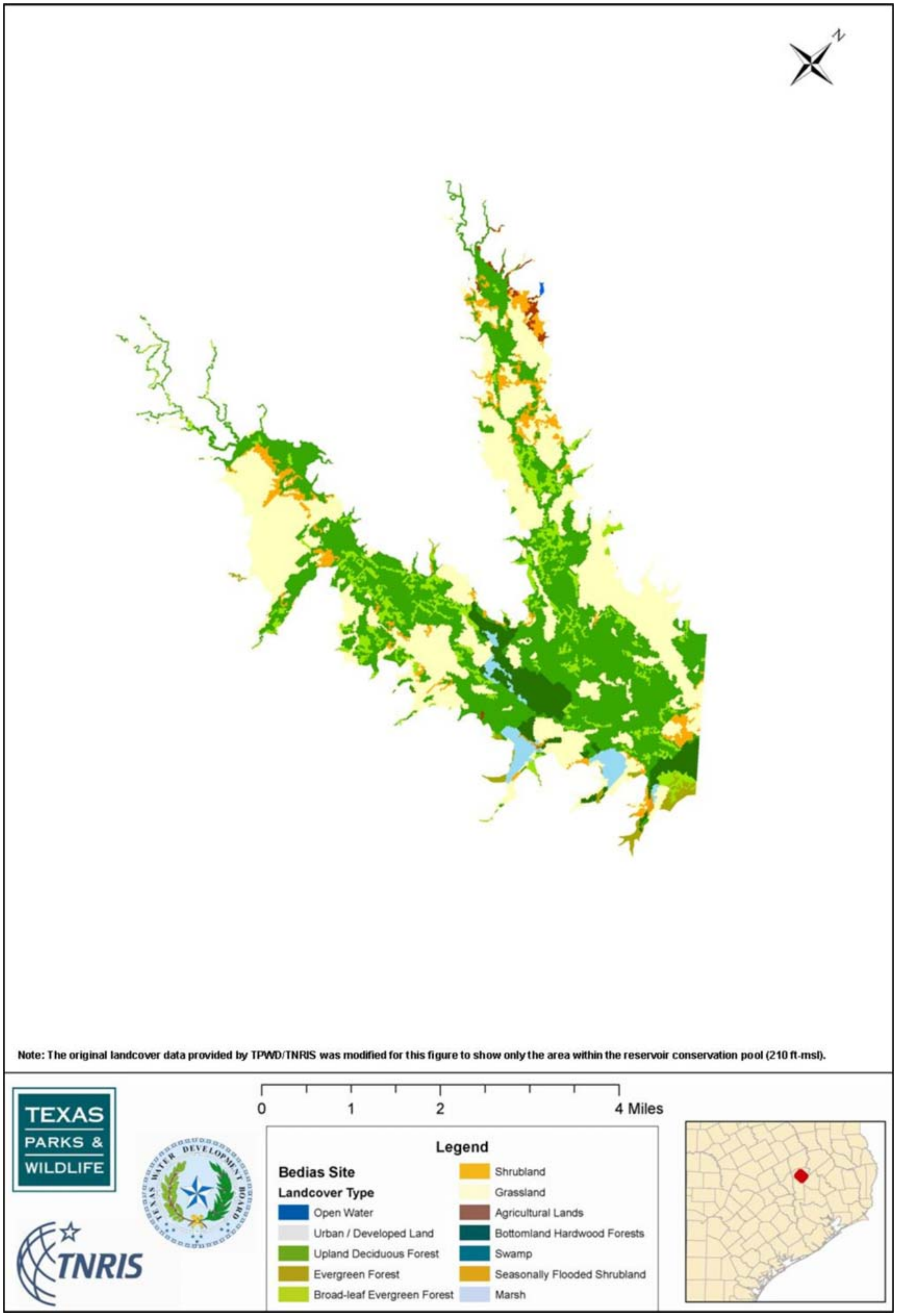

Figure 3.4.1-7. Existing Landcover for Bedias Reservoir

3.4.2 Brownsville Weir and Reservoir Project

3.4.2.1 Description

The Brownsville Public Utilities Board (PUB) is proposing to construct and operate the Brownsville Weir and Reservoir Project (BWR) on the Lower Rio Grande just below the City of Brownsville. The BWR (Water Rights Permit No. 5259) is designed to provide a maximum of 6,000 acft of storage capacity that will be used to capture and store excess flows of United States water in the Rio Grande that would otherwise flow to the Gulf of Mexico. The BWR, in conjunction with the PUB's existing excess flows diversion Permit No. 1838 (authorizes diversions of excess flows from the Rio Grande of 40,000 acft/yr), is to be operated as a system with PUB's existing Amistad-Falcon Reservoir storage rights to develop an additional municipal and industrial water supply for the PUB's customers located in south and southeastern Cameron County. The project is expected to provide an additional dependable supply of Rio Grande water on the order of 20,000 acft/yr. Approximately 71 percent of the time, it should be capable of supplying the full 40,000 acft/yr of municipal and industrial water authorized under Permit No. 1838.

This project has been recommended as a water management strategy in the 2001 and 2006 Region M Water Plans as well as the 2002 and 2007 Texas State Water Plans (Texas Water Development Board, 2002 and 2006). The projected water needs within 50 miles of the proposed reservoir site by 2060 are 223,489 acft/yr. The nearest major demand center is the Lower Rio Grande Valley, which extends north of the reservoir for approximately 60 miles.

The proposed BWR Project consists of a weir structure, which is to be constructed across the channel of the Rio Grande approximately 8 miles downstream of the International Gateway Bridge at Brownsville, and an associated riverine impoundment that will extend along the length of the river channel upstream for a maximum distance of approximately 42 miles when the reservoir is full. The weir structure, which will be gated to allow flood flows and non-project water to pass without being impounded, will be located at River Mile 47.8 (river miles above the mouth of the Rio Grande).

At full stage, the water surface of the proposed Brownsville Reservoir will be at 26 feet above mean sea level (msl). The elevation of the flowline of the river channel at the location of the weir structure is about one foot below mean sea level; hence, the maximum depth of the impoundment at its most-downstream end will be about 27 feet. From this point, the depth of the reservoir will gradually decrease in the upstream direction until it matches the normal depth of flow in the river.

At its normal maximum operating level, the Brownsville Reservoir will have a surface area of about 600 acres and store approximately 6,000 acft of water. Its top width will range from about 260 feet on the downstream end at the weir to less than a hundred feet where the upstream end of the pool meets the normal flow of the river. The average top width of the impoundment over its entire length will be about 110 feet. Under the normal maximum water level condition, the entire reservoir will be contained within the banks of the natural channel of the river. The general location of the BWR is shown on the map in Figure 3.4.2-1.

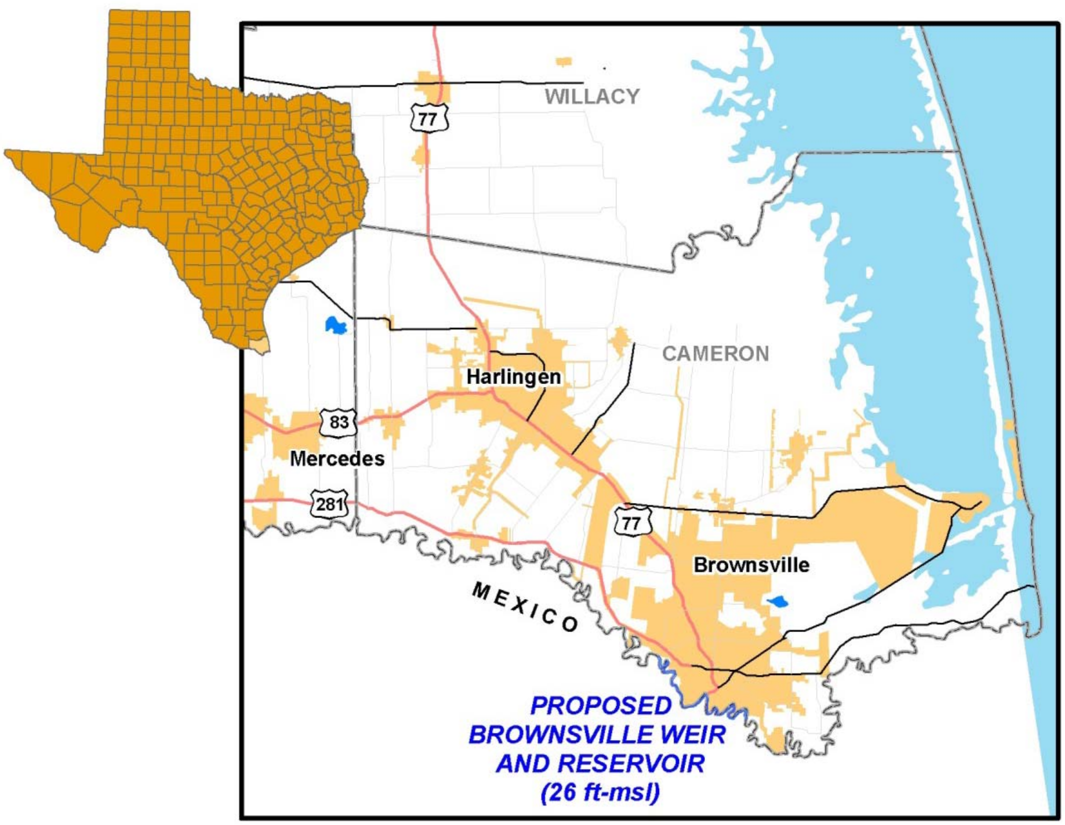

Figure 3.4.2-1. Location Map of Brownsville Weir and Reservoir

3.4.2.2 Reservoir Yield Analysis

The ability of the BWR to develop and provide an additional dependable supply of water from the Lower Rio Grande was investigated by the PUB as part of the water rights permitting process in the 1990s, and these earlier studies provide the basis for the project yield information reported herein. This earlier work involved a computer modeling analysis whereby the operation and performance of the BWR was simulated under actual historical hydrologic and climatic conditions. For this analysis, the historical quantities of United States water that flowed past the Brownsville streamflow gage, excluding water released from Falcon Reservoir for authorized downstream users and water required for existing instream uses and maintenance of bay and estuarine resources, were assumed to be available for capture and diversion by the BWR.

Simulations of storage variations for the Brownsville Reservoir were made on a daily basis in response to the historical river inflows and system releases from Falcon Reservoir and specified project and system water rights diversions, releases for historical downstream United States users and Mexican water pass-throughs, specified releases for instream uses and bay and estuarine purposes (minimum of 25 cfs in accordance with Permit No. 1838), evaporative losses, and certain system operating rules. The underlying objective of these simulations was to determine the maximum amount of water that could be dependably diverted from the reservoir annually to provide an additional supply of water for PUB's customers.

Historical conditions corresponding to the period 1960 through 1997 were used for the water supply evaluation of the BWR. This period encompasses a broad spectrum of river flow conditions that are reflected in the historical streamflows measured at the Brownsville gage, including major floods in 1973, 1976 and 1991-1992 and critical low-flow conditions between 1984 and 1987 and during the middle to late 1990s. This period of record was selected primarily because Anzalduas Reservoir, which is located approximately 100 river miles upstream of the BWR site and provides regulation of normal flows in the Lower Rio Grande, was completed in 1960 and, since that time, has had a direct influence on normal (non-flood) river flows at the Brownsville gage.

For purposes of simulating the operation and performance of the Brownsville Reservoir, in conjunction with PUB's existing Amistad-Falcon water rights, the computer program referred to as SIMYLD-IID was employed. This program, which is an extension of the SIMYLD-II program originally developed by the Texas Water Development Board, provides for the simulation of the movement and storage of water through a system of river reaches, canals, reservoirs and non-storage river junctions on a daily basis. The program was modified extensively to account for travel time effects along the Lower Rio Grande from Falcon Dam to Brownsville and to properly represent the specific operational elements of the BWR. Table 3.4.2-1 lists the elevation-area-capacity data for the BWR, and Figure 3.4.2-2 presents these data graphically. These data were originally developed by the PUB as part of the permitting studies. Since the proposed Brownsville Reservoir is entirely contained within the banks of the Rio Grande, an inundation map of the reservoir showing surface area as a function of elevation would not be meaningful and has not been prepared.

Table 3.4.2-1.
Elevation-Area-Capacity Relationship for Brownsville Weir and Reservoir

Elevation (feet)	***Area (acres)***	***Capacity (acft)***
-1.0	0	0
10.0	84	460
15.0	185	1,390
20.0	308	2,830
25.0	470	5,220
26.0	600	6,000

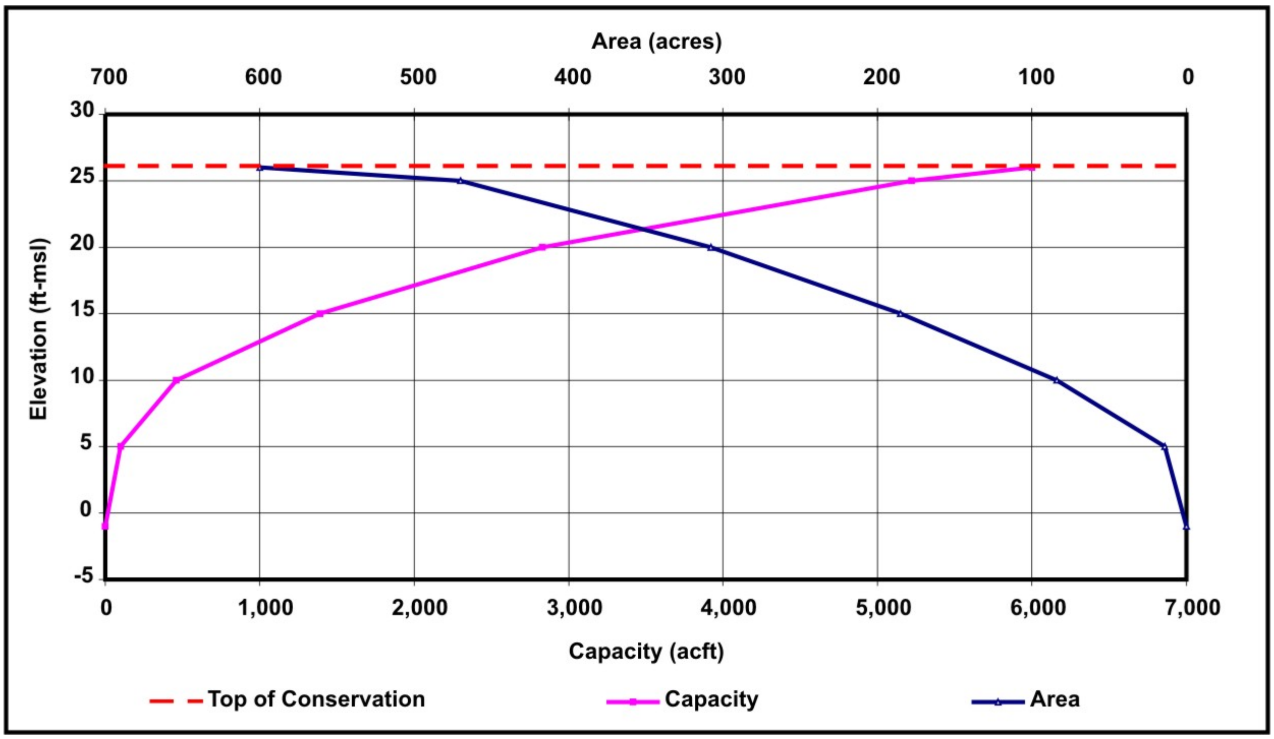

Figure 3.4.2-2. Elevation-Area-Capacity Relationship for Brownsville Weir and Reservoir

Results from the modeling of the BWR indicated that in most of the years of the 1960-1997 simulation period (71 percent), the total diversion of 40,000 acft/yr (as authorized under Permit No. 1838) could be fully achieved. In the most critical year of the simulation (1996), the total amount that could be diverted was 20,643 acft. This amount represents the additional dependable supply of Rio Grande water available to the PUB under Permit No. 1838 with the BWR Project in operation, and this is the amount considered to be the firm annual yield of the BWR. Figure 3.4.2-3 presents a simulated storage trace for the Brownsville Reservoir based on the minimum monthly storage amounts simulated with the SIMYLD-IID daily model. A frequency curve for storage content is also shown in Figure 3.4.2-3. Since the BWR is already permitted with a maximum storage capacity of 6,000 acft, no analyses of yield versus storage capacity have been performed.

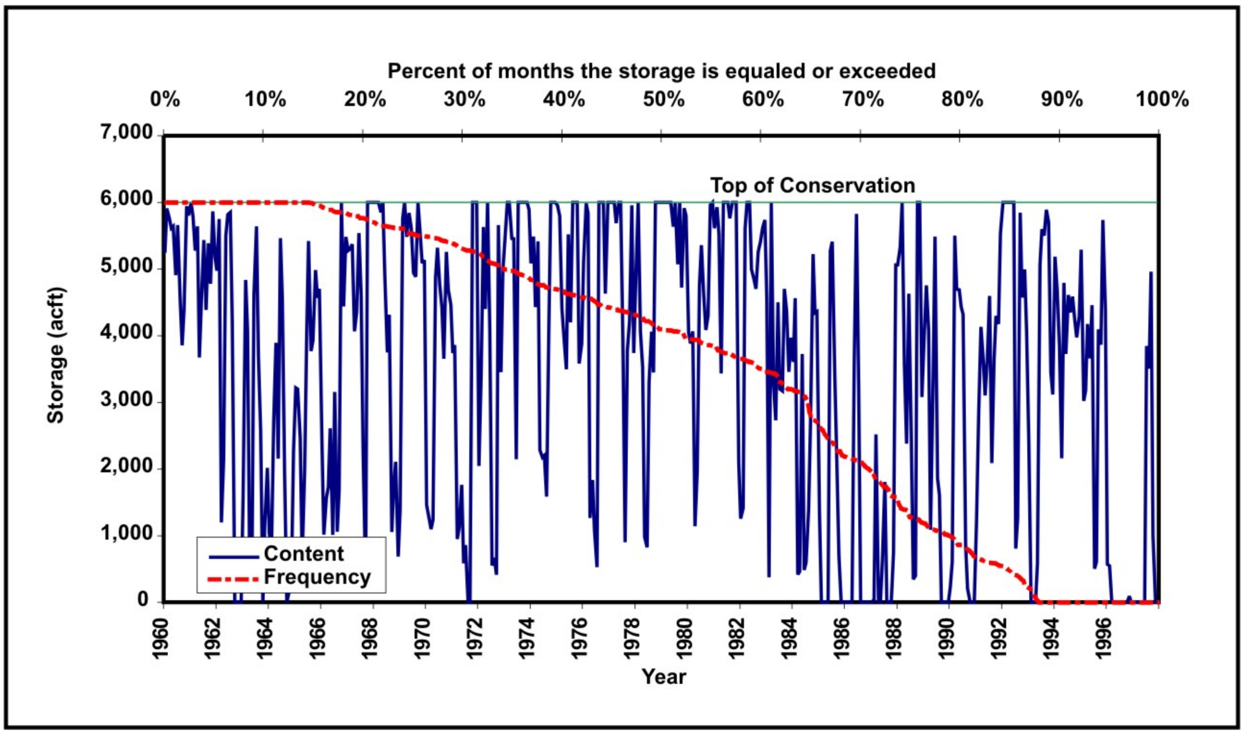

Figure 3.4.2-3. Simulated Storage in Brownsville Weir and Reservoir (Conservation Elevation = 26 ft-msl, Diversion = 20,643 acft/yr)

3.4.2.3 Reservoir Costs

The proposed Brownsville Weir structure will consist of a concrete sill constructed on steel sheet piling across the bottom of the channel of the river. The crest elevation of the sill is to be one foot above mean sea level. Concrete abutments will be constructed on each end of the sill, one on the United States side of the river and one on the Mexico side. Six radial gates 30 feet wide and 25 feet high, separated by concrete piers 6 feet wide, will be installed to close on the concrete sill. With the radial gates set on the bottom sill, water in the reservoir upstream will be impounded to a maximum elevation of 26.0 ft-msl. With the radial gates fully open, the design flood for the Rio Grande at Brownsville will be passed unobstructed at the current design flood level of the river. The length of the structure is approximately 400 feet, including the approach section. As proposed, the actual width of the gates and sill is approximately 210 feet.

A concrete stilling basin will be constructed downstream of the crest of the bottom sill, with its minimum bottom elevation set at -14.0 ft-msl. The overall facility also will include rock riprap downstream of the stilling basin, motorized gate hoists, a 12-foot wide service bridge across the weir, a control building, embankment erosion protection measures upstream and downstream of the weir, security fencing and other operational appurtenances. The top of the weir structure, at the deck of the service bridge, will be about 53 feet above the bottom of the existing river channel.

The foot-print of the weir and associated appurtenances will require approximately 11 acres of land. Access roads to the weir will require another 22 acres of land. During construction, a by-pass channel, requiring approximately 17 acres of land, will be constructed to divert river flows around the construction site. In addition, about 34 acres of land will be temporarily used for storage areas and other construction related activities.

The dam will be constructed within the active channel section of the Rio Grande and all stored water will be contained within the channel. Therefore, no conflicts are expected to be associated with this structure (Figure 3.4.2-4).

Table 3.4.2-2 shows the estimated capital costs for the Brownsville Weir, including costs for construction, engineering, permitting and mitigation. Unit costs for the dam and reservoir are based on the cost assumptions used in this study. The total estimated cost of the project is $45 million (2005 prices). Assuming an annual yield of 20,643 acft/yr, raw water from the project will cost approximately $181 per acre-foot ($0.55 per 1,000 gallons) during debt service period.

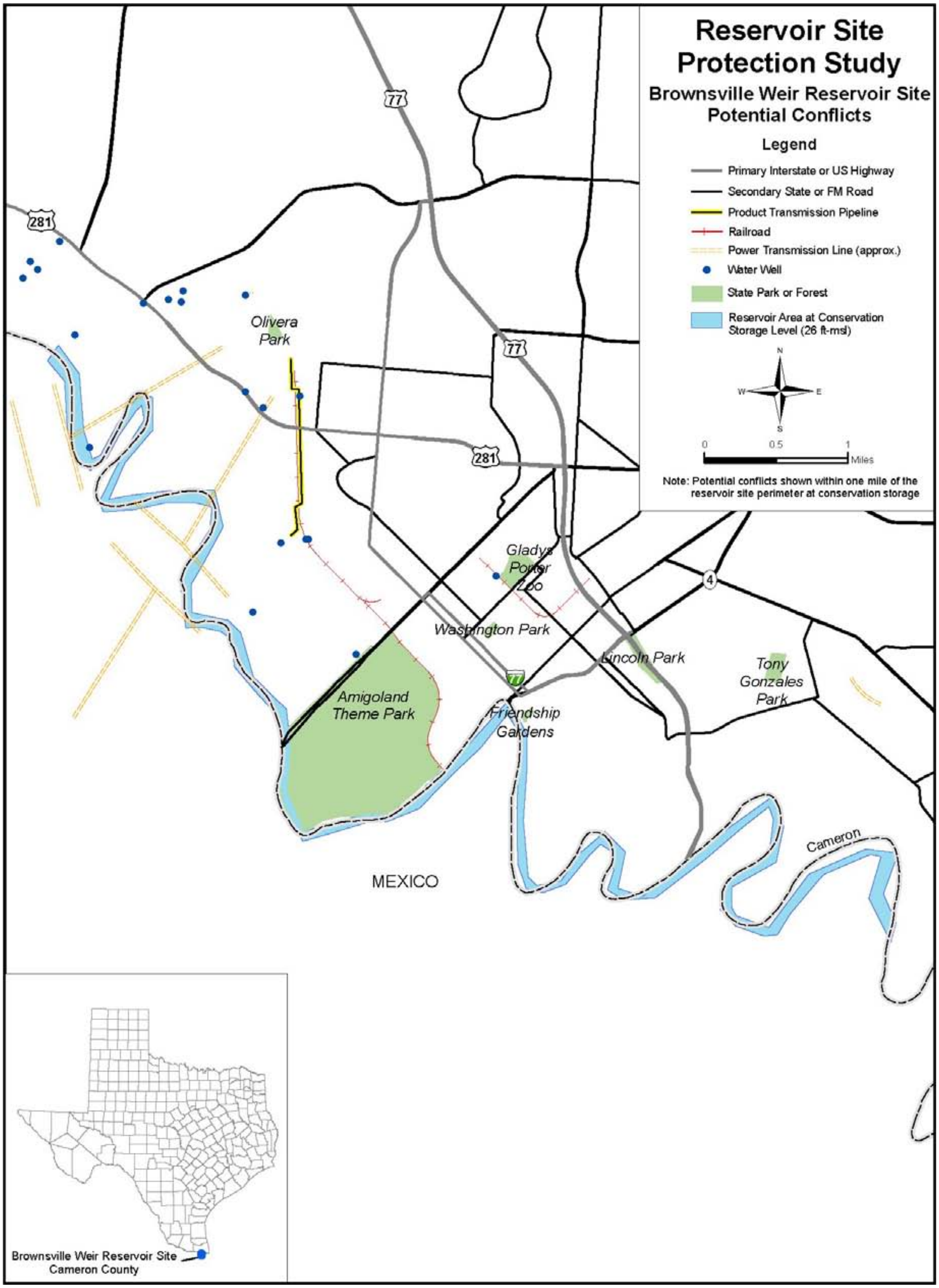

Figure 3.4.2-4. Potential Major Conflicts for Brownsville Weir and Reservoir

Table 3.4.2-2.
Cost Estimate — Brownsville Weir @ Elevation 26 ft-msl
(page 1 of 4)

	UNIT	QUANTITY	UNIT COST	COST
MOBILIZATION (5%)	LS	1	$1,469,358	**$1,469,358**
ACCESS ROAD				
CLEARING AND GRUBBING	AC	3.4	$2,000.00	$6,800
COMPACTED FILL	CY	20,000	$2.50	$50,000
FLEX BASE- 6 IN.	CY	1,514	$120.00	$181,680
PIPE 24"- RCP	LF	140	$42.53	$5,954
METAL GUARD RAIL	LF	4,800	$36.45	$174,971
CARE OF ROADS	SY	8,020	$3.04	$24,362
DIVERSION CHANNEL				
CLEARING & GRUBBING	AC	10	$2,000.00	$20,000
DEWATERING SYSTEM	LS	1	$60,753.92	$60,754
EXCAVATION	CY	324,385	$2.50	$810,963
RIP RAP BEDDING	CY	3,364	$35.00	$117,740
RIP RAP	CY	6,726	$172.50	$1,160,235
CONST. CROSSING	LS	1	$170,110.97	$170,111
MAINTENANCE	SY	50,622	$1.22	$61,510
RESTORATION	CY	356,823	$1.58	$563,638
SEEDING	AC	11	$729.05	$8,020
COFFER DAMS				
RANDOM FILL	CY	40,774	$2.50	$101,935
RIP RAP BEDDING	CY	700	$35.00	$24,500
RIP RAP	CY	1,867	$172.50	$322,058
SHEETPILING	SF	21,280	$30.38	$646,422
FLEX BASE	CY	526	$120.00	$63,120
MAINTENANCE	LS	1	$12,150.78	$12,151
REMOVAL	LS	40,774	$3.65	$148,631
CARE OF WATER	LS	1	$243,015.67	$243,016
SHEET PILE CUTOFF				
CELLS SHEETPILES	SF	52,053	$44.96	$2,340,193
PILES OTHER	SF	13,000	$42.53	$552,861
FOUNDATION PILES				
TEST PILES	EA	4	$3,645.23	$14,581
DESIGNED PILES	LF	22,380	$36.45	$815,804
GENERAL EXCAV.				
CLEARING AND GRUBBING	AC	6	$2,000.00	$12,000
UPSTREAM	CY	78,400	$2.50	$196,000
DOWNSTREAM	CY	74,100	$2.50	$185,250
OGEE & ABUTMENTS	CY	70,460	$2.50	$176,150
FOUNDATION PREP.	SY	65,500	$1.50	$98,250
IMPERVIOUS FILL	CY	32,000	$3.00	$96,000
RANDOM FILL	CY	108,200	$2.50	$270,500
STILLING BASIN				
DEWATERING SYSTEM	LS	1	$48,603.13	$48,603
SUB-DRAIN SYSTEM	LS	1	$36,452.35	$36,452
SHEET PILE CUTOFF	SF	6,000	$42.53	$255,166

Table 3.4.2-2.
Cost Estimate — Brownsville Weir @ Elevation 26 ft-msl
(page 2 of 4)

	UNIT	*QUANTITY*	*UNIT COST*	*COST*
REINFORCED CONCRETE				
COUNTERFORT WALLS	CY	7,360	$400.00	$2,944,000
OGEE CREST	CY	5,685	$400.00	$2,274,000
ABUTMENTS	CY	3,200	$400.00	$1,280,000
CUTOFF WALLS	CY	245	$400.00	$98,000
PIERS	CY	5,363	$400.00	$2,145,200
CONC. BASIN	CY	3,500	$400.00	$1,400,000
SPILLWAY BRIDGE	SF	3,840	$81.25	$312,000
(240'X16' PRESTRESSED)				
SPILLWAY RADIAL GATES				
RADIAL GATES 25'X35'	EA	6	$263,672.00	$1,582,032
GATA EMBEDS	EA	6	$70,474.54	$422,847
GATE HOISTS	EA	6	$208,993.47	$1,253,961
SUPPORTS				
WIRE ROPES				
ELEC. GENERATOR	EA	1	$21,871.41	$21,871
GEN. FUEL TANK	EA	1	$1,458.09	$1,458
ANCHORAGES	EA	12	$36,452.35	$437,428
OUTLET WORKS GATES				
3'X5' SLUICE GATES	EA	4	$97,206.27	$388,825
12X12 INCH SLUICE GATE	EA	2	$60,753.92	$121,508
18'X30' SLUICE GATE	EA	2	$85,055.48	$170,111
STOP GATES				
STOP GATES PLUS	LS	1	$243,015.67	$243,016
LIFTING BEAM				
LIFTING BEAM STORAGE PAD				
STOP GATE MONORAIL				
RAILS AND SUPPORTS	LS	1	$425,277.42	$425,277
ELECTRICAL SYSTEM				
TRAVELING HOIST				
BARRIER AND WARNING				
SYSTEM	LS	1	$64,399.15	$64,399
SITE WATER SERVICE				
BURIED WATER SERVICE	LF	10,500	$4.86	$51,033
SITE ELECTRICAL SYSTEM				
ELECT. EQUIPMENT SITE	LS	1	$291,618.80	$291,619
TRANSFORMER	LS	1	$24,301.57	$24,302
UNDERGROUND PRIM.LINE	LF	10,500	$9.72	$102,067
SITE COMPUTOR/TELEPHONE SERVICE				
UNDERGROUND LINE		10,500	$9.72	$102,067

Table 3.4.2-2.
Cost Estimate — Brownsville Weir @ Elevation 26 ft-msl
(page 3 of 4)

	UNIT	QUANTITY	UNIT COST	COST
CONTROL HOUSE				
CONCRETE BLDG.	SF	400	$48.60	$19,441
RESERVOIR GAGE	LS	1	$12,150.78	$12,151
MISC. INSTRUM.	LS	1	$12,150.78	$12,151
SEPTIC SYSTEM	LS	1	$5,467.85	$5,468
STEPS AND SIDEWALK	LS	1	$3,645.23	$3,645
FLAG POLE	LS	1	$1,215.08	$1,215
OPEN RISE PIEZOMETERS	EA	12	$2,673.17	$32,078
RIP RAP SLOPE PROTECTION				
UPSTREAM CHANNEL	CY	2,411	$172.50	$415,898
DOWNSTREAM CHAN.	CY	10,750	$172.50	$1,854,375
ABUTMENTS	CY	1,690	$172.50	$291,525
SURFACE MONUMENTS	EA	9	$6,075.39	$54,679
CHAIN LINK FENCE-6'	LF	2,500	$24.30	$60,754
BARBED WIRE FENCE	LF	5,000	$4.62	$23,086
CONCRETE PARKING AREA				
6 INCH CONC. PAVING	CY	550	$400.00	$220,000
LIGHTING	LS	1	$72,904.70	$72,905
GUARD RAIL	LF	1,520	$36.45	$55,408
4' CHAINLINK FENCE	LF	630	$18.23	$11,482
SEEDING AND LANDSCAPING	AC	11	$729.05	$8,020
SUBTOTAL WEIR CONSTRUCTION COSTS				**$29,387,680**
WEIR CONSTRUCTION COSTS				**$30,857,064**
ENGINEERING &CONTINGENCIES (35% WEIR CONSTRUCTION)				$10,799,972
TOTAL WEIR CONSTRUCTION				**$41,657,036**
CONFLICTS				
RESOLUTION OF CONFLICTS IN U.S. AND MEXICO	LS	1	$1,215,078.33	$1,215,078
IBWC STREAM GAGE AND ROAD RELOCATION	LS	1	$30,376.96	$30,377
SUBTOTAL CONFLICTS				**$1,245,455**
ENGINEERING &CONTINGENCIES (35% CONFLICTS)				$435,909
TOTAL CONFLICTS				**$1,681,365**
LAND PURCHASE COSTS	AC	86	$3,482	$299,452
ENVIRONMENTAL STUDIES & MITIGATIONS COSTS				$1,394,343
SUBTOTAL - OTHER PROJECT COSTS				**$3,375,159**
TOTAL CAPITAL COSTS				**$45,032,195**

Table 3.4.2-2.
Cost Estimate — Brownsville Weir @ Elevation 26 ft-msl
(page 4 of 4)

	UNIT	QUANTITY	UNIT COST	COST
INTEREST DURING CONSTRUCTION				**$4,127,045**
TOTAL CAPITAL COSTS				**$49,159,241**
ANNUAL COSTS				
DEBT SERVICE (6% FOR 40 YEARS)				**$3,267,199**
OPERATION & MAINTENANCE (1.5% WEIR CONSTRUCTION)				**$462,856**
TOTAL ANNUAL COSTS				**$3,730,055**
FIRM YIELD (ACRE-FEET PER ANNUM)				**20,643**
UNIT COST OF WATER (DURING AMORTIZATION)				
PER ACRE FOOT				**$181**
PER 1000 GALLONS				**$0.55**

Units: AC = Acre; CY = Cubic Yard; EA = Each; LB = Pound; LF = Linear Foot; LS = Lump Sum; SF = Square Foot; and SY = Square Yard.

3.4.2.4 Environmental Considerations

The BWR Project impacts two Texas Commission for Environmental Quality (TCEQ) Designated Water Quality Segments: Rio Grande Tidal — Segment 2301 and Falcon Reservoir — Segment 2302. The tidally influenced portion of the Rio Grande forms the boundary between the United States and Mexico from just downstream of the Brownsville Irrigation and Drainage District (BIDD) rock weir to the Gulf of Mexico, approximately 49 miles. Segment 2302 extends from its headwater at Falcon Dam in Starr County to the BIDD weir, approximately 226 miles. Both sections are identified as ecologically significant by the Texas Parks and Wildlife Department (TPWD) because they contain priority bottomland habitat and extensive freshwater and estuarine wetland habitats (Bauer et al. 1991).

Additionally, the Region M Regional Water Plan details possible water quality impacts such as increased salinity within and downstream of the reservoir as a result of changes in downstream flow and salinity patterns. A water right for BWR issued on September 29, 2000, contains special conditions in order to mitigate these possible impacts. Some of these conditions include a required minimum streamflow of 25-cfs whenever water is being impounded in the reservoir; monitoring of salinity in the Rio Grande downstream of the weir near the riverine/estuarine interface and only impounding water in the reservoir when measured salinity is less than the established near-fresh condition; and consulting with the appropriate agencies such as the TCEQ and TPWD to develop a mitigation plan for the entire BWR Project.

The BWR Project will inundate 600 acres of land at conservation storage capacity. Table 3.4.2-3 and Figure 3.4.2-5 summarize existing landcover for the BWR Project site as determined by TPWD using methods described in Appendix C. Existing landcover within this reservoir site is dominated by grassland (32 percent), agricultural land (22 percent), urban/developed land (18 percent), and open water (17 percent).

Table 3.4.2-3.
Acreage and Percent Landcover for Brownsville Weir and Reservoir

Landcover Classification	***Acreage[1]***	***Percent***
Upland Deciduous Forest	47	7.6%
Grassland	199	32.0%
Shrubland	17	2.8%
Agricultural Land	136	21.9%
Urban / Developed Land	115	18.4%
Open Water	108	17.3%
Total	622	100.0%

[1] Acreage based on approximate GIS coverage rather than calculated elevation-area-capacity relationship.

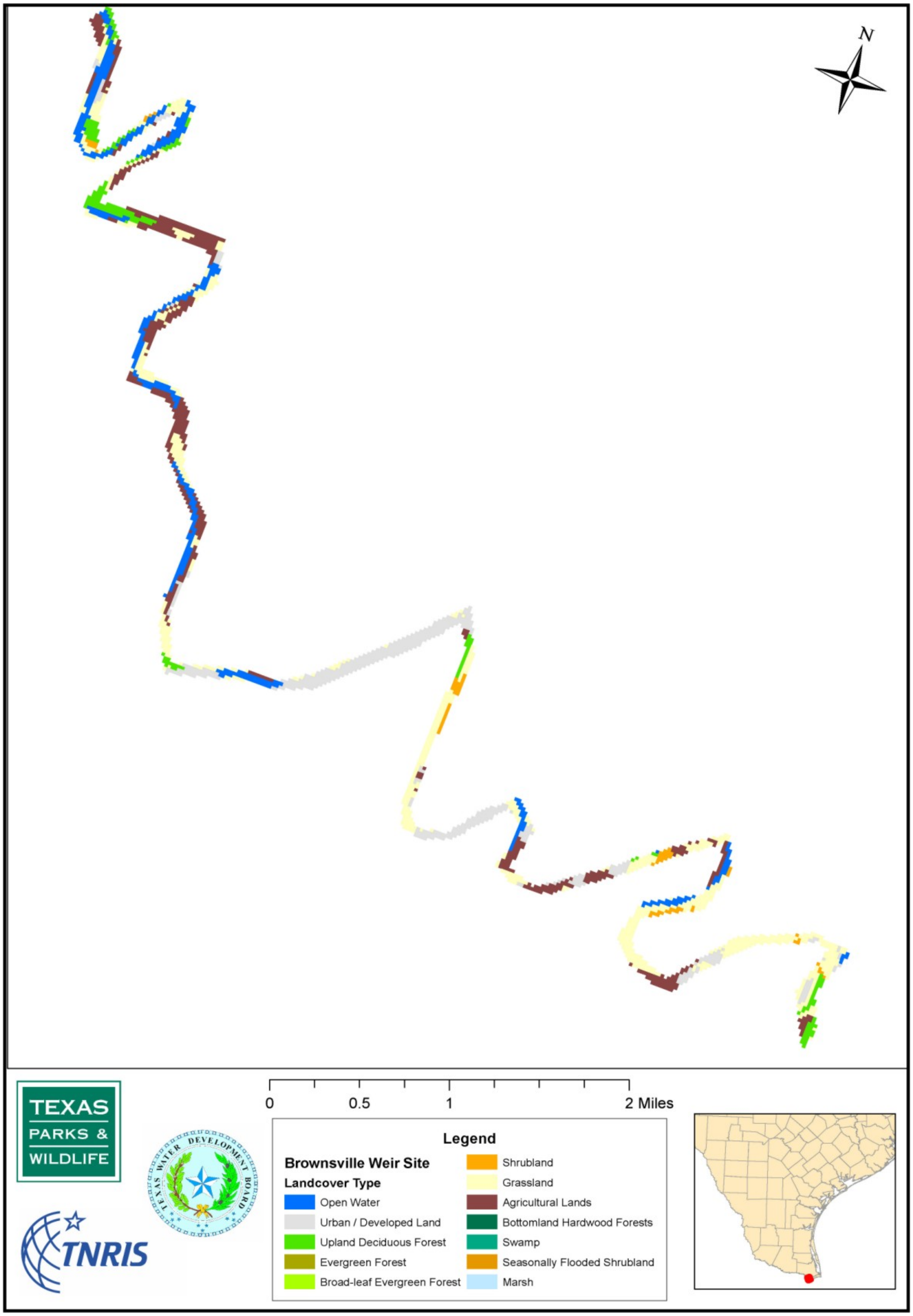

Figure 3.4.2-5. Existing Landcover for Brownsville Weir and Reservoir

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3.4.3 Brushy Creek Reservoir

3.4.3.1 Description

Brushy Creek Reservoir is a proposed reservoir which is part of the long-term plan developed by the City of Marlin and the Natural Resources Conservation Service (NRCS) for water supply and flood control purposes in the Big Creek watershed. Brushy Creek is a tributary of Big Creek, which is a tributary of the Brazos River. The Big Creek watershed, located in Central Texas in Falls, Limestone, and McLennan Counties, encompasses 369.6 square miles. The 1984 Big Creek Watershed Plan, described in a project report entitled "Watershed Plan and Environmental Impact Statement," includes three flood retarding structures located in the upper reaches of Brushy Creek and a larger multi-purpose dam located just above the confluence of Brushy Creek with Big Creek. This multi-purpose dam, when constructed, will form the Brushy Creek Reservoir (Figure 3.4.3-1) and impound runoff from a 44.3 square mile watershed. The projected needs within 50 miles of the proposed reservoir site by 2060 are 246,820 acft/yr. The nearest major demand center is the Austin area, which is located approximately 85 miles southwest of the reservoir site.

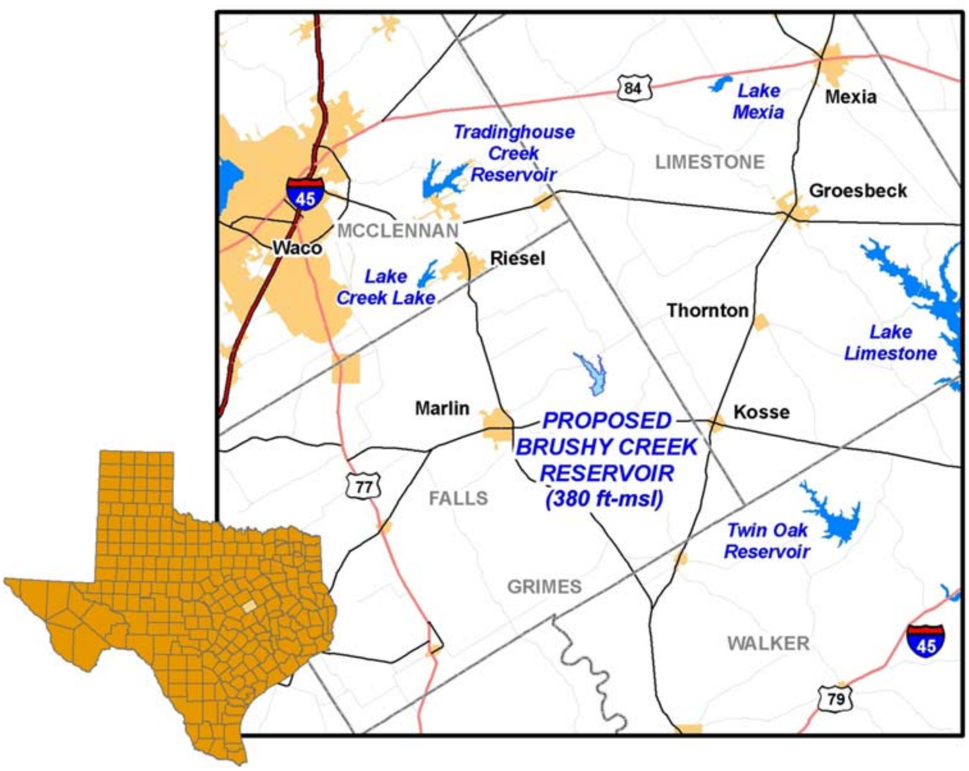

Figure 3.4.3-1. Location Map of Brushy Creek Reservoir

The purposes of the Brushy Creek Reservoir and the other structures included in the Big Creek Watershed Plan are to provide a dependable water supply for the City of Marlin, reduce channel erosion, reduce sedimentation, reduce downstream flooding, increase the availability of prime farmland soils, and increase the acreage of open water within the watershed. The Brushy Creek Reservoir itself is authorized as part of an existing water right (Certificate of Adjudication No. 12-4355) for water supply purposes for the City of Marlin as well as for flood control and recreation. Since the reservoir is authorized, it has been considered as an existing source of supply for the City of Marlin in the regional planning process. All of the land required for Brushy Creek Reservoir has been purchased by the City of Marlin.

3.4.3.2 Reservoir Yield Analysis

The firm yield of Brushy Creek Reservoir was calculated using the Brazos River Basin Water Availability Model (BWAM) with Run 3 assumptions as obtained from the Texas Commission on Environmental Quality (TCEQ). The monthly WAM simulations were performed using the Water Rights Analysis Package (WRAP). This existing BWAM model includes Brushy Creek Reservoir, and this representation of the reservoir has been reviewed and determined to be appropriate for this yield study.

The Brushy Creek Reservoir elevation-area-capacity relationship is presented in Table 3.4.3-1 and shown in Figure 3.4.3-2. The elevation-area-capacity data were developed by the Soil Conservation Service of the U.S. Department of Agriculture as part of the original watershed planning study. Figure 3.4.3-3 shows the area inundated by the reservoir at different water surface elevations.

For purposes of this yield study, Brushy Creek Reservoir is subject to an environmental flow restriction consistent with a special condition stipulated in the Certificate of Adjudication for the reservoir. This special condition requires a continuous release from the reservoir of at least 0.1 cfs.

WAM simulations were made to determine the firm yield of the reservoir for the authorized conservation pool elevation of 380.5 ft-msl, which corresponds to a maximum conservation storage capacity of 6,560 acft. The resulting firm yield is 1,380 acft/yr. Environmental flow requirements reduce the firm yield of the reservoir by approximately 55 acft.

Table 3.4.3-1.
Elevation-Area-Capacity Relationship for Brushy Creek Reservoir

Elevation (ft-msl)	*Area (acres)*	*Capacity (acft)*
352.0	0	0
356.0	1	1
360.0	33	68
364.0	115	363
368.0	234	1,059
372.0	341	2,208
376.0	497	3,884
380.0	668	6,214
380.5	697	6,560
384.0	896	9,296
388.0	1,065	13,119
392.0	1,310	17,868
394.0	1,431	20,608

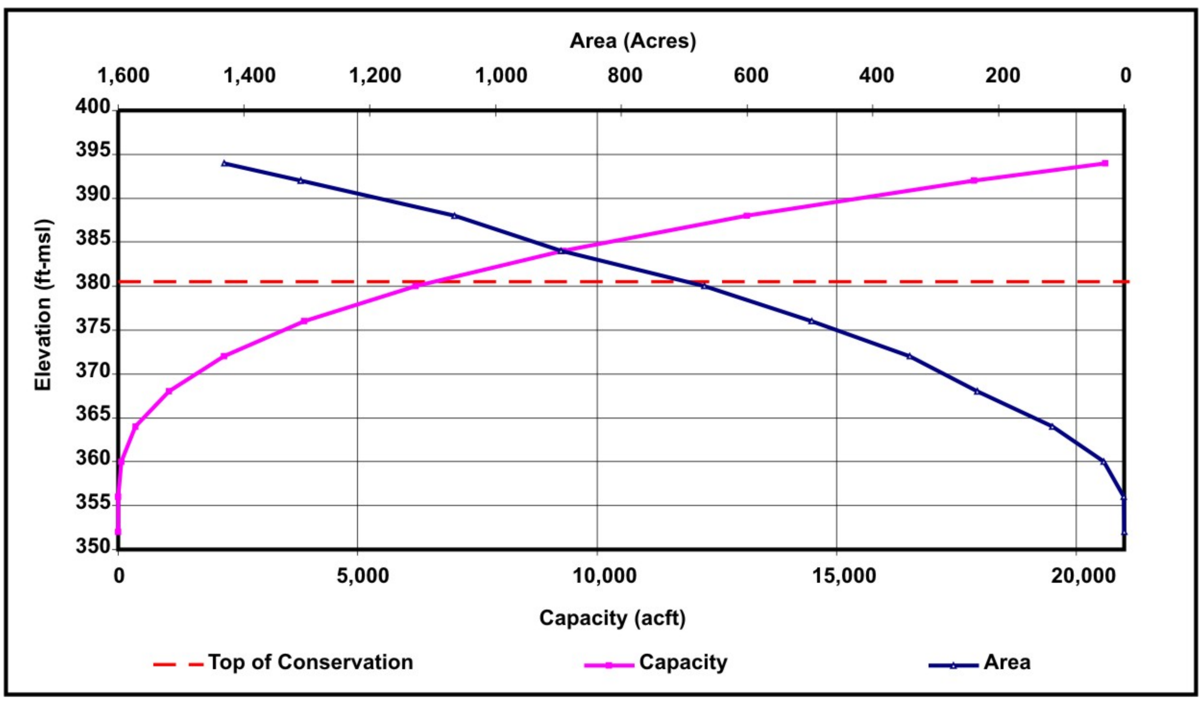

Figure 3.4.3-2. Elevation-Area-Capacity Relationship for Brushy Creek Reservoir

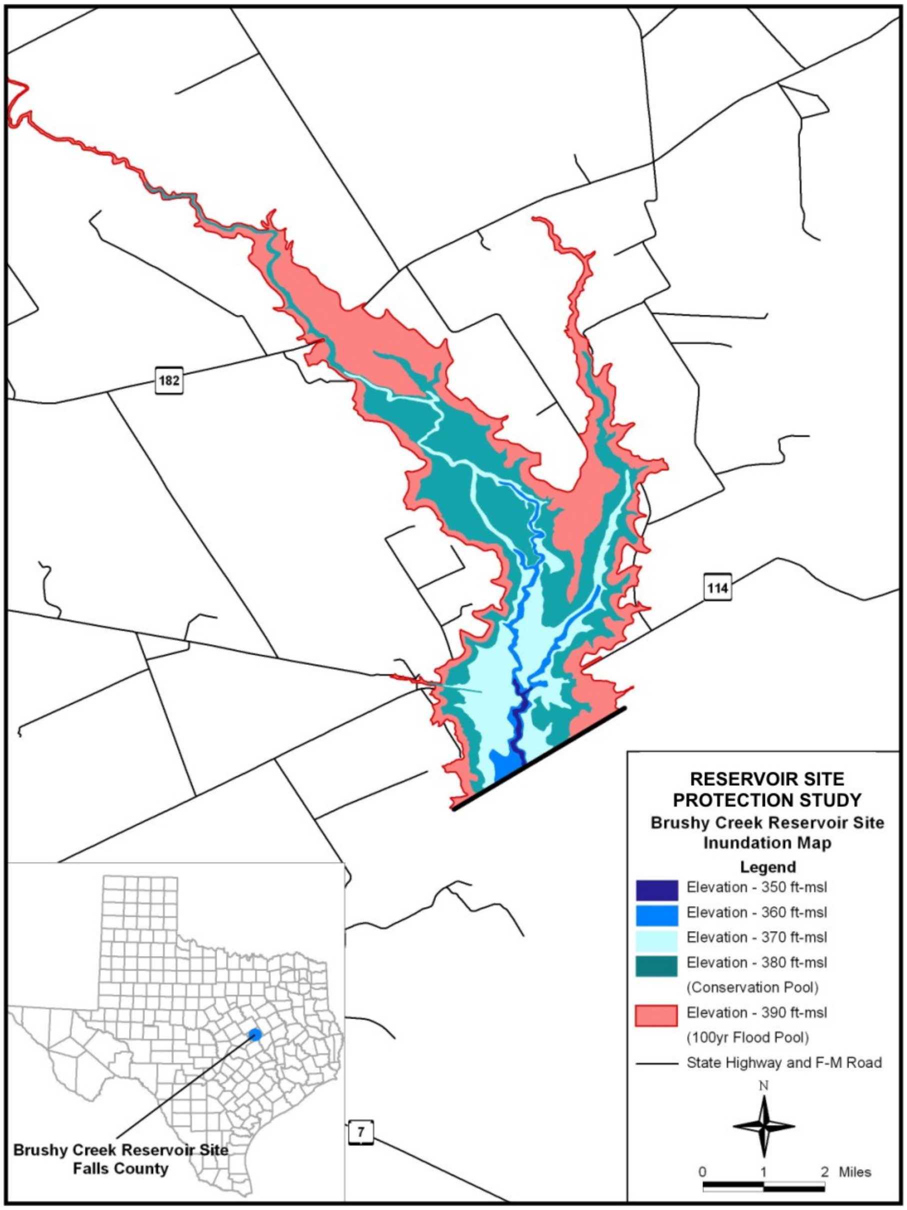

Figure 3.4.3-3. Inundation Map for Brushy Creek Reservoir

The monthly variation in storage in Brushy Creek Reservoir as simulated with the WAM over the 1940-1997 analysis period under firm yield conditions is shown in Figure 3.4.3-4. At the conservation pool elevation of 380.5 ft-msl (6,560 acft of storage capacity), the reservoir would be full about 25 percent of the time and would be below 50 percent of the conservation storage capacity about 12 percent of the time on a monthly basis. A frequency curve for storage content is also shown in Figure 3.4.3-4.

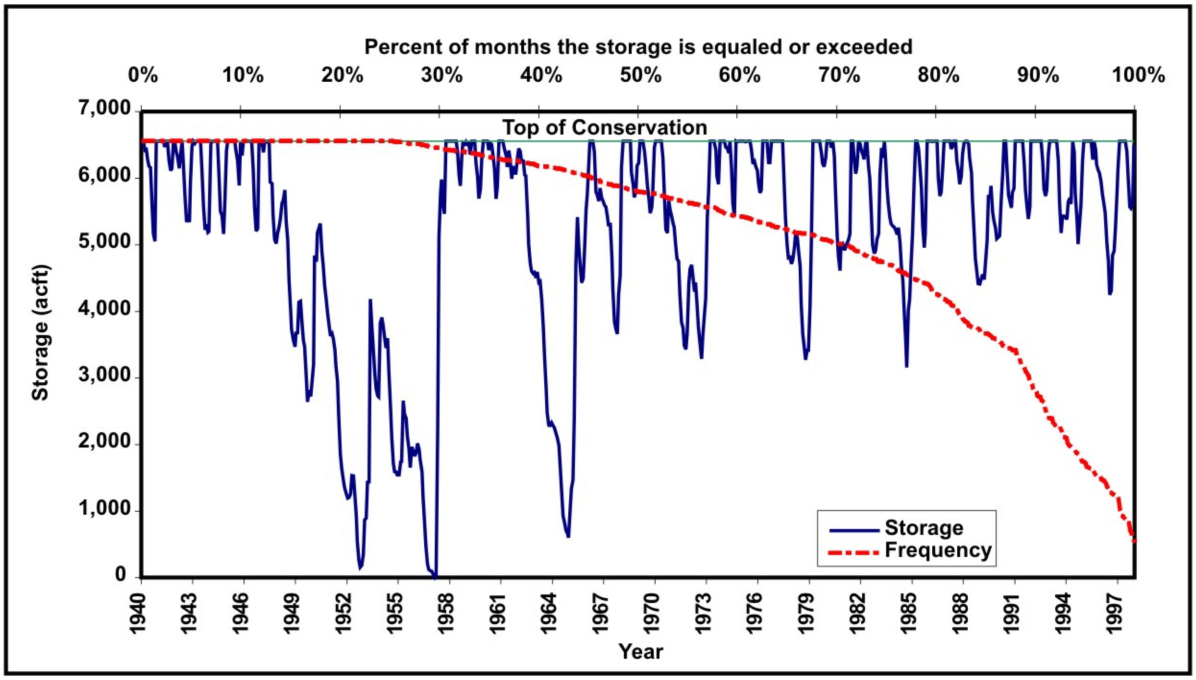

Figure 3.4.3-4. Simulated Storage in Brushy Creek Reservoir (Conservation Elevation = 380.5 ft-msl, Diversion = 1,380 acft/yr)

3.4.3.3 Reservoir Costs

The costs for the Brushy Creek Reservoir includes a rolled earth embankment with a length of approximately 7,740 feet and a height of 50 feet. A principal spillway, consisting of a reinforced concrete drop inlet structure connected to a 7-foot square box conduit through the dam, will control low flows and provide for the passage of environmental flows. The emergency spillway will be an earthen cut spillway with a bottom width of approximately 400 feet.

The conflicts identified at the site include water lines, electrical distribution and transmission lines, and county and FM roads. A list of the potential conflicts as identified by TNRIS is provided in Table 3.4.3-2, and they are shown in Figure 3.4.3-5. The conflict costs represent less than 17 percent of the total construction cost of the reservoir project.

Table 3.4.3-3 shows the estimated capital costs for the Brushy Creek Reservoir, including construction costs, engineering, permitting, and mitigation. Unit costs for the dam and reservoir are based on the cost assumptions used in this study. The total estimated cost of the project is $18.4 million (2005 prices). Assuming an annual yield of 1,380 acft/yr, raw water from the project will cost approximately $931 per acre-foot ($2.86 per 1,000 gallons) during the debt service period. Without the floodwater component of the project, the unit cost is approximately $484 per acre-foot ($1.48 per 1000 gallons).

Table 3.4.3-2.
List of Potential Conflicts for Brushy Creek Reservoir

Description	***Unit***	***Quantity***
Water Lines	Mile	2.5
Electrical Distribution & Transmission	Mile	3.0
County & FM Roads	Mile	1.2

3.4.3.4 Environmental Considerations

The Brushy Creek Reservoir site is not located on an ecologically significant stream as identified by the Texas Parks and Wildlife Department (TPWD). The main impacts of this project are significant only in the areas of construction of the dam and inundated areas. The reservoir will experience some sediment loading due to the nature of the soils within the drainage area. Several flood water retarding structures located in the upper part of the basin will act to reduce the loading. Temporary loading will occur immediately after construction of these upstream structures before all disturbed soils are re-vegetated. This effect is expected to greatly diminish as the vegetation matures and the sedimentation and erosion controls are maintained.

No endangered species have been identified in the basin area. Some archeological sites have been identified and ongoing work is scheduled through the sponsors of the project, which are the City of Marlin and the NRCS.

The dam is located on Brushy Creek immediately upstream of its confluence with Big Creek. Big Creek consists of a wide and flat braided stream that has many sloughs and wetlands. Hydraulic and hydrologic analyses of the dam indicate that the reduction of flows caused by storing water behind the dam would not have an adverse impact on the wetlands.

Brushy Creek Reservoir will inundate 697 acres of land at conservation storage capacity. Table 3.4.3-3 and Figure 3.4.3-6 summarize existing landcover for the Brushy Creek Reservoir site as determined by TPWD using methods described in Appendix C. Existing landcover within this reservoir site is dominated by upland deciduous forest (44 percent) and agricultural land (39 percent).

Table 3.4.3-3.
Acreage and Percent Landcover for Brushy Creek Reservoir

Landcover Classification	*Acreage*[1]	*Percent*
Upland Deciduous Forest	269	44.3%
Grassland	58	9.5%
Shrubland	45	7.3%
Agricultural Land	235	38.7%
Total	607	100.0%

[1] Acreage based on approximate GIS coverage rather than calculated elevation-area-capacity relationship.

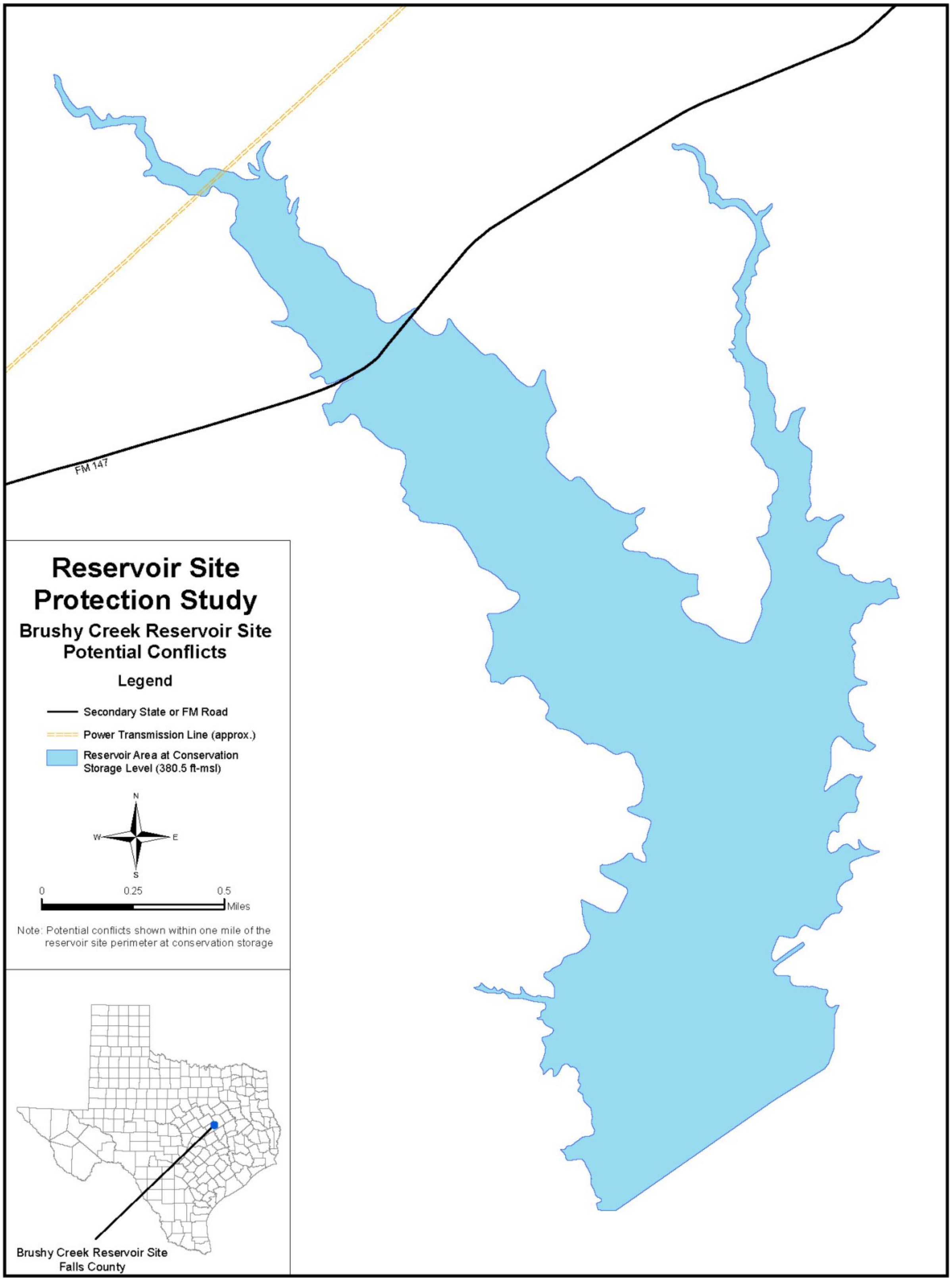

Figure 3.4.3-5. Potential Major Conflicts for Brushy Creek Reservoir

Table 3.4.3-4.
Cost Estimate — Brushy Creek Reservoir @ Elevation 380.5 ft-msl
(page 1 of 2)

	UNIT	QUANTITY	UNIT COST	COST
MOBILIZATION (5%)	LS	1		**$183,340**
FOUNDATION:				
CUTOFF EXCAVATION	CY	61,832	$2.50	$154,580
CHANNEL CLEANOUT EXCAVATION & FOUNDATION PREPARATION	CY	29,000	$2.50	$72,500
COMPACTED FILL - CUTOFF TRENCH	CY	61,832	$2.50	$154,580
SUBTOTAL - FOUNDATION CONSTRUCTION				**$381,660**
EMBANKMENT:				
CLEARING AND GRUBBING	AC	40	$2,000.00	$80,000
COMPACTED FILL	CY	579,789	$2.50	$1,449,473
RIP RAP & BEDDING	TON	12,500	$65.00	$812,500
TOPSOIL & GRASSING	AC	50	$4,500.00	$225,000
FENCING	LF	14,190	$4.00	$56,760
SUBTOTAL - EMBANKMENT CONSTRUCTION				**$2,623,733**
EMERGENCY SPILLWAY:				
EXCAVATION -EMERGENCY SPILLWAY	CY	110,000	$2.50	$275,000
SUBTOTAL - EMERGENCY SPILLWAY CONSTRUCTION				**$275,000**
PRINCIPAL SPILLWAY:				
REINFORCED CONCRETE				
7' X 7' BOX CULVERT CONDUIT	CY	290	$400.00	$116,000
ANTI-SEEP COLLARS	CY	39	$400.00	$15,600
RISER	CY	81	$400.00	$32,400
FOOTING	CY	31	$400.00	$12,400
ST. ANTHONY FALLS BASIN	CY	490	$400.00	$196,000
SLIDE GATE	EA	1	$6,000.00	$6,000
TRASH RACK	EA	1	$8,000.00	$8,000
SUBTOTAL - PRINCIPAL SPILLWAY CONSTRUCTION				**$386,400**
SUBTOTAL - DAM CONSTRUCTION				**$3,666,793**
CLEARING RESERVOIR	AC	175	$1,000.00	$175,000
SUBTOTAL - DAM & RESERVOIR CONSTRUCTION				**$4,025,132**
ENGINEERING & CONTINGENCIES (35% DAM & RESERVOIR)				**$1,408,796**
TOTAL - DAM & RESERVOIR CONSTRUCTION				**$5,433,928**
CONFLICTS (RELOCATIONS):				
12.5 kV DISTRIBUTION LINE	LS	1	$30,000.00	$30,000
69 kV TRANSMISSION LINE	LS	1	$270,000.00	$270,000
CLOSE COUNTY ROADS 182 & 182A	LS	1	$150,000.00	$150,000

Table 3.4.3-4.
Cost Estimate — Brushy Creek Reservoir @ Elevation 380.5 ft-msl
(page 2 of 2)

	UNIT	QUANTITY	UNIT COST	COST
WATER LINES	LS	1	$80,000.00	$80,000
TXDOT HIGHWAY 147	LS	1	$2,500,000.00	$2,500,000
SUBTOTAL - CONFLICTS				**$3,030,000**
ENGINEERING & CONTINGENCIES (35% CONFLICTS)				**$1,060,500**
LAND PURCHASE COSTS	AC	1,812	2,009	**$3,640,308**
ENVIRONMENTAL STUDIES & MITIGATION COSTS (100% LAND COSTS)				**$3,640,308**
CONSTRUCTION TOTAL				**$16,805,044**
INTEREST DURING CONSTRUCTION				**$1,608,625**
TOTAL COST				**$18,413,669**
ANNUAL COSTS				
DEBT SERVICE (6% FOR 40 YEARS)				**$1,223,801**
OPERATION & MAINTENANCE (1.5% OF DAM & SPILLWAY COSTS)				**$60,377**
TOTAL ANNUAL COSTS				**$1,284,178**
FIRM YIELD (ACRE-FEET PER ANNUM)				**1,380**
UNIT COST: CITY SHARE (52%) & NRCS SHARE (48%)				
UNIT COST OF WATER With NRCS floodwater component				
PER ACRE-FOOT				**$931**
PER 1,000 GALLONS				**$2.86**
UNIT COST OF WATER Without NRCS floodwater component (City's Share)				
PER ACRE-FOOT				**$484**
PER 1,000 GALLONS				**$1.48**

Units: AC = Acre; CY = Cubic Yard; EA = Each; LB = Pound; LF = Linear Foot; LS = Lump Sum; SF = Square Foot; and SY = Square Yard.

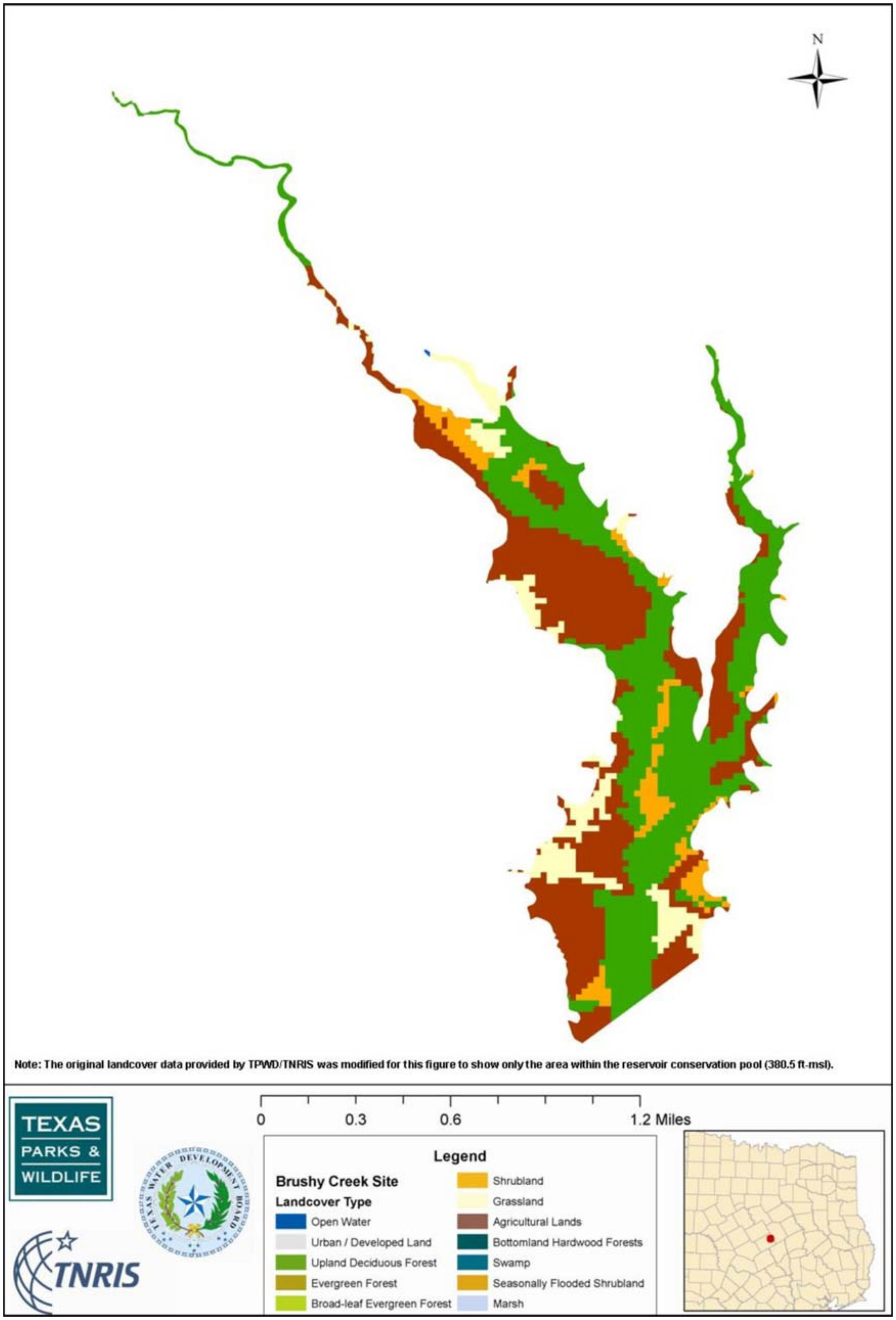

Figure 3.4.3-6. Existing Landcover for Brushy Creek Reservoir

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3.4.4 Cedar Ridge Reservoir (Breckenridge Reservoir)

3.4.4.1 Project Description

The Cedar Ridge Reservoir site, also referred to in past plans as the Breckenridge or Reynolds Bend site, is located in Throckmorton County on the Clear Fork of the Brazos River. This reservoir was first studied in 1971 and most recently in 2004 by HDR Engineering (HDR, September 2004). The location of this reservoir site differs from the locations in previous reports. A location upstream of the confluence of Paint Creek has been selected in order to minimize conflicts with historic structures in the area as well as to improve water quality by excluding flows from Paint Creek. The selected dam site is located about 5 miles upstream of Paint Creek on the west side of the hill known as Cedar Ridge and is about 50 miles north of the City of Abilene, as shown in Figure 3.4.4-1. The proposed reservoir will impound 310,383 acft and inundate 6,190 acres at the full conservation storage level of 1,430 ft-msl.

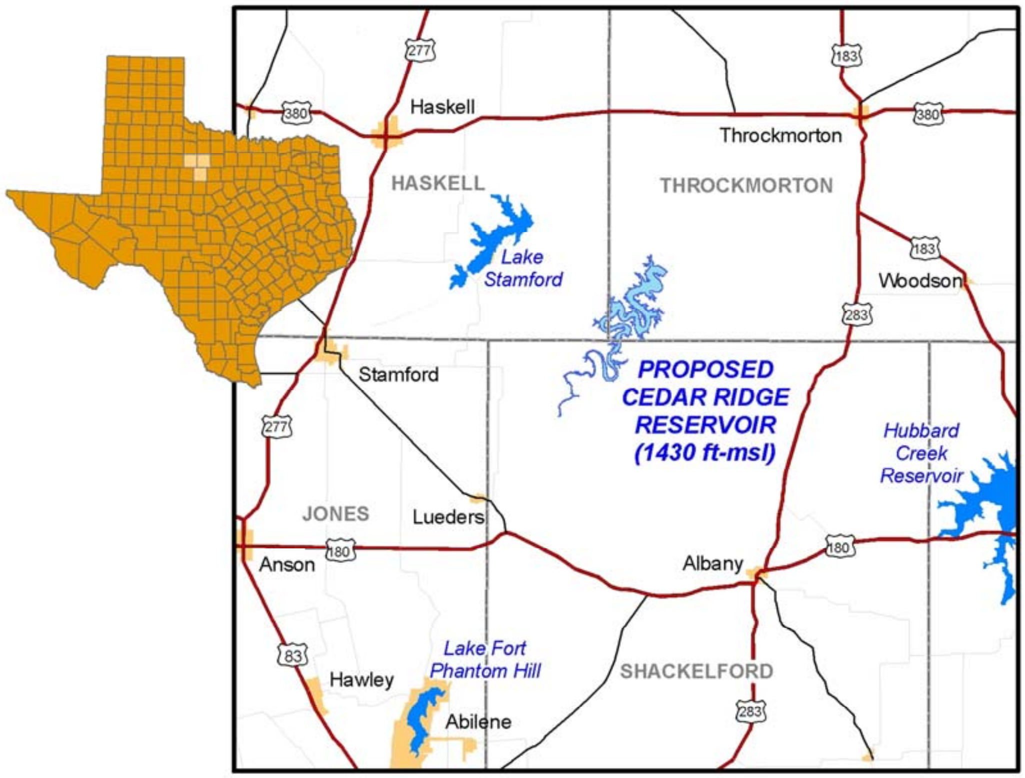

Figure 3.4.4-1. Location Map of Cedar Ridge Reservoir

With the establishment of regional water planning as part of the process for updating the State Water Plan (pursuant to Senate Bill 1 of the 75th Texas Legislature), Cedar Ridge Reservoir was identified as a potentially feasible project in the 2001 Brazos G Regional Water Plan. In the 2006 Brazos G Water Plan (approved by the TWDB on April 18, 2006), Cedar Ridge Reservoir is a recommended water management strategy to meet projected needs for the City of Abilene, the West Central Texas Municipal Water District, and irrigated agriculture in Throckmorton County. The 2007 State Water Plan (TWDB, 2007) recommends Cedar Ridge Reservoir be designated as a unique reservoir site by the legislature. Projected municipal, industrial (including manufacturing), and steam-electric needs for additional water supply in 2060 total 17,240 acft/yr for counties within a 50-mile radius of the Cedar Ridge Reservoir site. The nearest major population and water demand centers to the Cedar Ridge Reservoir site are Dallas / Fort Worth (146 miles) and Austin (211 miles).

3.4.4.2 Reservoir Yield Analyses

The elevation-area-capacity relationship for Cedar Ridge Reservoir is presented in Figure 3.4.4-2 and in Table 3.4.4-1 and was developed from 10-ft contour, digital hypsography data from the Texas Natural Resources Information System (TNRIS). These data are derived from the 1:24,000-Scale (7.5-minute) quadrangle maps developed by the USGS. The total area inundated at each 10-ft elevation contour is shown in Figure 3.4.4-3. At the conservation storage pool elevation of 1,430 ft-msl, Cedar Ridge Reservoir would inundate 6,190 acres and have a capacity of 310,383 acft.

Table 3.4.4-1.
Elevation-Area-Capacity Relationship for Cedar Ridge Reservoir

Elevation (feet)	Area (acres)	Capacity (acft)
1,290	0	0
1,300	97	548
1,320	455	5,626
1,340	1,202	21,599
1,360	1,927	52,605
1,380	2,710	98,753
1,390	3,209	128,311
1,400	3,772	163,178
1,410	4,482	204,399
1,420	5,274	253,125
1,430	6,190	310,383
1,440	7,294	377,727
1,460	10,066	550,585

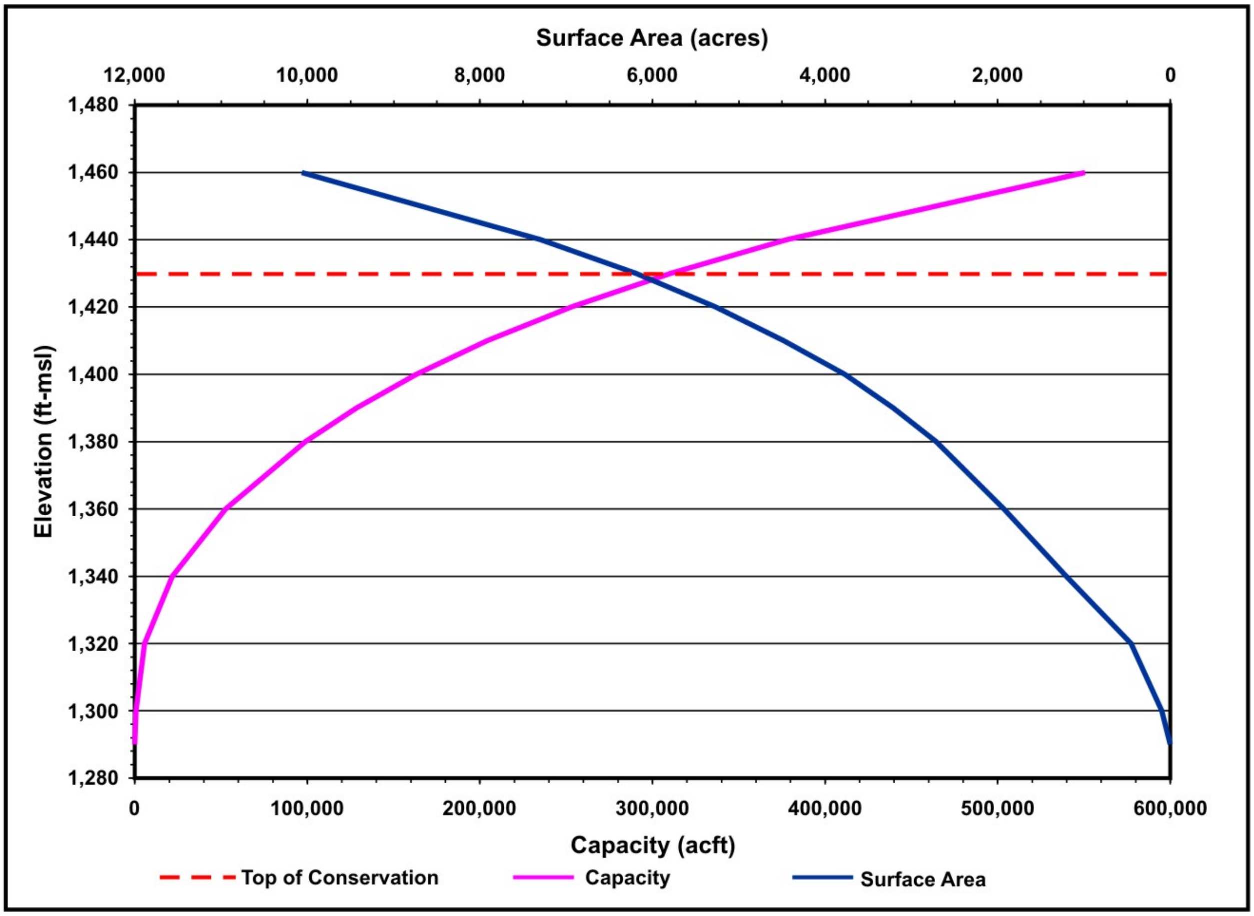

Figure 3.4.4-2. Elevation-Area-Capacity Relationship for Cedar Ridge Reservoir

Median and quartile (25th percentile) streamflows have been calculated for the Cedar Ridge site based on monthly naturalized flows from the Brazos WAM. These monthly naturalized flows were then disaggregated to daily naturalized flows using historical records of the USGS streamflow gaging station on the Clear Fork near Nugent. For each month, daily flows are ranked with median and quartile flows then extracted. The natural median and quartile flows for the Cedar Ridge site are presented in Table 3.4.4-2.

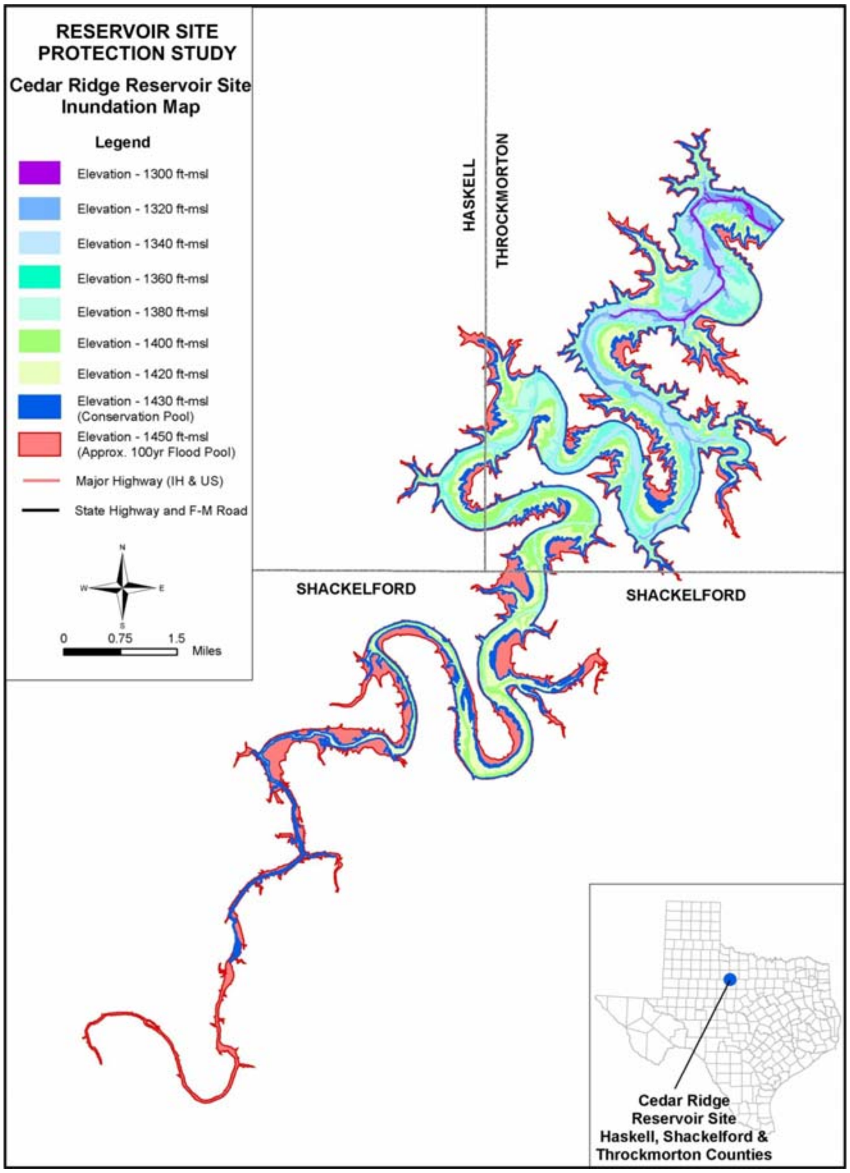

Figure 3.4.4-3. Inundation Map for Cedar Ridge Reservoir

Table 3.4.4-2.
Consensus Criteria for Environmental Flow Needs for Cedar Ridge Reservoir

	JAN	*FEB*	*MAR*	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*
Median (cfs)	24.6	30.0	34.6	37.2	54.0	53.7	21.3	13.0	21.3	24.1	18.5	16.7
Median (acft/mo)	1,510	1,664	2,125	2,212	3,322	3,192	1,311	799	1,269	1,482	1,099	1,024
Quartile (cfs)	13.5	14.7	17.3	12.8	12.6	16.8	2.7	1.5	1.5	3.8	4.1	7.0
Quartile (acft/mo)	829	815	1,065	760	772	1,000	168	74	57	236	246	432
7Q2 (cfs)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
7Q2 (acft/mo)	92	83	92	89	92	89	92	92	89	92	89	92
Note: The 7Q2 value is used when the 7Q2 value exceeds the value of the median and/or quartile.												